Identifying high-risk patients undergoing urgent and emergency surgery

WD NEARY, C FOY, BP HEATHER, JJ EARNSHAW

Gloucestershire Vascular Group, Gloucestershire Royal Hospital, Gloucester, UK

ABSTRACT

INTRODUCTION The aim was to identify high-risk patients undergoing non-elective orthopaedic and general surgery.

PATIENTS AND METHODS This was a retrospective cohort study of all non-elective general and orthopaedic surgical procedures performed in a 1-year interval in a district general hospital. A total of 1869 patients underwent urgent or emergency surgery in the calendar year 2000. Outcomes were identified from various related hospital databases. Case notes of those who died were reviewed. Risk factors for mortality were examined using univariate and multivariate analysis.

RESULTS The mortality rates were 89/1869 (5%) at 30 days and 216 (12%) after 1 year. The high initial death rate continued for about 100 days after surgery. Increasing age ($P < 0.0001$), size of operation ($P = 0.004$) and American Society of Anesthesiologists (ASA) fitness grade ($P < 0.0001$) were associated with significantly higher risk of death at 1 year on multivariate analysis. A high risk group was identified of 273 patients aged over 50 years, of ASA Grade III or above who needed major surgery; they had a 30-day mortality rate of 18%.

CONCLUSIONS A simple scoring system could be used to identify high-risk patients who require non-elective surgery that could be a target for interventions to try and reduce their risk of death.

KEYWORDS

Emergency – High-risk patients – Non-elective surgery – Scoring system

CORRESPONDENCE TO

Mr JJ Earnshaw, Department of Vascular Surgery, Gloucestershire Royal Hospital, Great Western Road, Gloucester GL1 3NN, UK
T: +44 (0)8454 226190; F: +44 (0)1452 790100; E: jjeearnshaw@tiscali.co.uk

Whereas the outcomes from planned elective surgery are well documented, there is little published material describing the results of urgent and emergency surgery where it is generally believed that morbidity and mortality rates are higher. Series that describe emergency operating often highlight differences in outcome in specific patient groups such as the elderly,^{1–4} or after a single type of procedure,⁵ but seldom look at overall results. Identification of high-risk patients could be used to focus resources and interventions towards non-elective procedures.

The excess mortality associated with non-elective surgery is recognised by most surgical-risk scoring systems. The American Society of Anesthesiologists (ASA) score includes a prefix to denote emergency work.⁶ The Physiological and Operative Severity Score for the enUmeration of Morbidity and mortality (POSSUM) also recognises the risks of emergency surgery and creates a score that predicts death and complications.^{7,8} The Acute Physiology And Chronic Health Evaluation (APACHE) scoring system also predicts a greater risk of death if the mode of admission is not elective.^{9,10}

The National Confidential Enquiry into Perioperative Death (NCEPOD) has published an annual report since 1990 that samples case notes of patients who die after surgery, and makes recommendations on optimal surgical practice.^{11,12} Due to their excess mortality, non-elective procedures are more often highlighted than elective operations. This valuable process highlights defects in care; however, by examining only patients who have died, the process is limited. Much may be learned from survivors, with and without complications. The results of NCEPOD suggest that out-of-hours operating should be avoided because of the higher rate of complications;¹¹ however, in some patients, further delay could increase their mortality rate.¹⁵ Operating at night on patients who cannot be resuscitated further is also high risk, partly because of the physiological state of the patient, but also the fact that their treatment cannot be postponed.¹⁴

The aim of this study was to review all non-elective general surgical procedures in a district general hospital in the year 2000. Clinical details of the patients and their surgical procedures were obtained from the hospital computer

Figure 1 (a) Age profile of 857 patients who had non-elective general surgery procedures during 2000. (b) Age profile of 1012 patients who had non-elective orthopaedic surgery procedures during 2000.

information resources, and then related to both 30-day and 1-year mortality rates. The aim was to identify patient sub-groups at highest risk of death and complications.

Patients and Methods

The operating theatre Patient Administration System (PAS) database was interrogated to identify all operations commenced outside standard operating theatre sessions (9 am to 5.30 pm, Monday to Friday), and on emergency or trauma lists in the calendar year 2000. Using the database, it was possible to identify patients who had their surgery on an emergency list and also those operated on an elective list, but added as urgent on the day of their operation. These data were confirmed manually from written operating theatre records. Verification and additional clinical data were retrieved from departmental databases. General surgery and urology patients had individual data retained on a bespoke database, Auditbase™. For orthopaedic procedures, the operative diagnosis was compared with the discharge diagnosis on the hospital PAS system. The BUPA classification of the severity of the operation and 30-day morbidity and mortality were collected from these databases. Hospital case notes were reviewed to verify morbidity and mortality rates and to determine the cause. Long-term survival data were obtained through the Office of Population Census and Survey (OPCS) hospital system. One year after their emergency admission, the database was searched, and the case notes of all patients from the original cohort who were no longer alive were reviewed. Causes and time of death were recorded from death certificates and hospital notes.

During the period of the study, a CEPD emergency theatre was available morning and afternoon during the week. A second trauma theatre was available for emergency procedures. At

night and weekends, only a single combined emergency theatre was available. The procedures described in this study were largely carried out in one of these two theatres. All other surgical emergencies were accommodated in one of these theatres, except obstetrics and gynaecology which had their own facility and were not part of this review. Patients who had operations in these theatres were almost all admitted to hospital as an emergency; some required urgent intervention, but many had a considerable delay from admission to operation whilst their medical condition was optimised. Orthopaedic patients sometimes waited several days before their procedures were scheduled.

Statistical analysis was done initially by univariate and multivariate analysis, with Kaplan-Meier evaluation of survival rates with the log-rank test and Cox proportional hazards regression. A *P* value of less than 0.05 was considered significant.

Results

Patient details

Over the year, 1911 non-elective operations were performed. The vast majority of these were orthopaedic and trauma (1012) or general surgical/urological (857) procedures. Other specialties used the emergency lists less often, including ear, nose and throat and maxillofacial surgeons. Emergency tracheostomy was usually performed by percutaneous dilation in intensive care. Other infrequent users were the cardiology team although, at the time of this review, cardioversions in unstable patients were usually performed in the accident and emergency department. The analysis was confined to the 1869 patients who had general surgery or orthopaedic procedures.

The 1869 patients who had general or orthopaedic surgery included 975 men and 894 women; the male:female

Figure 2 ASA distribution of patients who had non-elective general or orthopaedic surgical procedures during 2000.

ratio of the entire patient group was 52:48. The proportion of men was higher in general surgery (54:46) than in orthopaedic patients (49.5:50.5). The age distribution of all non-elective patients was bimodal; this was more marked in trauma and orthopaedics than general surgery patients (Fig. 1). The bimodal age distribution in orthopaedics and trauma reflected the different presentation of men and women. Young men contributed most to the early peak whilst elderly female patients contributed to the second peak in age distribution. In general surgery, both men and women had an equal bimodal age distribution at presentation.

The majority of patients undergoing non-elective surgery were ASA grades 1 and 2 (Fig. 2). Although a greater proportion of orthopaedic and trauma patients were ASA-1, this did not reach statistical significance. The BUPA classification of all procedures is shown in Table 1. The majority of procedures in general surgery were in the intermediate

Table 1 BUPA classification of non-elective general and orthopaedic surgery procedures done during 2000

	Minor	Inter- mediate	Major and complex major	Total
Gastrointestinal	11	55	482	548
Vascular	2	10	61	73
Superficial				
general surgery	138	10	4	149
Urological	20	56	11	87
Orthopaedic	391	305	316	1012

category and gastrointestinal procedures predominated. Not surprisingly, superficial general surgery, often abscess drainage, was usually a minor procedure. None of the orthopaedic procedures was classified as complex major.

Clinical outcomes at 30 days and 1 year

The 30-day mortality in the 1869 patients who underwent non-elective surgery in Gloucester in 2000 was 89 (5%). A further 127 patients died within 12 months giving a mortality rate of 216/1869 (12%) at 1 year. The leading causes of death were malignant disease, sepsis (including chest infections) and cardiac complications (Fig. 3). Infrequent causes of death were perforated viscus (non-cancer; 7), haemorrhage (6) and thrombo-embolic causes (5). Multi-organ failure was reported on only a single death certificate in 1 year; deaths from renal failure and stroke were also rare. The causes of death were similar in proportion, regardless of the time after operation. The high initial death rate continued well beyond 30 days and the rate only began to reduce after about 100 days (Fig. 4).

Figure 3 Causes of death after 30 days and from 30 days to 1 year following non-elective general or orthopaedic surgery in 2000.

Factors affecting outcome at 30 days

On univariate analysis, patient age had the expected association with mortality, both after 30 days and 1 year. There were only 8 deaths in the series in patients under 50 years old (Table 2). Mortality increased with increasing age ($P < 0.001$, Chi-squared for trend). Multivariate analysis showed age to be a highly significant risk factor for death after 1 year with a hazard ratio of 1.056 (95% confidence interval [CI] 1.044–1.068) per extra year of life ($P < 0.0001$). For every extra year of age, the odds of dying increased by

5.6%. The 30-day mortality rate was significantly higher in women 57/894 (6.4%) than in men 32/975 (3.3%) on univariate analysis. However, this result disappeared on multivariate analysis, the effect being due to the excess number of elderly female patients.

The 30-day mortality rate rose with increased procedure severity (Table 3). Multivariate analysis of overall survival showed a hazard ratio of 1.34 (95% CI 1.10–1.64) for each step up the BUPA operation scale ($P = 0.004$). The 30-day mortality also rose significantly with increasing ASA grade (Table 3). Multivariate analysis showed ASA to be a highly significant risk factor for death after 1 year, with a hazard ratio of 2.04 (95% CI 1.69–2.47) for each step up the ASA grade ($P < 0.0001$); the odds of death doubled for each increase in ASA grade.

The highest grade of surgeon and anaesthetist present during the operation is shown in Table 4. Overall, operations done by senior surgeons and anaesthetists had higher 30-day mortality rates. This trend continued for up to 1 year, but multivariate analysis showed that the grade of surgeon and anaesthetist did not contribute significantly to outcome ($P = 0.82$ surgeon; $P = 0.14$ anaesthetist). The apparent difference came from senior staff operating on older patients who needed bigger operations.

Discussion

This retrospective audit confirmed that non-elective surgery had the expected high mortality rate. The study examined a large number of unselected patients treated as an

Table 2 The 30-day and 1-year mortality rates related to age at operation in patients who had non-elective general or orthopaedic surgery during 2000

Age (years)	No. of operations (n)	30-day deaths (n)	1-year deaths (n)	30-day mortality	1-year mortality
0–33	693	0	0	0.00	0.00
34–39	96	0	2	0.00	0.02
40–44	79	0	1	0.00	0.01
45–49	57	2	5	0.04	0.09
50–54	88	2	2	0.02	0.02
55–59	83	0	2	0.00	0.02
60–64	79	3	11	0.04	0.14
65–69	108	8	16	0.07	0.15
70–74	120	11	30	0.09	0.25
75–79	138	13	34	0.09	0.25
80–84	148	22	49	0.15	0.33
85–89	112	12	34	0.11	0.30
90–94	52	11	22	0.21	0.42
95–100+	16	5	8	0.31	0.50

Table 3 The 30-day mortality after non-elective surgery related to patient and operative variables

	General and urological surgery (<i>n</i> = 857)	Orthopaedic surgery (<i>n</i> = 1012)
> 50 years old	49/427 (11)	38/515 (0.07)
< 50 years old	2/413	0/497
ASA I	0/374	0/493
ASA II	10/223 (0.04)	11/311 (0.04)
ASA III	16/151 (0.11)	24/174 (0.13)
ASA IV	17/54 (0.31)	3/11 (0.27)
ASA V	3/4 (0.75)	0
Minor or intermediate operations	13/299 (0.04)	8/696 (0.01)
Major or complex major operations	38/558 (0.07)	30/316 (0.09)
> 50, ASA > III, Major	26/149 (17)	23/124 (0.18)

Figures in parentheses are percentages.

emergency in a large district general hospital. The novel part was to continue follow-up out to 1 year. Conventional mortality rates following surgery are reported at 30 days, or hospital discharge, because most deaths attributable to surgical complications should have occurred by then. It was a

surprise, therefore, that deaths continued to occur throughout the year of follow-up, and only started to plateau about 100 days postoperatively. Indeed over half the total deaths in the year occurred later than 30 days after surgery. This difference from elective surgery presumably reflects the underlying disease processes in this group of patients.

The two main causes of death in these patients were malignancy and infection, with cardiac complications in third. It would be expected that the late deaths would be more likely to be due to malignancy, but in fact the proportions of each of these causes remained constant before and after 30 days. Other causes of death such as thromboembolic disease were relatively rare, perhaps attesting to the hospital programme of antithrombotic prophylaxis.

In studying ways to reduce the peri-operative mortality rate, we have focused on an examination of factors associated with death at 30 days, since the important variables here could possibly be influenced by intervention. Several factors were shown to be related to 30-day mortality rates. Age was an important risk factor, although it was affected by the type of procedure required. The excess mortality in female orthopaedic patients was mostly due to the asymmetry of the sex and age distribution. Most male orthopaedic patients were young and fit, whereas many of the women were elderly and infirm. Death was very rare in patients under 50 years old. There was also a clear association between ASA grade and mortality; in terms of absolute numbers, ASA grade III patients produced the highest number of deaths. There were fewer patients in the categories ASA IV and V, though this group also had high mortality rates. Previous studies have demonstrated poor specificity using ASA grade because clinicians tend to group a large number of patients in ASA grade III, with a moderate risk of operative complications.⁶ ASA is a relatively simple grading system that is widely used and can easily be gathered for all patients undergoing emergency procedures.

Complex scoring systems such as POSSUM and APACHE are not ideal when used to score outcomes retrospectively. In the present review, it was possible to identify a high-risk group of patients using simple criteria. Patients over 50 years of age who were ASA III or above and who needed major surgery had a peri-operative mortality rate of 18%. The recommendations of NCEPOD apply especially to this group;^{11,12} the question remains whether any intervention in this high-risk group could reduce the peri-operative mortality rate. It is difficult to see how death associated with malignancy could be reduced easily, as it is often the underlying advance condition that proves fatal. Likewise, infection is often the final result of major surgery in a compromised patient, and reducing death from sepsis may be difficult. Routine antibiotic prophylaxis and intensive chest physiotherapy in high-risk groups may bring some benefit, but the exact roles of these factors could not be established

Table 4 Outcome at 30 days and 1 year after non-elective general or orthopaedic surgery related to grade of surgeon and anaesthetist

	Operations (<i>n</i>)	30-day mortality	1-year mortality
Surgical grade			
Consultant	482	34 (0.07)	71 (0.15)
Non-training grade	464	16 (0.03)	42 (0.09)
SpR	702	35 (0.05)	89 (0.13)
BST	151	2 (0.01)	6 (0.04)
Unknown	70	2 (0.03)	8 (0.12)
Anaesthetic grade			
Consultant	586	38 (0.07)	95 (0.16)
Clinical assistant	670	26 (0.04)	55 (0.08)
SpR	335	11 (0.03)	30 (0.09)
BST	184	10 (0.05)	23 (0.13)
Unknown	94	4 (0.04)	13 (0.14)

in a retrospective study. Death related to cardiac complications is a potential area to reduce mortality, as cardiac disease is usually a co-morbidity and not directly related to the need for surgery in this group of patients.

Potential strategies for reducing cardiac morbidity have included identifying high-risk patients and then intervening, either by improving cardiac function (coronary angioplasty or bypass) or by pharmacotherapy. In elective patients, there is time for non-invasive testing of cardiac function, followed by assessment and intervention. This strategy has been shown to reduce the rate of cardiac complications in major surgery.¹⁵ There is no time for formal assessment in patients who require emergency operation.

Medical prophylaxis may be appropriate for this high-risk group. Simple possibilities include routine supplementary oxygen to reduce hypoxia and β -blockade to reduce cardiac oxygen demand. A number of studies have shown that β -blockade reduces cardiac complications in elective major surgery.^{16–18} The question arises whether β -blockade could be effective in emergency surgery, especially in high-risk patients.

Conclusions

Non-elective surgery is high-risk, and that the risk continues well beyond the conventional 30-day assessment. It may be necessary to review outcome recording after emergency surgery. The findings of NCEPOD, that early death was likely to be due to surgical complications whilst later death was due to co-morbidity, was not supported. The cause of death was similar for both early and late deaths. A high-risk group was identified using this simple retrospective analysis. Patients over 50 years of age who require major urgent or emergency surgery and have co-morbid conditions that render them ASA grade III could be a target for intervention to try to reduce the peri-operative mortality rate. One potential is to see whether β -blockade could reduce the rate of cardiac complications in this group.

References

1. Trembl J, Kroker PB. Orthopaedic surgery in the elderly. *Hosp Med* 2000; **61**: 417–9.
2. Cook TM, Britton DC, Craft TM, Jones CB, Horrocks M. An audit of hospital mortality after urgent and emergency surgery in the elderly. *Ann R Coll Surg Engl* 1997; **79**: 361–7.
3. McIntyre R, Reinbach D, Cuschieri RJ. Emergency abdominal surgery in the elderly. *J R Coll Surg Edinb* 1997; **42**: 173–8.
4. Ngian KS, Nambiar R. Major surgery in the elderly – a study of outcome in 295 consecutive cases. *Singapore Med J* 1989; **30**: 339–42.
5. Ascanelli S, Navarra G, Tonini G, Feo C, Zerbinati A, Pozza E *et al*. Early and late outcome after surgery for colorectal cancer: elective versus emergency surgery. *Tumori* 2003; **89**: 36–41.
6. Saklad M. Grading of patients for surgical procedures. *Anesthesiology* 1941; **2**: 281–4.
7. Copeland G, Jones D, Walters M. POSSUM: a scoring system for surgical audit. *Br J Surg* 1991; **78**: 356–60.
8. Neary WD, Heather BP, Earnshaw JJ. The Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity. *Br J Surg* 2003; **90**: 157–65.
9. Knaus W, Wagner D, Draper E. The APACHE III prognostic system. Risk prediction of hospital mortality for critically ill hospitalized adults. *Chest* 1991; **100**: 1619–36.
10. Schein M, Gecelter G, Freinkel Z, Gerding H. APACHE II in emergency operations for perforated ulcers. *Am J Surg* 1990; **159**: 309–13.
11. NCEPOD. *Changing the way we operate. The 2001 Report of the National Confidential Enquiry into Perioperative Deaths*. London: NCEPOD, 2001.
12. NCEPOD. *Working as a team. The 2002 Report of the National Confidential Enquiry into Perioperative Deaths*. London: NCEPOD, 2002.
13. Copeland GP. The POSSUM system of surgical audit. *Arch Surg* 2002; **137**: 15–9.
14. Copeland GP. Assessing the surgeon: 10 years' experience with the POSSUM system. *Clin Excellence* 2000; **2**: 187–90.
15. Goldman L, Caldera DL, Southwick FS, Nussbaum SR, Murray B, O'Malley TA *et al*. Cardiac risk factors and complications in non-cardiac surgery. *Medicine (Baltimore)* 1978; **57**: 357–70.
16. Mangano DT, Layug EL, Wallace A, Tateo I. Effect of atenolol on mortality and cardiovascular morbidity after noncardiac surgery. Multicenter Study of Perioperative Ischemia Research Group. *N Engl J Med* 1996; **335**: 1713–20.
17. Poldermans D, Boersma E, Bax JJ, Thomson IR, Paelinck B, van de Ven LL *et al*. Bisoprolol reduces cardiac death and myocardial infarction in high-risk patients as long as 2 years after successful major vascular surgery. *Eur Heart J* 2001; **22**: 1353–8.
18. Poldermans D, Boersma E, Bax JJ, Thomson IR, van de Ven LL, Blankensteijn JD *et al*. The effect of bisoprolol on perioperative mortality and myocardial infarction in high-risk patients undergoing vascular surgery. Dutch Echocardiographic Cardiac Risk Evaluation Applying Stress Echocardiography Study Group. *N Engl J Med* 1999; **341**: 1789–94.