Ann R Coll Surg Engl 1997; 79: 361–367

An audit of hospital mortality after urgent and emergency surgery in the elderly

T M Cook FRCA
Specialist Registrar in Anaesthesia

D C Britton FRCS
Consultant Surgeon

T M Craft FRCA
Consultant Anaesthetist

C B Jones FRCS
Consultant Orthopaedic Surgeon

M Horrocks FRCS
Professor of Surgery

Royal United Hospital, Bath

Key words: Elderly; Mortality; Postoperative; Surgery

An audit was carried out of 102 patients aged over 75 years undergoing urgent or emergency surgery in a district general hospital. The risk of death in hospital after general surgery (13 deaths in 49 patients) was greater than after orthopaedic surgery (two deaths in 53 patients) ($P < 0.05$). In particular, laparotomy carried a high in-hospital mortality: 12 of 25 patients undergoing laparotomy died. Risk of death after general surgery increased with increasing preoperative ASA class, increasing medical risk factors and duration of operation. Orthopaedic cases were fitter than the general surgical cases as determined by ASA class and the number of medical risk factors.

NCEPOD has recommended increased involvement of senior medical staff in operations, reduced night-time operating and avoidance of futile surgery. A high proportion of cases were operated on and anaesthetised by higher specialist trainees and consultants. Death rate was not affected by the seniority of doctors involved, nor by the time of day the operation took place. General surgical deaths were predictable postoperatively in most cases, but preoperative prediction of outcome was not specific enough to alter management.

Emergency surgery is associated with a higher mortality than elective surgery *(1)*. The Reports of the National Confidential Enquiry into Perioperative Deaths (NCEPOD) *(2–4)* have recommended that night-time urgent and emergency surgery should be avoided whenever possible and that senior medical staff should be involved in perioperative care. NCEPOD cautions against attempting futile heroic surgery.

In contrast to elective surgery, when planning unscheduled surgery there may be insufficient time to assess the patient and to improve fitness for surgery. The underlying pathological process may prevent physiological improvement. An ability to predict which patients will not survive surgery would assist in the frequently difficult decision of when to operate and when not to.

This study examines the in-hospital mortality of a cohort of elderly patients requiring urgent and emergency surgery at a district general hospital. It examines whether the recommendations of NCEPOD are followed and attempts to determine to what degree deaths in this group are predictable.

Method

A prospective evaluation of a consecutive series of patients aged 75 years or older undergoing surgery classified by NCEPOD as 'urgent' or 'emergency' (Fig. 1) was carried out over a period of 5 months. All patients listed for surgery on the hospital's trauma list or dedicated emergency list were considered. All unplanned additions to elective operating lists were also considered. Only those patients whose operations satisfied the definitions of 'urgent' or 'emergency' were audited. If a patient had more than one such operation during their admission only the first was considered.

Correspondence to: Dr T M Cook, 12 Sunningdale, Bristol BS8 2NF

Emergency

Immediate life saving operation, resuscitation simultaneous with surgical treatment. Operation usually within one hour.

Urgent

Operation as soon as possible after resuscitation. Operation within 24 hours.

Scheduled

An early operation, but not immediately life-saving. Operation usually within 3 weeks.

Elective

Operation at a time to suit both patient and surgeon.

Figure 1. NCEPOD classification of urgency of operation.

A questionnaire (Fig. 2) was completed for each patient by the senior anaesthetist present. This documented the preoperative ASA (American Society of Anesthesiologists) physical status class accorded to the patient by the anaesthetist (Fig. 3), preoperative risk factors, operative and anaesthetic details.

For analysis, consultants and higher specialist trainees were regarded as 'senior' staff, other grades as 'junior'. This is not to imply that higher specialist trainees have the same competence as consultants but to determine if patients were being treated by inappropriately junior trainees. Operations were classified as minor, intermediate or major according to the BUPA schedule of procedures.

Date.............Patient name...............................Consultant....................
Reg number.......................Age.................Ward............
Time.......0800-1700 /1701-2200/2201-0800

PRE-OPERATIVE ASSESSMENT
Indication............................ Grade of surgeon......................
Grade of anaesthetist.................... Immediate pre-op ASA.............

Do you think the patient will leave hospital alive?	Yes/No
Does the surgeon?	Yes/No
Was the patient adequately resuscitated pre-operatively	Yes/No

PRE-OPERATIVE RISK FACTORS

poor general condition	Y/N	hypertension	Y/N
dehydration/hypovolaemia	Y/N	heart failure	Y/N
electrolyte disturbance	Y/N	valvular disease	Y/N
[state..................]		IHD	Y/N
anaemia[Hb<10]	Y/N		
malnutrition	Y/N	non-sinus ECG	Y/N
marked obesity	Y/N	other significant ECG abnormality [state..................]	Y/N
septicaemia	Y/N		
diabetes	Y/N	acute respiratory disease	Y/N
		chronic respiratory disease	Y/N
dementia or confusion	Y/N		
		raised creatinine or urea	Y/N
		acute renal failure	Y/N
too sick for above to be determined	Y/N		
other [state..............................]	Y/N		

ANAESTHETIC MANAGEMENT
GA / GA+Regional/ Regional
Invasive monitoring (IABP / CVP / PAWP) Y/N

POST-OPERATIVE MANAGEMENT
Operation performed.. Duration..................

Did the patient spend enough time in recovery?	Y/N
Was the patient sent to ICU?	Y/N
Would you have sent the patient to ICU if not for age?	Y/N
Would you have sent the patient to ICU but ICU full?	Y/N
Do you think the patient will leave hospital alive?	Y/N
Does the surgeon?	Y/N

Figure 2. Questionnaire.

Class 1

No organic, physiological, biochemical or psychiatric disturbance. The pathological process for which the operation is to be performed is localised and does not entail a systemic disturbance.

Class 2

Mild to moderate systemic disturbance caused either by the condition to be treated surgically or by other pathophysiological processes.

Class 3

Severe systemic disturbance or disease of whatever cause, even though it may not be possible to define the degree of disability with finality.

Class 4

Severe systemic disorders that are already life threatening, not always correctable by operation.

Class 5

The moribund patient who has little chance of survival but is submitted to operation in desperation. Most of these patients require operation as a resuscitative measure with little if any anaesthesia.

Figure 3. American Society of Anesthesiology (ASA) classification of physical status (abridged).

A risk score was calculated by adding, without weighting, the preoperative risk factors. The surgeon's and anaesthetist's opinion on outcome was recorded before and immediately after surgery. Patients were followed up until they died or were discharged from hospital.

Differences between groups were determined with χ^2, Fisher, Mann–Whitney and *t* tests. A *P* value of 0.05 was considered to denote statistical significance.

Results

In all, 102 patients were audited: 49 undergoing general surgery and 53 orthopaedic surgery. There were 15 deaths. The mortality rate in the general surgical group (13 of 49) was significantly higher than in the orthopaedic group (2 of 53) (Fisher test $P=0.002$).

General surgery patients (Table I)

There were 49 patients in this group (age 75 to 95 years, median 83 years), of whom 13 died (overall mortality 27%). Differences in age between survivors (median 85 years) and patients who died (median 82 years) were not significant (unpaired *t* test, $P=0.5$). Mortality rate was higher in the very elderly, but this did not reach statistical significance. Major surgery was associated with an in-hospital mortality of 13 out of 31 (42%). Twenty-five patients underwent laparotomy, of whom 12 died (48%). The other death was a patient undergoing femorodistal bypass. Death was significantly more likely after laparotomy than after all other operations (Fisher, $P<0.005$). Fourteen operations were performed at night (after 2200); the proportion of deaths was not increased when operating at this time (χ^2, $P=0.2$).

Table I. Preoperative assessment

	General surgery		*Orthopaedic surgery survivors (deaths)*
	Deaths	*Survivors*	
Number of patients	13	36	51 (2)
Operation type			
Major	13	18	47 (1)
Intermediate	0	15	2
Minor	0	3	2 (1)
Laparotomy	12	13	—
Time of operation			
0800–1700	6	21	41 (2)
1701–2200	3	5	8
2201–0759	4	10	2
Age group (years)			
75–84	6	21	30 (1)
85–89	5	11	11
>90	2	4	10 (1)
Median age	85	82	83
ASA class			
5	6	0	0
4	5	3	2
3	2	19	17 (2)
2	0	12	29
1	0	2	3
Risk factor score			
Mean	6.5	3.2	2.7
Range	2–9	0–7	0–10

No patient accorded ASA class 5 left hospital alive (Fig. 3); 79% ASA class 4 patients died. No patient of ASA class 1 or 2 died. Patients who died had a higher ASA (mean 4.3) than those who survived (mean 2.6) (Mann–Whitney, $P < 0.001$).

Risk factor scores ranged from 0 to 9 (mean 4.0). Risk factor score was higher in the group that died (mean 6.2) than in those that survived (mean 3.2) (Mann–Whitney, $P < 0.001$).

Higher specialist trainees or consultants operated on 40 cases and anaesthetised 36 (Table II). A basic specialist trainee, only, was present in four cases, one of these involved major surgery. No basic surgical trainee operated on patients undergoing major surgery, who were aged over 85 years. Basic anaesthetic trainees managed patients undergoing major surgery, who were aged over 85 years or ASA 3–5 on eight occasions. Higher specialist trainees and consultants managed these high-risk groups more frequently than those younger, fitter and having more minor surgery. Mortality rate was unaffected by the seniority of surgeon or anaesthetist.

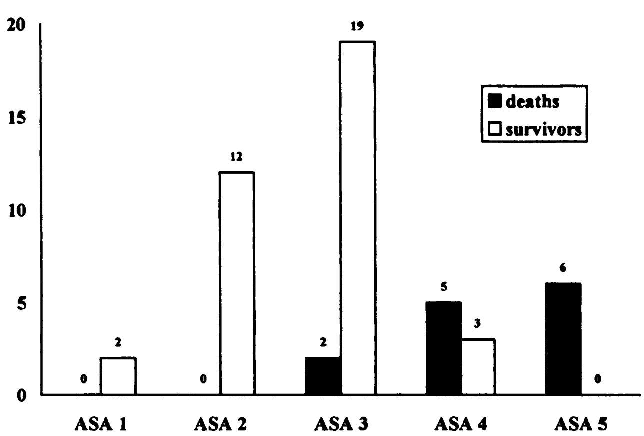

Figure 4. Outcome according to preoperative ASA classification (general surgical patients).

Eight patients, all after laparotomy, were sent to the intensive care unit (ICU); six died. No ICU bed was available on one occasion. Seven patients died without ICU admission (Table III). Death occurred within 6 h of surgery in six cases and within 2 days in all cases except one. Four of the six ASA class 5 patients died within 3 h of surgery.

Preoperatively, the anaesthetist predicted outcome correctly in 40 of the 49 cases (Table IV). Anaesthetists predicted in-hospital death correctly in eight of the 13 cases preoperatively (sensitivity 62%), and all 13 postoperatively (sensitivity 100%). The surgeon predicted the outcome correctly in 38 of 49 cases, predicted six of the deaths preoperatively (sensitivity 46%) and seven postoperatively (54%). Postoperatively, anaesthetists were significantly better than surgeons at predicting death correctly (Fisher, $P < 0.01$), but not preoperatively.

Orthopaedic patients

Of 53 patients (aged 75 to 103 years, median 83 years) two patients died (4%) (Table I). Forty-three patients underwent surgery for fractured femoral neck and five

Table II. Personnel involved in operation

	General surgery		
	Deaths (%)	*Survivors (%)*	*Orthopaedic surgery survivors (deaths)*
All patients	13	36	51 (2)
Seniority of staff in theatre			
Surgeon			
Higher specialist trainee or consultant	13 (100)	27 (75)	46 (1)
Basic specialist trainee	0 (0)	9 (25)	5 (1)
Anaesthetist			
Higher specialist trainee or consultant	11 (85)	25 (69)	37 (1)
Basic specialist trainee	2 (15)	11 (31)	14 (1)
Surgeon and anaesthetist both basic specialist trainees	0 (0)	4 (11)	0
High risk group A			
Major surgery and ASA 3–5 ($n=26$)			($n=21$)
Surgeon			
Higher specialist trainee or consultant	13 (100)	12 (92)	18 (1)
Basic specialist trainee	0 (0)	1 (8)	2 (0)
Anaesthetist			
Higher specialist trainee or consultant	11 (85)	8 (62)	19 (0)
Basic specialist trainee	2 (15)	5 (38)	1 (1)
Surgeon and anaesthetist both basic specialist trainees	0 (0)	0 (0)	0
High risk group B			
Major surgery and age >85 years ($n=14$)			($n=20$)
Surgeon			
Higher specialist trainee or consultant	7 (100)	7 (100)	17 (1)
Basic specialist trainee	0 (0)	0 (0)	2 (0)
Anaesthetist			
Higher specialist trainee or consultant	6 (86)	4 (57)	14 (0)
Basic specialist trainee	1 (14)	3 (43)	5 (1)
Surgeon and anaesthetist both basic specialist trainees	0 (0)	0 (0)	0 (0)

Table III. Operative management

	General surgery		
	Deaths	*Survivors*	*Orthopaedic surgery survivors (deaths)*
Type of anaesthesia			
General	6	24	29 (1)
Regional	1	2	8 (1)
Combined	6	10	14
Duration of surgery			
<1 h	1	11	18 (1)
1–2 h	2	17	22 (1)
>2 h	10	8	11
Invasive haemodynamic monitoring			
Used	12	4	0
Not used	1	32	51 (2)
Postoperative care			
Wards	7	34	51 (2)
ICU	6	2	0

patients had minor or intermediate operations. Two operations were performed at night and 37 between 0800 and 1700. No patient was considered ASA class 5. Risk factor scores ranged from 0 to 10 (mean 3.2). The patients who died were aged 79 and 91 years, both ASA class 3, one had minor and one major surgery. Both died 14 days after surgery.

Orthopaedic and general surgical patients were similar ages (unpaired t test, $P=0.1$). Orthopaedic patients had a more favourable ASA class (Mann–Whitney, $P=0.002$) and lower risk factor score (Mann–Whitney, $P=0.04$) than general surgical patients.

Higher specialist trainees and consultants operated on 47 cases and anaesthetised 38 (Table II). A higher

Table IV. Prediction of outcome

	General surgery		*Orthopaedic surgery*	
	Deaths	*Survivors*	*Deaths*	*Survivors*
Preoperative				
Anaesthetist				
Correct	8	32	0	49
Wrong	5	4	2	2
Surgeon				
Correct	6	32	0	48
Wrong	7	4	2	3
Postoperative				
Anaesthetist				
Correct	13	32	0	49
Wrong	0	4	2	2
Surgeon				
Correct	7	33	0	48
Wrong	6	3	2	3

General surgery
Anaesthetist: Preoperative positive predictive value (PPV) of death 8/12 = 67%, sensitivity 8/13 = 62%, specificity 4/36 = 11%
Postoperative PPV 13/17 = 76%, sensitivity 13/13 = 100%, specificity 4/36 = 11%
Surgeon: Preoperative positive predictive value (PPV) of death 6/10 = 60%, sensitivity 6/13 = 46%, specificity 4/36 = 11%
Postoperative PPV 7/10 = 70%, sensitivity 7/13 = 54%, specificity 3/36 = 8%

specialist trainee or a consultant was present in all cases. Basic surgical trainees operated in two cases of patients having major surgery classed as ASA 3–5, aged over 85 years. Basic anaesthetic trainees managed these patients in six cases.

The anaesthetist's preoperative prediction of patient outcome was correct in 49 of the 53 cases. Surgeons were correct in 48 of 53 cases (Table IV). These figures were unaltered postoperatively. Neither orthopaedic death was predicted by the anaesthetist or surgeon.

Discussion

This study examined operations that fell within the NCEPOD definitions 'urgent' and 'emergency'. These operations carry a considerably higher rate of complications and death than elective cases *(1)*. It should be noted when comparing our figures with those of NCEPOD that NCEPOD includes elective and scheduled procedures and the report for the years 1992–1993 excludes patients over 70 years of age.

Surgery in the elderly is more hazardous than in the young *(5)*, especially when it is urgent or an emergency *(1)*. As the elderly population increases, operative mortality might be reduced by appropriate screening and early intervention to prevent emergency presentations *(6)*. However, elderly patients are more likely to present with abdominal emergencies than the young *(6,7)* and many trauma cases cannot be prevented. For these reasons emergency procedures in the elderly are unlikely to decrease in the near future.

This study did not identify those patients who had surgically remediable conditions but, as they were considered too ill, did not undergo surgery. Those who were considered fit enough for laparotomy had an in-hospital mortality rate of 48%.

Twelve general surgical deaths occurred within 48 h of the operation and were likely to be related to underlying pathology, surgery and anaesthesia. The two orthopaedic deaths occurred 14 days after surgery and the link is less clear. Many factors differ between general surgical and orthopaedic emergencies. Orthopaedic operations are often restricted to limbs and entail less perioperative disruption of cardiorespiratory function, metabolic derangement and ileus. Orthopaedic patients had a more favourable ASA classification and risk factor score than surgical patients, indicating that they were fitter. Orthopaedic surgery was often 'urgent' rather than 'emergency' and could be deferred for patient preparation. As a result, the majority of unscheduled orthopaedic surgery took place on a regular daytime 'trauma list'. Despite the provision of a daytime emergency theatre many general surgical cases did not. In this hospital all orthopaedic patients having major surgery are nursed in a high care area for at least 12 h after surgery. It is not possible to determine from this study which, if any, of these factors were significant in affecting outcome.

General surgical patients undergoing major surgery had a high, early in-hospital mortality, particularly patients of ASA classes 3–5 and with multiple risk factors preoperatively. Long operations carried a high mortality and most who died did so despite full haemodynamic monitoring during surgery. Half of the patients who died went to intensive care postoperatively. These findings highlight the difficulty of surgery in this patient group and would seem to support the importance of preoperative assessment by senior doctors before proceeding to surgery, to balance the potential benefits against the considerable risk.

NCEPOD retrospectively examines a large cohort of fatal case histories. Its reports recommend avoiding night-time operations and that full support services should be available at all times *(3)*. In this small prospective study there was no association between operating at night and mortality. Theatre recovery rooms were always available and intensive care was available when required on all but one occasion.

NCEPOD and recent government-supported plans *(8)* recommend that senior staff should be involved with a greater proportion of emergency work than at present. Higher specialist trainees or consultants operated in over 80% of cases and anaesthetised in over 70%. In this study, the seriously ill and older patients undergoing major surgery were more likely to receive treatment from seniors which matches previous NCEPOD recommendations *(3)*. Mortality in general surgical and orthopaedic patients was not altered whether the patient was attended by a higher specialist trainee/consultant or a basic specialist trainee. Basic anaesthetic trainees treated elderly sick patients more often than basic surgical trainees operated and this was also reported in NCEPOD *(4)*. While more senior trainee anaesthetists are involved in the provision of maternity and intensive care services, a solution to this is difficult without an entirely consultant provided service.

The findings of this paper produced a change in the priority given to emergency surgery in this hospital. For historical reasons, over the years the greatest priority has been given to elective surgery to reduce waiting lists. The dilemma of whether to submit an elderly ill patient to surgery that may be life-saving, but is certainly life-threatening is common, and inevitably patients often opt for surgery despite the risks. It was evident from this prospective survey of a cohort of elderly sick patients that patients were being operated on out of hours and on occasions without the facilities (such as ICU) which might have improved their slim chances of survival. A change in emphasis has been instituted so that a complete surgical team is available during the day and night for a whole week for care of emergency cases. During this week all the elective surgery is cancelled for that team so that they can give full attention to emergency work. While we now consider this 'best practice' it had considerable resource implications.

High ASA class was associated with high in-hospital mortality. Only 31% of patients graded ASA 4–5 left hospital alive. Importantly, no patient in classes ASA 1 or 2 died. This supports the use of ASA class as one measure of the patient's overall preoperative condition. Because it is inconsistently applied, it cannot be regarded as a sole indicator of patient condition *(9)*. ASA classification relates to the severity of pathophysiology rather than its breadth. For this reason we also evaluated the breadth of comorbidity (risk factor score). Both increasing ASA class and increasing risk factor score were significantly associated with increasing mortality.

Avoiding futile operations requires identification of preoperative factors associated with a poor outcome. Preoperatively, neither surgeons nor anaesthetists were able to predict mortality with enough specificity to alter proceeding to surgery. Anaesthetic clinical judgement had a positive predictive value of 67% for general surgical deaths. This is better than that achieved by complex or simple scoring systems in a similar group of patients (APACHE II or Sickness Assessment) *(10)*. Postoperatively, anaesthetists more accurately identified those general surgical patients who subsequently died (sensitivity 100%) than did surgeons (54%). Peroperatively, surgical concentration is directed at the surgical procedure. The anaesthetist is aware of the patient's physiological response to anaesthesia, surgery and their pathological condition; this may explain the anaesthetist's improved sensitivity of prediction after surgery, while the surgeon's changes little. This wisdom after the event is of little use in preventing futile operations but may be useful in guiding further management of the patient.

In some high-risk patients, cardiovascular optimisation has been shown to improve survival *(11)*. Preoperative resuscitation before gastrointestinal surgery has been shown to improve morbidity and mortality *(12)*. One practical proposal to improve outcome might be to defer operation in elderly patients classed as ASA 4 or 5 or with high risk factor scores. These patients could, if the surgical condition allowed, by actively treated in a high dependency area to try to improve their condition and a decision to proceed to surgery made in the light of their response to resuscitation. To improve outcome, shorter and less extensive operations may be appropriate. This small study has not demonstrated a reduced mortality when senior doctors are involved in operations. However, this reduction may result from the presence of senior surgeons and anaesthetists if they consider alternative surgical techniques and carry them out with greater speed and expertise.

In conclusion, despite the recommendations of NCEPOD, mortality rates for these patients were not altered by the time of day they had their operation or by the presence of senior surgeons or anaesthetists. This study has found no preoperative factors that allow us to predict the survival or death of elderly patients undergoing unscheduled surgery: ASA classification, risk factor score and clinical opinion are useful but none is specific enough reliably to predict outcome. The difficult decision of when to submit the elderly frail patient to emergency surgery remains an imperfect science.

The authors thank their surgical and anaesthetic colleagues at the Royal United Hospital, Bath, whose assistance has been invaluable in completing this study. Thanks also to Dr C Peden, for comments on the manuscript.

References

1 Pedersen T, Eliasen K, Henriksen E. A prospective study of mortality associated with anaesthesia and surgery: risk indicators of mortality in hospital. *Acta Anaesthesiol Scand* 1990; **34**: 176–82.

2 Campling EA, Devlin HB, Hoile RW, Lunn JN, eds. *Report of the National Confidential Enquiry into Perioperative Deaths 1990*. National Confidential Enquiry into Perioperative Deaths. London, 1992.

3 Campling EA, Devlin HB, Hoile RW, Lunn JN, eds. *Report of the National Confidential Enquiry into Perioperative Deaths 1991/1992*. National Confidential Enquiry into Perioperative Deaths. London, 1993.

4 Campling EA, Devlin HB, Hoile RW, Lunn JN, eds. *Report of the National Confidential Enquiry into Perioperative Deaths 1992/1993*. National Confidential Enquiry into Perioperative Deaths. London, 1995.

5 Lubin MF. Is age a risk factor for surgery? *Med Clin North Am* 1993; **77**: 327–33.

6 Seymour DG, Pringle R. Surgical emergencies in the elderly: can they be prevented? *Health Bull (Edinb)* 1981; **41**: 112–31.

7 Waldron RP, Donovan IA, Drumm J, Mottram SN, Tedman S. Emergency presentation and mortality from colorectal cancer in the elderly. *Br J Surg* 1986; **73**: 214–16.

8 Health Publications Unit. *Hospital Doctors: Training for the Future*. The Report of the Working Group on Specialist Medical Training. London: Department of Health, April 1993.

9 Haynes SR, Lawler PGP. An assessment of the consistency of ASA physical status classification allocation. *Anaesthesia* 1995; **50**: 195–9.

10 Kennedy RH, Al-Mufti RA, Brewster S, Sherry EN, Magee TR, Irvin TT. The acute surgical admission: is mortality predictable in the elderly? *Ann R Coll Surg Engl* 1994; **76**: 342–5.

11 Boyd O, Grounds MR, Bennett ED. A random clinical trial of the effect of deliberate peri-operative increase of oxygen delivery on mortality in high-risk surgical patients. *JAMA* 1993; **270**: 2699–2707.

12 McIlroy B, Miller A, Copeland GP, Kiff R. Audit of emergency preoperative resuscitation. *Br J Surg* 1994; **81**: 200–202.

Received 5 February 1997