Mortality in a university surgical unit: what is an avoidable death?

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Summary
Between January 1978 and December 1987 there were 23 557 surgical admissions to the University Surgical Unit in Southampton. During this period there were 543 deaths, an overall death per admission rate of 2.3%. During the 10-year period the number of admissions per year had risen from 1884 in 1978 (death per admission=3.6%) to 3467 in 1987 (death per admission rate=1.7%).

At the monthly audit meeting an attempt was made to classify each death as 'avoidable' or 'unavoidable'. During this 10-year period it was considered that there were 89 'avoidable' deaths. This represents an avoidable mortality rate (AMR) of 0.38%.

These 'avoidable' deaths were due to a wide variety of causes and this paper discusses the lessons learnt from a review of surgical mortality and outlines how units might compare results.

Introduction

There have now been several papers on surgical audit published in Britain[1-3] but few which have looked specifically at mortality. Case fatality has been compared between teaching and non-teaching hospitals[4]; in urology[5] and for appendicitis[6]. In a paper from Belfast[7] the concept of 'expected' versus 'unexpected' deaths was developed and the rate of 'unexpected' deaths was calculated as 0.26% of total operations performed. This represents a quarter of the deaths on their unit during that period. A paper from Zambia[8] expanded the concept of the avoidable mortality rate (AMR) while others have used the terms 'viable' and 'non-viable'[9]. The Confidential Enquiry into Perioperative Deaths[10] used the term 'avoidable elements' in its analysis and found that the average percentage of deaths as defined as having 'avoidable elements' by the surgical assessors was 16.9%.

Our study adds to this body of knowledge and outlines more detailed definitions of what is an avoidable death.

Methods

Between the years 1978 and 1987 inclusive, all admissions to the University Surgical Unit in Southampton were audited prospectively on a monthly and annual basis. The date of admission; the date of birth; age; sex; diagnosis and clinical cause of death were recorded. If further information was available from postmortem this was included. During the last 4 years of the study period additional information was collated which included a detailed analysis of the particular operative procedure; the proportion of patients who did not undergo surgery and the emergency admission rate. A detailed breakdown of the age distribution of all patients admitted was only possible for the last year of the study from the Southamptom District Clinical Information Service.

The data over the last 7 years was collected by a research nurse who monitored the progress of the patients throughout their admission. Prior to this the house surgeons collected the data by filling in an audit book. The data was then collated monthly by the registrar on standard forms.

At the monthly audit meetings members of the unit discussed outcomes in detail with reference to complications and death. The causes of death were critically judged and if any part of the preoperative assessment or surgical treatment was found wanting the death was classified as 'avoidable'. Any post-operative features of interest were noted by the team and these were not necessarily deemed to be judged the main avoidable factor in the patient's management. Existing co-morbidity was also noted.

The avoidable mortality rate (AMR) was the avoidable deaths per admission expressed as a percentage as defined by Heywood *et al.*[8].

Deaths relate predominantly to inpatient deaths. In recent years our audit nurse has followed patients into the community and more complete information has been obtained.

The University Surgical Unit is responsible for general surgical planned and emergency admissions. With a few exceptions urological and vascular cases were referred to other units.

Results

There were 23 557 admissions and 543 deaths resulting in an overall death per admission rate of 2.3%. Figure 1 illustrates the increase in surgical

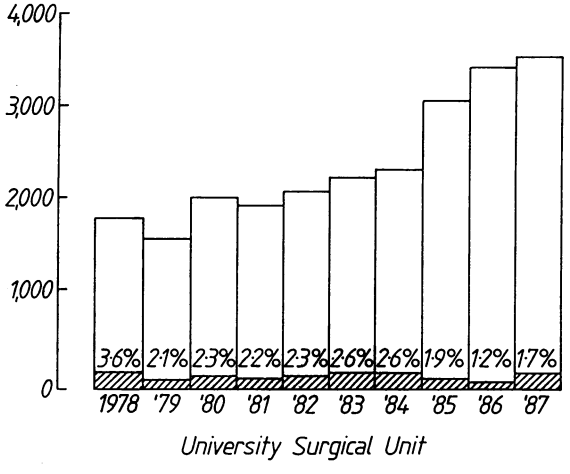

Figure 1. Admissions to the unit and deaths (%) for each year

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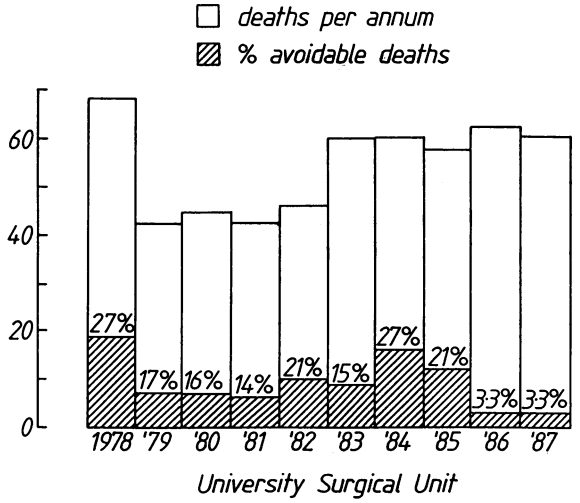

Figure 2. Percentage of 'avoidable' deaths each year

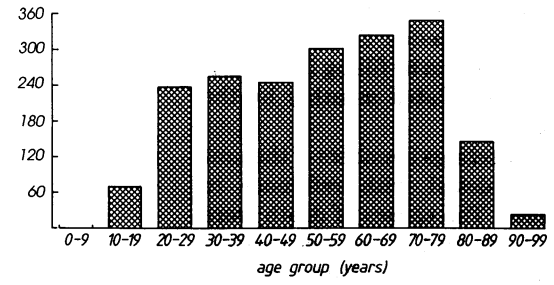

Figure 3. Age distribution of surgical admissions during 1987

admissions over the study period from below 2000 to nearly 3500 patients per annum. The death per admission rate has been fairly steady until the last 3 years of the study period when it has fallen.

There were considered to be 89 'avoidable' deaths during the whole 10-year period.

Figure 2 shows the number of deaths per annum with the 'avoidable' deaths expressed as a percentage. The avoidable mortality rate was 0.38%.

Over the last 4 years of the study 31% of patients were emergency admissions and 27% of all admissions did not proceed to surgery and this figure was approximately the same for the patients who died in hospital (28%). Fifty-two per cent (52%) of emergency admissions underwent surgery.

The age distribution of the surgical admissions over a 6-month period in 1987 is shown in Figure 3.

Figure 4 compares the age distribution of all the deaths to those considered 'avoidable'. The distribution

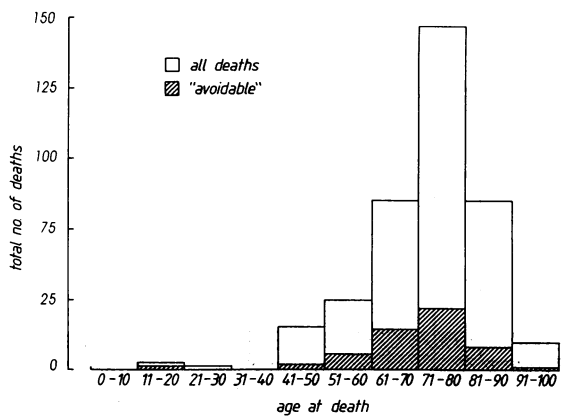

Figure 4. Total number of deaths in each age group during study period

Table 1. 'Avoidable' deaths

Clinical condition	*Number of patients*
Colonic carcinoma	21
Peptic ulcer	12
Diverticular disease	10
Aortic aneurysm	8
Gastric cancer	7
Hernias	6
Small bowel obstruction	6
Small bowel infarction	3
Appendicitis	3
Road traffic accidents	3
Cholecystectomy	2
Oesophageal cancer/head injury/pancreatic cancer/Crohn's disease/aortic occlusion/ sigmoid volvulus/breast cancer/hiatus hernia	1 each
Surgical errors	
Anastomotic leaks	18
Preoperative delay	6
Wound dehiscence	3
Caecal perforation	3
Gastroscopy peritonitis	1
Mistaken diagnosis	1

is similar between these two groups but as expected those patients who died were older than the overall population of admissions. Indeed 66% of all admissions were less than 65 years of age compared with only 17% of those dying.

The mean age of the 'avoidable' death group was 70.2 years. Sixty-one per cent were male and the interval from admission to death was 10.3 days (range 0-58 days). Death in the 'avoidable' group occurred within 30 days of operation in 94% of cases.

Table 1 lists the clinical conditions of the patients dying with an 'avoidable' element. A list of surgical errors has been compiled illustrating that a leaking anastomosis is the commonest identifiable cause of an 'avoidable' death.

Twelve patients in the avoidable death group had a diagnosis of peptic ulceration. Several factors were identified as contributing to their death: postoperative ulcer haemorrhage (two cases), wound dehiscence (two cases); late diagnosis (two cases); myocardial infarction (two cases); small bowel obstruction (one case); peritonitis (one case); renal failure (one case) and chest infection (one case). It must be remembered that although some of these features may have been judged as being 'avoidable' (eg repeated haemorrhage after operation), others were noted as the precipitating cause of death (eg myocardial infarction) which could have followed an avoidably complicated and stressful operation.

Table 2 lists other postoperative features and co-morbidity of note. Not every death had an associated feature marked against it in the records and so the total figures do not tally exactly. Pulmonary embolism was a significant problem in the 'avoidable' group. In the early part of the study period heparin prophylaxis in patients undergoing major surgery was not routine but support stockings were used (thrombo embolism deterrence). In the latter half of the study low dose subcutaneous heparin was given. If the patient had not received heparin prophylaxis they were defined in this group.

Table 2. 'Avoidable' deaths

Postoperative features	*Number of patients*
Pulmonary embolism	9
Pneumonia (3 aspiration)	8
Renal failure	6
Myocardial infarction	5
Heart failure	3
Ischaemic colon	1
Postoperative pancreatitis	1
Cardiac arrest	1
Cerebrovascular accident	1
Co-morbidity	
Leukaemia	2
Cirrhosis	1
Diabetes	1
Marrow failure	1

Surprisingly only five patients had existing medical problems that were thought to have contributed to their demise (see Table 2 - co-morbidity). However, these are 'avoidable' deaths, that is, patients who died with pre-existing medical problems were much more likely to be classified as 'unavoidable'.

Discussion

This audit of postoperative mortality shows similar features to the previous published studies. In the Whipps Cross analysis of one year's experience[11] their overall death rate per admission was 3.1% compared with 2.3% in our study. Neither of these figures, however, appear as good as the 1.2% death per operation reported from Belfast[7]. But this Belfast figure is not strictly comparable as the non-operative deaths have been selected out. However, avoidable mortality rates (AMR) are similar between the Zambian figure of 0.33%[8] and our figure of 0.38%.

Our non-operative admission rate at present is 27% compared with the Whipps Cross study at 38.5%[11] and our emergency admission rate was 31% while at Whipps it was 47%. Referral patterns and habits of patients and general practitioners are more likely to explain these differences than disease prevalence variations. Information about changing patterns of age and the proportion of emergencies are unavailable from our data for the whole study period. They have been calculated for 1987. It is not known if there has been a change in the nature and severity of the diseases referred to the unit. Staffing levels have remained similar throughout the decade.

We defined our postoperative deaths as any death that could be considered directly related to the surgical admission. Most authorities have defined a 30-day period as the limit for a postoperative death but this may underestimate the effect of the disease and the surgery. However, in our study we found that 94% of all deaths occurred within 30 days of admission.

We have presented the features of the 89 patients in the 'avoidable' death group in the hope of learning lessons. From the craftmanship aspect it is still clear that the ability to perform (or judge when it is safe to perform) an anastomosis is still the single most important factor. It could be argued that not all anastomoses can be secure and that a proportion will leak however perfectly the surgery is performed. There may be some justification for this argument for even some of the surgical experts have a significant rate of anastomotic dehiscence[12]. Despite this we also know clearly that the surgeon performing the operation is the most important determining factor with regard to postoperative anastomotic integrity[13]. Therefore, if we are to attempt 'critical' audit we must attempt to achieve perfect results.

Other lessons from this audit were learnt and the management of patients streamlined. The nine patients with pulmonary embolism made us examine carefully our heparin prophylaxis regimens. This enquiry revealed that some of these patients had not received the heparin despite unit policy in the latter years of the study.

A discussion of the scientific data for and against prophylactic heparin is outside the scope of this article. However, we note with interest that up to the end of 1984, when we became concerned about our high pulmonary embolism rate and reviewed the efficiency of our heparin policy, we had 13 deaths from pulmonary embolism (2.2 per annum). Of these patients only two were known to have received prophylactic heparin. Since 1984 in the last 3 years of the study period we have noted four deaths from pulmonary embolism (1.3 per annum) of which one is in the avoidable group as he did not receive low dose subcutaneous heparin.

Pneumonia is still an important feature in the postoperative period emphasizing the importance of physiotherapy.

Our greatest difficulty throughout the period of study is the struggle to reach a sensible definition of 'avoidable'. Various terms have been used in the past; 'unexpected', 'unnecessary', 'untimely', 'inappropriate', 'viable'. Each term is not quite adequate. On the one hand 'avoidable' and 'unnecessary' imply too much culpability and on the other 'unexpected' is too bland. On reviewing the forms it was often tempting to suggest that a death that had been classified as 'avoidable' by the team at the time was really just an acceptable complication. We have strongly resisted any reclassification of this kind as only the team at the time of the admission could be in full possession of the facts of each admission.

One of the problems with surgical audit is that only the figures emerge not the real lessons. Perhaps a scheme of degrees of avoidability as suggested in Table 3 might be helpful: unavoidable; partially avoidable; avoidable; and mismanaged. It is accepted that the exact category of avoidability for a death

Table 3. Degrees of avoidability

0	UNAVOIDABLE: eg painful hernia operated upon by a trained surgeon. Patient receives prophylactic heparin, but develops a pulmonary embolus and dies on 12th day.
1	PARTIALLY AVOIDABLE: eg 80-year-old woman with strangulated hernia taken to theatre in haste despite fluid and electrolyte imbalance and dies of postoperative renal failure.
2	AVOIDABLE: eg correctable lesion in fit patient missed or mistreated; eg failure to diagnose diabetic pre-coma in a patient with abdominal pain →appendicectomy but dies in the postoperative period.
M	MISMANAGED: eg patients with carcinomatosis who are operated upon when it is obvious that they will die anyway. This group could include administrative shortcomings.

may vary between surgeons and audit groups. However, an attempt at quantifying the problem is desirable if units are to compare results. All admissions to the surgical unit should be included in the mortality audit figures and deaths before and after 30 days recorded where death is due to the surgical management.

Of course, the need for confidentiality of audit records as sanctioned by the Secretary of State is paramount when assessments of this nature are being recorded. The legal aspects of audit are still a source of great anxiety to clinicians who are honestly trying to scrutinize their work. Although audit records are protected in theory, in practice they could be used by lawyers and misinterpreted for the benefit of a claim. This would do huge damage to the individual surgeon as well as the profession's efforts to monitor their performance. Extreme caution and discrete filing of records (preferably not on computers where they must be registered) is to be recommended at present.

In conclusion our 10-year audit has highlighted many features of concern as it has progressed. Action has been taken to prevent further mishaps or oversights: reiteration of unit policy; sharpening lines of communication and giving surgeons an insight into their weaknesses so that further training be arranged. This must be the function of surgical audit. Indeed, it just might be the reason why in the last 2 years of the study we found it hard to identify as many patients as having 'avoidable' features as we had previously.

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