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ORIGINAL ARTICLE

Antecedents to hospital deaths

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Abstract

Background: Recent studies have suggested there are a large number of potentially preventable deaths in Australian hospitals.

Aim: This study aimed to document antecedent factors in hospital deaths in an attempt to identify potentially preventative factors.

Methods: The study was conducted at three separate acute hospitals. Demographics of all deaths were recorded over a 6-month period as well as antecedent factors present within 0–8 and 8–48 h of all deaths including vital sign abnormalities, cardiorespiratory arrests and admission to intensive care. Separate analysis was performed on 'not for resuscitation' deaths.

Results: There were a total of 778 deaths, of which 549 (71%) were 'not for resuscitation'. There were 171 (22%) deaths preceded by arrest and 160 (21%) preceded by admission to intensive care. Of the remaining deaths, 30% had severely abnormal physiological abnormalities documented. This incidence was 50% in the non-do not resuscitate (DNR) subgroup. Concern about the patient's condition was expressed in the patient's notes by attending nursing staff and junior medical staff in approximately one-third of non-DNR deaths. Hypotension (30%) and tachypnoea (17%) were the most common antecedents in the non-DNR deaths.

Conclusion: There is a high incidence of serious vital sign abnormalities in the period before potentially preventable hospital deaths. These antecedents may identify patients who would benefit from earlier intervention. (Intern Med J 2001; 31: 343–348)

Key words: antecedent, death, hospital, intensive care unit.

INTRODUCTION

One of the most universally accepted and available indicators of a hospital's performance is mortality.[1] However, mortality may reflect differences in the mix of patients rather than differences in quality of care.[2] Attempts have been made to adjust hospital death rates in order to make it a more accurate tool for measuring the quality of hospital care.[3,4] Up to 27% of deaths have been found to be potentially preventable and between 4.9 and 13.6% of adverse events in a hospital, lead to death.[5–7] While the general concept of preventability of hospital deaths has been explored, there is little information on their immediate precursors. Up to 84% of in-hospital cardiorespiratory arrests are preceded by a slow deterioration in vital signs and many patients admitted to an intensive care unit (ICU), especially from the general wards of the hospital, have had suboptimal management prior to their admission.[8–10]

The purpose of the present study was to examine the incidence of serious and potentially preventable abnormalities immediately preceding hospital deaths that were not related to a cardiorespiratory arrest or unexpected admission to an ICU.

METHODS

All deaths were identified at three similarly sized acute hospitals for the period from 8 July to 31 December 1996. As soon as practical after an event, all patients

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aged 14 years or over had their medical record reviewed for demographic information. The time and place of all deaths during that period as well as documentation of a do not resuscitate (DNR) order prior to death were noted.

The patient's record was reviewed for documented antecedent factors preceding death. Factors examined for were cardiorespiratory arrest, intensive care admission or, if these were not present, abnormal physiological values recorded for the 8-h and the 8–48-h periods prior to the time of death. The abnormal physiological values were classified according to the following categories: (i) a major threat to airway associated with neck swelling, (ii) difficulty swallowing saliva and/or stridor, (iii) a respiratory rate of more than 36 breaths/min or less than 5 breaths/min, (iv) a pulse rate of less than 40 b.p.m. or more than 140 b.p.m., (v) a systolic blood pressure of less than 90 mmHg, (vi) a sudden fall in the level of consciousness by two or more Glasgow Coma Scale points and (vii) the presence of repeated or prolonged seizures. Information was also collected on whether there was concern expressed about the patient's condition by the attending junior medical or nursing staff, resulting in an entry to that effect in the patient's notes.

Data were collected by three critical care nurses trained in the data collection process that was refined during a 2-week pilot programme. Individual nurses were familiar with the layout of the medical record at the three hospitals and with the local recording practices. Where the information contained in the history was unclear, information was confirmed with the treating staff.

Incomplete data item forms and those where error was suspected were returned to the data collector for checking. Forms were then entered onto a database (Microsoft Access 2.0; Microsoft, Redmond, WA, USA). A data collector then compared all forms with the database to ensure no typographical errors occurred. A further check was performed to determine obvious errors such as duplicated results, admission after discharge, and anomalous data. The original medical records were reviewed and the database corrected. Data were then exported to SAS v 6.12 (SAS Institute Inc., Cary, NC, USA) for analysis. Results were tabulated as number, percentage of factor prevalence and mean or median for continuous variables. The study was part of a larger investigation on medical emergency processes in those hospitals. The study proceeded only after review by the three hospitals' Ethics Committee and subsequent ratification by the relevant university body. Each body waived the need for informed patient consent.

RESULTS

There were a total of 50 942 inpatients treated over the 6-month period at the three hospitals and a total of 778 deaths occurred in the same period (Table 1). Of these, 424 were male (54%). The mean age of those who died across the three hospitals was 72 years and the median age 75 (range 18–99; Table 1).

Most of the patients died on general wards (519 total, 67%). The times of deaths were distributed equally over the 24-h period. Of the patients who died, the length of stay was 10 days (mean) with a median of 5 and a range from 0 to 99 days. Almost one-quarter (n = 178) of patients who died were in hospital for more than 14 days. Of the 778 deaths, 549 (71%) had been assigned a DNR order.

Of the 778 deaths, 171 (22% of total deaths) had a cardiorespiratory arrest that resulted in death and 53 (31%) of these subsequently had an explicit DNR order. One hundred and sixty of the deaths occurred in an ICU (21% of total deaths). Of these 160, 111 were admitted in an elective or expected fashion from either the Emergency Department (ED) or operating rooms (OR). Eighty-two of these patients (74%) eventually had a DNR order.

The remaining 49 patients were admitted unexpectedly from the general wards of the hospital to the ICU. Of these, 31 (66%) eventually had an explicit DNR order.

One hundred and twenty-five (29%) of the remaining 447 patients after exclusion of cardiac arrest and ICU-related deaths had serious physiological abnormalities documented within 8 h before death (Table 2). However, half of all deaths without DNR orders had serious physiological abnormalities documented within 8 h of death and approximately the same percentage had abnormalities in the period between 8 and 48 h. Almost one-third had the same serious abnormalities for the whole 48-h period before death (Table 2).

The commonest physiological abnormality was hypotension (Table 2). Tachypnoea was the second most common antecedent. Tachycardia was the next most common abnormality (Table 2). Between 11% (in deaths with a DNR order) and 25% (in deaths without a DNR order) of patients who died in

Table 1 In-hospital deaths: descriptive statistics

Deaths	Crude no.				Test of hospital independence χ^2 (P value)
	Total	Hospital 1	Hospital 2	Hospital 3	
No. events	778	240	243	295	
Males (%)	424 (54.5)	128 (53.3)	149 (61.3)	147 (49.8)	$\chi^2_{(2)} = 7.3$ ($P < 0.05$)
Mean age in years (SD)	72.2 (14)	71.8 (14)	69.3 (15)	74.8 (13)	
Median (range)	75 (18–99)	75 (18–98)	72 (19–99)	77 (19–97)	
Distribution: *n* (%)					
14–29	16 (2.1)	5 (2.1)	7 (2.9)	4 (1.4)	$\chi^2_{(8)} = 19.3$ ($P < 0.05$)
30–44	32 (4.1)	8 (3.3)	18 (7.4)	6 (2.0)	
45–59	80 (10.3)	23 (9.6)	31 (12.8)	26 (8.8)	
60–74	263 (33.8)	84 (35.0)	85 (35.0)	94 (31.9)	
75 +	387 (49.7)	120 (50.0)	102 (42.0)	165 (55.9)	
Length of stay (admission–death)					
Average no. days (SD)	10.2 (14.2)	11.0 (15.8)	8.3 (11.6)	11.1 (14.7)	
Median (range)	5 (0–99)	5 (0–99)	4 (0–77)	6 (0–87)	
Distribution: *n* (%)					
Same day	80 (10.3)	24 (10.0)	22 (9.0)	34 (11.5)	$\chi^2_{(8)} = 10.5$ (NS)
1 day	129 (16.6)	34 (14.2)	52 (21.4)	43 (14.6)	
2–7 days	262 (33.7)	85 (35.4)	86 (35.4)	91 (30.8)	
8–14 days	129 (16.6)	44 (18.3)	35 (14.4)	50 (16.9)	
> 14 days	178 (22.9)	53 (22.1)	48 (19.7)	77 (26.1)	
Time of death (%)					
00.00–< 08.00 hours	240 (30.8)	65 (27.1)	73 (30.0)	102 (34.6)	$\chi^2_{(4)} = 6.3$ (NS)
08.00–< 16.00 hours	265 (34.1)	95 (39.6)	79 (32.5)	91 (30.8)	
16.00–< 24.00 hours	273 (35.1)	80 (33.3)	91 (37.4)	102 (34.6)	
Site of death (%)					
Ward	519 (66.7)	155 (64.6)	168 (69.1)	196 (66.4)	$\chi^2_{(8)} = 21.4$ ($P < 0.01$)
ICU + other critical unit	199 (25.6)	66 (27.5)	66 (27.2)	67 (22.7)	
Emergency department	40 (5.1)	8 (3.3)	6 (2.5)	26 (8.8)	
Operating theatre	14 (1.8)	7 (2.9)	3 (1.2)	4 (1.4)	
Others	6 (0.8)	4 (1.7)	0 (0.0)	2 (0.7)	
Death with DNR (%)	549 (70.6)	154 (64.2)	188 (77.4)	207 (70.2)	
Death without DNR (%)	229 (29.4)	86 (35.8)	55 (22.6)	88 (29.8)	$\chi^2_{(2)} = 10.2$ ($P < 0.01$)
Death not preceded by cardiac arrest or unexpected ICU admission and without DNR (%)	66 (8.5)	35 (14.6)	15 (6.2)	16 (5.4)	$\chi^2_{(2)} = 16.5$ ($P < 0.01$)

NS, not significant; DNR, do not resuscitate; ICU, intensive care unit.

hospital had at least one entry by attending nursing or junior medical staff expressing concern about the patient's condition within 8 h of death.

DISCUSSION

In the present study, death was found to be commonly preceded by a cardiorespiratory arrest call or intensive care admission. Both of these events have been shown to be preceded by serious abnormalities and deterioration. A high incidence of serious abnormalities has also been described within 8 h preceding in-hospital cardiorespiratory arrests.[8,11–13] Between 60 and 84% of patients had identifiable deterioration of vital signs, similar to those used in the present study. The authors suggested that in-hospital cardiorespiratory arrests may not always be sudden and unexpected events. More than half of the deaths without DNR orders in the present study were preceded by a cardiorespiratory arrest. Similarly, many unexpected admissions to ICU are preceded by measurable deterioration prior to definitive treatment.[9,10]

Table 2 Incidence of antecedent factors prior to deaths not preceded by cardiorespiratory arrest or admission to ICU

	Total deaths	Deaths with DNR orders	Deaths without DNR orders
Deaths with antecedents	447	382	66 (100)
Missing records	2	1	
Presence of 0–8 h antecedents (%)			
Airway threatened	2 (0.5)	1 (0.0)	1 (1.5)
Respiratory rate < 5	3 (0.7)	2 (0.5)	1 (1.5)
Respiratory rate > 36	39 (8.7)	28 (7.3)	11 (16.7)
Pulse rate < 40	9 (2.0)	5 (1.3)	4 (6.1)
Pulse rate > 140	17 (3.8)	15 (3.9)	2 (3.0)
Systolic BP < 90	86 (19.2)	66 (17.3)	20 (30.3)
Sudden fall in GCS > 2	11 (2.5)	7 (1.8)	4 (6.1)
Repeated/prolonged seizure	4 (0.9)	4 (1.0)	0 (0.0)
'Worried' only	57 (12.8)	41 (10.7)	16 (24.2)
One or more antecedents (– worry): *n* (%)	125 (28.9)	96 (25.1)	33 (50.0)
No. patients with 8–48 h antecedents	418	367	52
Presence of 8–48 h antecedents (%)			
Airway threatened	6 (1.4)	4 (1.1)	2 (3.8)
Respiratory rate < 5	1 (0.2)	1 (0.0)	0 (0.0)
Respiratory rate > 36	69 (16.5)	63 (17.2)	6 (11.5)
Pulse rate < 40	7 (1.7)	4 (1.1)	3 (5.8)
Pulse rate > 140	39 (9.3)	35 (9.5)	4 (7.7)
Systolic BP < 90	115 (27.5)	99 (27.0)	16 (30.8)
Sudden fall in GCS > 2	20 (4.8)	18 (4.9)	2 (3.8)
Repeated/prolonged seizure	5 (1.2)	5 (1.4)	0 (0.0)
'Worried' only	90 (21.5)	83 (22.6)	7 (13.5)
One or more antecedents (– worry): *n* (%)	187 (45.2)	164 (44.7)	25 (48.1)
Presence of 0–8 and 8–48 h antecedents			
Airway threatened	1 (0.2)	0 (0.0)	1 (1.9)
Respiratory rate < 5	0 (0.0)	0 (0.0)	0 (0.0)
Respiratory rate > 36	20 (4.8)	15 (4.1)	5 (9.6)
Pulse rate < 40	2 (0.5)	2 (0.5)	0 (0.0)
Pulse rate > 140	5 (1.1)	5 (1.4)	0 (0.0)
Systolic BP < 90	37 (8.9)	31 (8.4)	6 (11.5)
Sudden fall in GCS > 2	3 (0.7)	2 (0.5)	1 (1.9)
Repeated/prolonged seizure	2 (0.5)	2 (0.5)	2 (3.8)
'Worried' only	15 (3.6)	13 (3.5)	0 (0.0)
One or more antecedents (– worry): *n* (%)	77 (18.4)	60 (16.3)	17 (32.7)

DNR, do not resuscitate; ICU, intensive care unit: BP, blood pressure; GCS, Glasgow coma scale.

Approximately 20% of all patients who died without a DNR order in the present study were admitted to an ICU. Of the patients whose death was not preceded by cardiorespiratory arrest or admission to an ICU, there was a high incidence of serious abnormalities in vital signs within 8 h of death in hospital (Table 2). Half of all patients without a DNR order and presumably receiving therapy had serious abnormalities within 8 h of death in hospital. Slightly fewer had the disturbances in the period between 8 and 48 h of death and many had the same abnormalities in both time periods. This identifies a group of at-risk individuals who may have had a potentially preventable component in their hospital death.

The physiological abnormalities that were identified before potentially preventable hospital deaths (Table 2) involved mainly the basic functions of airway, breathing and circulation, which in turn determine the delivery of oxygenated blood to cells. The physiological criteria used in the present study were markers of significantly abnormal organ dysfunction. Hypotension was the most common antecedent across all categories and for both time periods and

tachycardia was the third most common. Many patients could have been suffering ischaemia or shock as a result. Tachypnoea, which was the second most common abnormality, has previously been associated with severe hypoxia and as an early warning predictor of serious illness.[14,15] Epilepsy was the only disease-specific illness for defining at-risk hospital patients. For many reasons it is associated with sudden death.[16] Although there were few patients with conditions such as threatened airway and bradypnoea, they were considered serious enough to include as potentially life-threatening. Many patients had serious abnormalities between 8 and 48 h before death as well as in the final 8 h (Table 2). This may indicate that they had been in a highly at-risk category for a prolonged period without appropriate action.

Some of the non-DNR deaths may have been dying in an expected fashion but without explicit DNR orders. The present study did not attempt to differentiate this group. However, patients who had explicit DNR orders in their notes comprised 71% of all recorded deaths, which is high compared to other studies.[17,18] However, the incidence of antecedents to death was only recorded from clinical notes and the real incidence may have been higher.

A high incidence of potentially preventable hospital deaths has been previously reported.[5–7] These studies have used retrospective chart review and a methodology largely based on expert review reconstructed from the clinical notes. These studies attempted to assign cause of death to factors such as medication error, management error, error in diagnosis and technical complications.[5–7] Regardless of the ultimate cause of hospital death, patients who are dying would be expected to demonstrate serious abnormalities in vital signs, such as those used in the present study, unless they suffered a sudden and catastrophic event such as a cardiac dysrhythmia or massive stroke.

The high incidence of serious abnormalities before death may lend itself to earlier and more effective intervention. It was on the basis of readily measurable antecedents occurring before in-hospital cardiorespiratory arrests that a system to replace the cardiac arrest team was established and called the Medical Emergency Team (MET).[19–21] The antecedents used in the present study were the same used as criteria for the MET system (Appendix 1). Patients without a DNR order and who had serious abnormalities in vital signs before death may have been possible candidates for earlier and more appropriate intervention. In a recently published article, the MET system was associated with a significant decrease in unanticipated admissions to ICU as well as mortality in one of the two comparison hospitals.[22]

The use of MET criteria and a system response to those criteria may also assist in defining patients who are in the DNR category. The term DNR is defined as not for cardiopulmonary resuscitation after cardiac arrest.[23] Addressing whether resuscitation is appropriate at an earlier stage, as opposed to whether CPR is necessary, may assist in defining those in-hospital patients who are dying, so that policies about active withholding and withdrawing of treatment, similar to those used in ICU, could be implemented across hospitals.[24,25] This may become more important as acute hospitals increasingly care for the more seriously ill.[26]

Accountability and quality are increasingly being emphasized in health care. Systems for reviewing hospital quality using potentially preventable deaths have involved retrospective and extensive patient case note review. Documentation of antecedents to hospital deaths and the response to these may be a basis for evaluating the quality of health care in a hospital. The high incidence of serious abnormalities just before death represents an opportunity not only to audit hospital quality but to prevent further deterioration: a form of real-time quality assurance or critical incident monitoring and management.

Apart from a cardiac arrest team, there is little in the way of a systematic response that crosses geographical and functional boundaries to seriously ill patients in acute hospitals. Of concern was the high incidence of patients who had explicit entries by attending nursing staff and junior medical staff within 48 h of death (Table 2). Almost one-quarter of all patients who did not have DNR orders had entries to this effect as opposed to approximately 10% of patients who had DNR orders. In association with the high incidence of serious abnormalities in vital signs, this concern may indicate the lack of immediate and appropriate assistance when required. The lack of staff with skills and knowledge about all aspects of advanced resuscitation and delays in treatment were major factors in patients being admitted unexpectedly to ICU.[9]

The present study has demonstrated that almost one-half of in-hospital deaths that have no DNR orders are preceded by serious and potentially correctable abnormalities before death. The presence of these abnormalities may provide the basis for a closer audit of hospital deaths as well as more systematic response to at-risk patients.

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APPENDIX I. MEDICAL EMERGENCY TEAM CRITERIA

Table A1 Medical Emergency Team criteria

Region of acute change	Physiology
Airway	Threatened
Breathing	All respiratory arrests
	Respiratory rate < 5
	Respiratory rate > 36
Circulation	All cardiac arrests
	Pulse rate < 40
	Pulse rate > 140
	Systolic blood pressure < 90
Neurology	Sudden fall in level of consciousness
	(Fall in GCS of > 2 points)
	Repeated or prolonged seizures
Other	Any patient who you are seriously worried about that does not fit the above criteria

GCS, Glasgow coma scale.