After-hours discharges from intensive care are associated with increased mortality

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ABSTRACT

Objective: To investigate the change in pattern of discharge of patients from an intensive care unit (ICU) to hospital wards and to determine the impact of discharge time on subsequent hospital mortality.

Design and participants: A retrospective cohort study of 10 903 patients discharged alive from a single ICU between 1 January 1992 and 31 December 2002.

Main outcome measure: In-hospital mortality.

Results: Of the 10903 patients discharged alive from the ICU, 486 (4.5%) died in hospital wards. When discharge times were categorised according to nursing shift (morning, 07:00–14:59; afternoon, 15:00–21:59; and night, 22:00–06:59), patients were more likely to be discharged on an afternoon shift (odds ratio, 3.63; 95% CI, 3.05–4.30) or night shift (4.52; 95% CI, 3.15–6.64) in 2000–2002 compared with 1992–1994. In a multiple logistic model, hospital mortality after discharge from the ICU was increased by higher APACHE II score (1.14; 95% CI, 1.12–1.16); admission to ICU from the operating room (1.47; 95% CI, 1.11–1.95) and from the general ward (1.75; 95% CI, 1.37–2.23); and discharge during the afternoon (1.36; 95% CI, 1.08–1.70) and night shifts (1.63; 95% CI, 1.03–2.57).

Conclusion: Over an 11-year period, more patients are being discharged from the ICU in the afternoon and night suggesting increasing pressure on ICU beds. Patients discharged on these shifts have an increased risk of death.

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The in-hospital mortality rate for patients admitted to the intensive care unit (ICU) is high, with estimates ranging from 20%–30%.[1-3] Of these deaths, around a third can occur after discharge from the ICU. Some of these deaths are inevitable, with severity of illness the major determinant.[1] A previous study by Goldfrad and Rowan noted that patients discharged from the ICU after-hours were more likely to die than those discharged during normal working hours.[4] Furthermore, after-hours discharges had increased over a 10-year period and were more likely to be premature; the authors attributed this rise to increased pressure on ICU beds.[4]

Changes in ICU practices have occurred in Victoria over the past decade, brought on by reductions in hospital beds and, specifically, ICU beds. There is a general feeling within the intensive care community that more patients are being referred for treatment; that discharges to the ward occur later in the day due to a lack of ward beds; and that some people are discharged prematurely to make way for a patient with more serious illness. Our ICU has kept a record of all admissions and discharges since 1985. The size of the database and the completeness of the data provided a unique opportunity to examine the pattern of discharges and post-ICU mortality over an 11-year period spanning the changes to health care in Victoria.

METHODS

Hospital and intensive care unit

St Vincent's Hospital is a 400-bed tertiary referral hospital associated with the University of Melbourne. The hospital provides medical and surgical services including cardiac surgery and neurosurgery. Trauma and burns patients are generally directed to dedicated services at other hospitals. During the 1990s, the number of inpatient beds was reduced from 550 to 400, yet the number of patient separations subsequently increased.

The ICU was established in 1961. It is the sole ICU in the hospital, and receives 1100 to 1200 admissions per year. In 1995, a new inpatient building with a 16-bed ICU was commissioned, although budgetary constraints have limited the number of beds open to 10, and the number of ICU beds has remained static over the 11-year period.

Dataset

Detailed records of ICU admissions have been collected since 1985, most by a single clinician. Discharge time was added to the dataset in 1992. We used this database for our analysis which includes 10 903 patients discharged alive from the ICU to hospital wards between 1 January 1992 and 31 December 2002.

As a proportion of patients have more than one ICU admission during their hospital stay, only the final one was used in the analysis. While it could be argued that the initial admission and associated severity of illness would determine outcome, it was felt that the final ICU admission of a complex hospitalisation should be included, as that discharge might have influenced hospital outcome.

Discharge times

These were defined by variables relating to nursing shift and hospital medical officers' hours. There were three nursing shifts in each 24-hour period, with some overlap for handover. For our analysis, the three nursing shifts were defined as 07:00–14:59 (morning shift), 15:00–21:59 (afternoon shift) and 22:00–06:59 (night shift). Working hours for hospital medical officers (interns, junior medical officers and registrars) are generally 08:00–18:00 Monday to Friday, with a reduced number of staff between 18:00–08:00 and during weekends and on public holidays. For our analysis, out-of-hours for doctors (medical officer nights) was defined as 18:00–07:59, and medical officer weekends as Friday 18:00 to Monday 07:59. No attempt was made to account for gazetted public holidays in Melbourne each year. An analysis using the night (22:00–06:59) and early hours (00:00–04:59) discharges defined by Goldfrad and Rowan[4] was also undertaken for comparison.

Severity of illness

Severity of illness was estimated by APACHE II (Acute Physiology and Chronic Health Evaluation) score,[5] in which points are accrued for abnormal clinical and blood test parameters, increasing age, defined chronic conditions, and emergency surgery, to a maximum of 71. Risk of in-hospital mortality increases with higher APACHE II scores. APACHE II scores were not calculated for short-stay admissions (< 12 hours), although they were calculated for the small number of patients under 18 years of age.

Factors possibly associated with outcome

The source of admission to ICU was coded as emergency department or interhospital transfer, operating or recovery room, or ward (general medical and surgical wards). There were four broad categories of health units: general medicine, special medicine (eg, cardiology, endocrinology), general surgery, and special surgery (eg, vascular, cardiothoracic).

In analysis of after-hours discharges, no attempt was made to differentiate between premature discharge (when the attending intensivist felt that, beds allowing, the patient would have benefited from continued care in the ICU) and delayed discharge (when a decision to discharge had been made, but a ward bed had not been available until later in the day). Although such coding is made, it remains subjective and the dataset was incomplete. Similarly, whether the patient was discharged for active management or for palliative care was not coded in the ICU database and was not included in the analysis.

Analysis period

The cohort was analysed for two periods (1992–1994 and 2000–2002) to determine whether the discharge patterns had changed before and after the move to the new hospital building in 1995. The two periods also contrasted clinical practice before and after new funding strategies implemented by the Department of Human Services in Victoria.

Statistical analysis

The primary outcome measure was hospital mortality after discharge from the ICU. For continuous variables, results are expressed as median (range), as none were normally distributed. Number and percentage are reported for categorical variables. Univariate analyses included the Mann–Whitney *U* test for continuous variables, and χ^2 or Fisher's exact test for categorical variables. Logistic regression analysis[6] was used to calculate adjusted odds ratios, and stepwise logistic regression (backward and forward elimination) was used for the multivariate analysis. $P < 0.05$ was used to indicate statistical significance and all calculations were two-sided. Analyses were performed using Stata (version 8, StataCorp, College Station, Tex, USA).

1 Characteristics of patients ($n = 12\,079$) admitted to the intensive care unit (ICU), 1992–2002

	Percentage or median (range)
Male	65%
Age in years (median, range)	64 (13–98)
Post-cardiac surgery	48%
APACHE II score (median, range)	13 (0–53)
Time spent in ICU in hours (median, range)	22 (0.17–2250)
Source of admission	
Emergency department or interhospital transfer; operating or recovery room; ward	26%; 65%; 9%
Health units	
General medicine; special medicine; general surgery; special surgery	15%; 10%; 10%; 65%

2 Comparison of patients admitted to the intensive care unit (ICU), 1992–1994 and 2000–2002

	1992–1994 ($n = 3093$)	2000–2002 ($n = 3172$)	*P*
Male (%)	66%	64%	0.203
Age in years (median, range)	63 (15–98)	64 (16–94)	< 0.001
Post-cardiac surgery (%)	53.8%	45.1%	< 0.001
APACHE II score (median, range)	12 (0–52)	15 (0–49)	< 0.001
Time spent in ICU in hours (median, range)	23.0 (0.25–2250)	22.5 (0.3–1505)	< 0.001
Source of admission (%)			< 0.01
Emergency department or interhospital transfer; operating or recovery room; ward	19%; 72%; 9%	28%; 62%;10%	
Health unit (%)			< 0.001
General medicine; special medicine; general surgery; special surgery	10%; 8%; 13%; 69%	17%; 12%; 9%; 62%	
Deaths (%)			
Died in ICU	8.8%	9.7%	0.09
Died in hospital	13.6%	14.9%	0.129

RESULTS

Over the 11-year period from 1 January 1992 to 31 December 2002, there were 12 693 discharges from the ICU. By including only the last admission for multiple ICU episodes, 12 079 individual ICU admissions remained. Patient characteristics are given in Box 1.

A total of 1662 patients died (13.8% mortality) over the 11-year period, of which 1176 (9.7% of the total) died in ICU; 10 903 were discharged to the wards where 486 (4% of 12 079; 4.5% of 10 903 discharged from ICU alive) died in hospital.

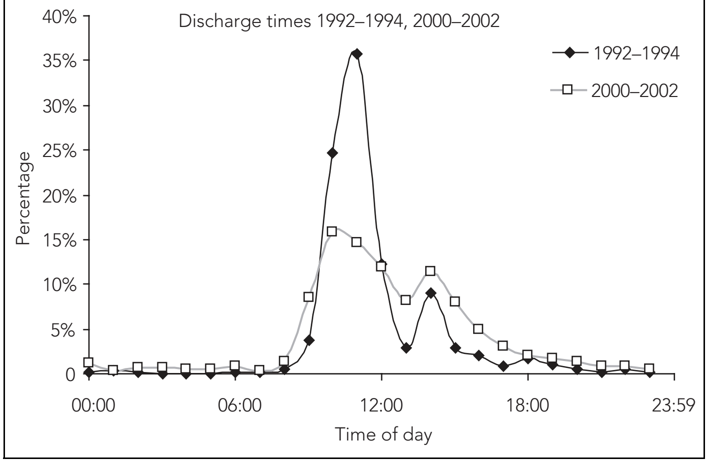
The patient profile over the 11-year period changed between the 1992–1994 dataset and that of 2000–2002 (Box 2). Similar patient numbers were treated over the two periods (3093 versus 3176) with similar proportions of males in each group (66% versus 64%). However, the median age increased and the percentage of cardiac surgical patients decreased. The patients tended to be sicker, but ICU stay was shorter. The origin of patients also changed with more patients being admitted from the emergency department and from interhospital transfers. Medical patients made up a higher proportion of the latter group. Hospital mortality rates were not significantly different (Box 2).

The pattern of discharge also changed between the two periods. Discharges in 2000–2002 had morning and afternoon peaks compared with a major morning peak in 1992–1994. Discharges were more likely to occur in the afternoon and overnight in 2000–2002 than in 1992–1994 (Box 3 and Box 4), during medical officer after-hours and medical officer weekend shifts.

3 Percentages and odds ratios (95% CIs) for discharge (alive) from the intensive care unit in the two periods, 1992–1994 and 2000–2002

Discharge time	1992–1994 (*n* = 2799)	2002–2004 (*n* = 2833)	Odds ratio (95% CI)
Morning nursing shift (07:00–14:59) (reference)			
Afternoon nursing shift (15:00–21:59)	7.18%	21.92%	3.63 (3.05–4.30)
Evening nursing shift (22:00–06:59)	1.36%	5.86%	4.52 (3.15–6.64)
Medical officer after-hours (18:00–07:59)	5.14%	12.32%	2.59 (2.11–3.17)
Medical officer weekends (Fri 18:00 to Mon 07:59)	16.26%	20.65%	1.34 (1.17–1.54)

4 Frequency distribution of discharge times from the intensive care unit for the two study periods



Univariate predictors of mortality after discharge from ICU are shown in Box 5. Category of admission includes an assessment of elective or emergency requirement for ICU, renal replacement therapy and discharge times.

In a multiple logistic model, independent predictors were APACHE II score, origin of admission (operating room, general wards), category of admission (cardiac surgery, postoperative monitoring) and nursing shift. The inclusion of category of admission led to a change in effect for origin of admission (odds ratio, 0.22–1.47) which now represented high-risk emergency patients from the operating theatre. Nursing shift was a better predictor than models with medical officer after-hours or medical officer weekend shifts included. A Kaplan–Meier survival analysis (Box 6) showed that 25% of the observed mortality occurred within 3 days of intensive care discharge, 50% by Day 6 and 75% by Day 14.

DISCUSSION

Our study shows that, over an 11-year period at our institution, severity of illness on ICU admission increased, afternoon and evening or night discharges became more frequent, and such discharges were associated with a statistically significant increase in mortality. A quarter of these deaths occurred within the first 3 days after ICU discharge. These findings are in keeping with studies from the United Kingdom[4,7] and previous Australian studies,[8,9] but extend the period of risk to the afternoon shift.

There was an increase in the odds of afternoon and night discharges from the ICU in 2000–2002, and discharges were more evenly spread through the day, with morning and afternoon peaks, compared with the large morning peak in 1992–1994. This change may reflect delayed discharge due to a lack of available ward beds.[10] This is more likely to occur now as hospitals have significantly downsized and attempted to maximise bed usage with day-of-admission surgery, for which postoperative beds are not guaranteed. Alternatively, the discharge pattern may be due to a demand for ICU beds in excess of supply, so that the unplanned discharge of the "least sick or least needy patient" will occur to accommodate an emergency admission.

Afternoon shift discharges were 3.87 times and night shift discharges 5.47 times more likely to occur in the 2000–2002 period. Goldfrad and Rowan[4] analysed two databases (10 806 entries spanning 1988–1990 and 22 089 entries for 1995–1998) of admissions to a number of UK intensive care units. They found that night discharges (22:00–06:59) increased from 2.7% to 6.0%, proportions very similar to our own. They attributed this to increasing demand — the result of clinicians identifying more patients as being suitable for ICU, and rising rates of surgical procedures.

Night and afternoon discharges were associated with higher post-ICU mortality. Fur-

5 Univariate and multivariate analysis of predictors of mortality after discharge from the intensive care unit (ICU). Results are odds ratios (95% CIs)

	Univariate	Multivariate
Older age (years)	1.03 (1.02–1.04)	
Increasing APACHE II score	1.19 (1.17–1.20)	1.14 (1.12–1.16)
Admitted to ICU from:		
Emergency department (reference)		
Operating room/recovery room	0.22 (0.17–0.27)	1.47 (1.11–1.95)
General wards	2.17 (1.73–2.72)	1.75 (1.37–2.23)
Treatment category		
General (reference)		
Cardiac surgery	0.05 (0.03–0.37)	0.08 (0.05–0.13)
Postoperative monitoring	0.24 (0.16–0.37)	0.60 (0.37–0.97)
Renal replacement therapy	1.38 (1.12–1.17)	
Discharge times		
Morning nursing shift (07:00–14:59) (reference)		
Afternoon nursing shift (15:00–21:59)	2.78 (2.27–3.41)	1.36 (1.08–1.70)
Evening nursing shift (22:00–06:59)	2.08 (1.37–3.18)	1.63 (1.03–2.57)
Medical officer after-hours (18:00–07:59)	2.29 (1.78–2.94)	
Medical officer weekends (Fri 18:00 to Mon 07:59)	1.46 (1.18–1.81)	

thermore, our estimate of mortality risk for night discharge (1.63; 95% CI, 1.03–2.57) is very similar to that observed by Goldfrad and Rowan[4] (1.33; 95% CI, 1.06–1.65), Beck et al[7] (1.7; 95% CI, 1.28–2.25) and Duke et al[9] (1.7; 95% CI, 1.03–2.9).

Several factors might explain these results. Transfer from the ICU to a ward is associated with a significant reduction in clinical observation and monitoring, with the ratio of nurses to patients varying from 1: 4 to 1: 10. There are also fewer medical staff on the wards, with the least numbers of nurses and doctors at night. Several investigators have shown that increasing severity of illness or dependency of care at time of ICU discharge adversely affects hospital mortality.[1,7,11,12] Our finding that afternoon discharges are also associated with poorer outcomes suggests that longer medical and nursing observation of newly discharged patients during the day may reduce complications.

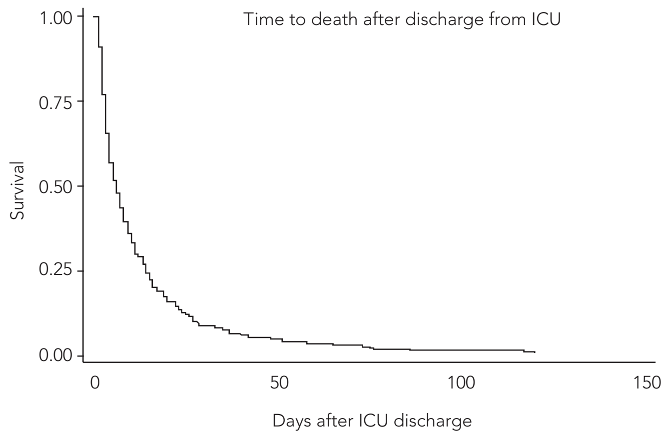
As previously noted, increased mortality of patients discharged at night may reflect premature discharge of patients with residual organ dysfunction who still require a greater level of nursing care than the wards can provide. While studies of post-ICU mortality support this hypothesis,[1,11,12] we do not have enough information about the patients who died to be certain. A proportion of patients discharged at night may be those for whom continued ICU care is judged futile, or for whom palliative care has been instituted, as they are not expected to survive to hospital discharge. Such patients would be discharged before patients receiving active care, and their discharge may have skewed the mortality rates when defined by nursing shift. Limitation of treatment orders are strongly associated with mortality after ICU discharge,[9,13] although, in a previous study, late discharge was still associated with increased mortality when limitation of treatment orders was taken into account.[9]

Thus, it seems likely that hospital "systems", such as nursing and medical staff numbers, play an important role in the outcome of patients with more severe illness (eg, those discharged from ICU). Changing hospital systems might reverse this negative association, and there is some evidence to support this hypothesis. More intensive nursing is one strategy. Beck et al were able to show reduced mortality for ICU patients discharged to a high dependency unit compared with those sent to general wards.[7] Critical Care Outreach Teams, as implemented in the UK, have been shown, in a number of studies, to reduce mortality, ICU admissions, and adverse events.[14-16] The role of medical emergency teams in Australia[17,18] needs to be defined; otherwise, health institutions will be pressured to increase ICU beds to meet increased demand and the need to hold patients for longer periods.

Our study has several limitations. The data come from a single university-associated tertiary institution. Casemix, patient-to-staff ratios, and emergency services may vary from hospital to hospital, so that the effect of night discharge may change. On the other hand, the consistency of estimates of risk at different hospitals in different countries suggests that this is a real and increasing phenomenon. A prospective study involving a spectrum of hospitals, adjusting for predefined risk factors, such as severity of illness on discharge, discharge destination, prematurity and treatment limitation orders, is needed. Such a study might concentrate on the 50% who succumb early and for whom better ward monitoring or extended ICU care may prevent complications.

In conclusion, afternoon and night discharges from the ICU have increased over time and are associated with excess in-hospital mortality, which may reflect a system problem related to increasing pressure on ICU beds and less intense after-hours supervision of patients on wards.

6 Kaplan–Meier survival curve for patients discharged alive from the intensive care unit (ICU)



COMPETING INTERESTS

None identified.

AUTHOR DETAILS

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