Does after-hours discharge of ICU patients influence outcome?

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ABSTRACT

Objective: To assess the frequency of after-hours discharges of patients from the intensive care unit and its effect on in-hospital mortality.

Design, setting and participants: Observational cohort study conducted in the ICU of Westmead Hospital, a tertiary care teaching hospital in Sydney. All adult patients admitted to the ICU between 1 January 2004 and 31 December 2006 were included in the study cohort. Patients were grouped into two categories based on the time of discharge from the ICU: during work hours (08:00–17:59 hours) or after-hours (18:00–07:59 hours).

Main outcome measure: Mortality after discharge from the ICU according to time of discharge.

Measurements and main results: 2300 patients accounted for 2451 admission episodes during the study period. There were 151 readmissions, involving 133 patients (5.8%). Excluded from the study cohort were 36 patients (1.6%) who were discharged home, 39 (1.7%) who were transferred to other hospitals, and 354 (15.4%) who died during their first stay in the ICU. Data on the remaining 1871 patients who were discharged alive at the end of their first ICU admission were included in our analysis. Of these patients, 1221 (65.3%) were discharged from the ICU during work-hours and 650 (34.7%) after-hours. Crude mortality for patients discharged after-hours was 13.7%, compared with 10.1% for those discharged during work hours. After adjustment for age, APACHE II score and discharge destination, the risk of mortality among patients discharged after-hours was statistically significant (adjusted odds ratio, 1.38 [95% CI, 1.01–1.88]; $P < 0.05$).

Conclusions: A high proportion of patients (34.7%) were discharged from the ICU after-hours. Discharge after-hours was associated with a higher risk of in-hospital mortality than discharge during work hours.

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Over the past decade, studies from Europe,[1-3] Australia[4-6] and North America[7-9] have highlighted the risk of adverse outcomes associated with untimely discharge of patients from the intensive care unit. These have included an increase in the risk of post-ICU mortality,[1-2,4-8] higher ICU readmission rates[4,6,7,9] and longer overall hospital length of stay[9] among patients discharged from the ICU after-hours.

Ever since the publication of a seminal paper by Goldfrad and Rowan[1] nearly 10 years ago, an impression has prevailed that mortality following after-hours discharge of patients is due to premature discharge of existing ICU patients to make way for sicker ones. This explanation was questioned when similar results were reported from centres in which delayed discharges were more common than premature ones.[4,6] As a result, even after several years of investigation, it is unclear as to why after-hours discharge of patients from the ICU is associated with poor patient outcomes. It is also not clear whether the problem of untimely discharge of ICU patients is limited to large metropolitan hospitals of publicly funded health care systems (like Australia's) or one that is more widespread.

We therefore conducted a retrospective cohort study to explore the relationship between after-hours discharge from the ICU and subsequent mortality, as an initial part of an ongoing investigation designed to clarify the influence of premature or delayed discharge and not-for-resuscitation (NFR) status on mortality of patients discharged after-hours.

Methods

Our study was undertaken at Westmead Hospital, a tertiary care teaching hospital affiliated with the University of Sydney. The ICU at Westmead Hospital is a 20-bed, Level III[10] medical–surgical (non-cardiac) ICU with a throughput of over 900 high-acuity admissions per year. More than 95% of patients admitted to this ICU are mechanically ventilated, and nearly 30% receive some form of renal replacement therapy. The unit is a major referral centre for trauma, but does not handle burns.

All patients aged > 18 years who were discharged alive from Westmead Hospital ICU over a 3-year period (1 January 2004 to 31 December 2006) were included in our study cohort. Patients transferred to another health care facility or those discharged home from the ICU were excluded. Readmissions were carefully identified and the outcomes of patients after their first admission to the ICU were analysed.

The primary outcome studied was post-ICU mortality in hospital. The outcome of patients who were discharged after-hours was compared with those discharged during

work hours. The hospital's Scientific Advisory Committee approved the study protocol as an audit project and waived the need for consent.

After-hours discharge

We defined after-hours discharges as those occurring between 18:00 and 07:59 hours. We used this definition on the basis of normal work schedules in our ICU and in recognition of the staffing pattern of medical officers and paramedical staff, as well as support from clinical and non-clinical departments that differs between work hours and after hours. Our definition of after-hours discharge was identical to one used by a Canadian multicentre study[8] and very similar to one used recently in an Australian study.[6] Weekday discharges were defined as those occurring from Monday to Friday and weekend discharges were those occurring on Saturday or Sunday.

Severity of illness

Severity of illness was recorded in two different ways — Acute Physiology and Chronic Health Evaluation (APACHE) II score or APACHE III score. For our analysis, we used the APACHE II score, as this was the standard risk assessment tool in our ICU until we changed to the APACHE III system in late 2004.

Statistical analysis

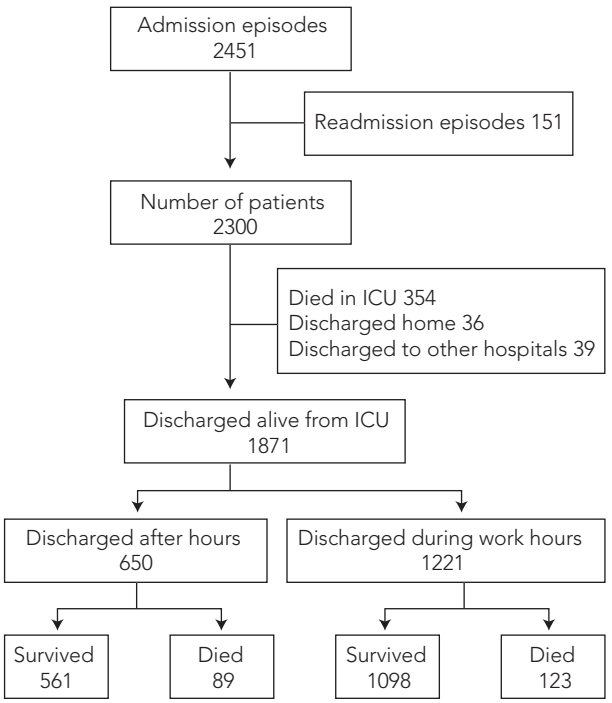
Continuous variables were expressed as median or mean, as appropriate. All categorical variables (expressed as numbers and percentages) were compared using the χ^2 test. An epidemiological model was developed with post-ICU mortality as the outcome variable and after-hours discharge from the ICU as the exposure variable. All covariates known to have an effect on post-ICU mortality were included. Multivariate logistic regression analysis was done using SAS version 9.1 (SAS Institute, Cary, NC, USA). A P value < 0.05 was taken to indicate statistical significance.

Results

During the 3-year study period, 2300 patients accounted for 2451 admission episodes. These included 133 patients with one or more readmissions (151 episodes) to the unit. For these patients, data from their *first* ICU admission was used in the analysis. Thirty-six patients (1.6%) were discharged home, 39 (1.7%) were transferred to other hospitals, and 354 (15.4%) died in the ICU. Our study cohort included the remaining 1871 patients who were discharged alive at the end of their first ICU admission (Figure 1).

The median age of the study population was 60 years. There were 1146 men (61.3%) and 725 women (38.7%). The median APACHE II score was 18 (range, 1–44), and about

Figure 1. Patient enrolment into the study cohort



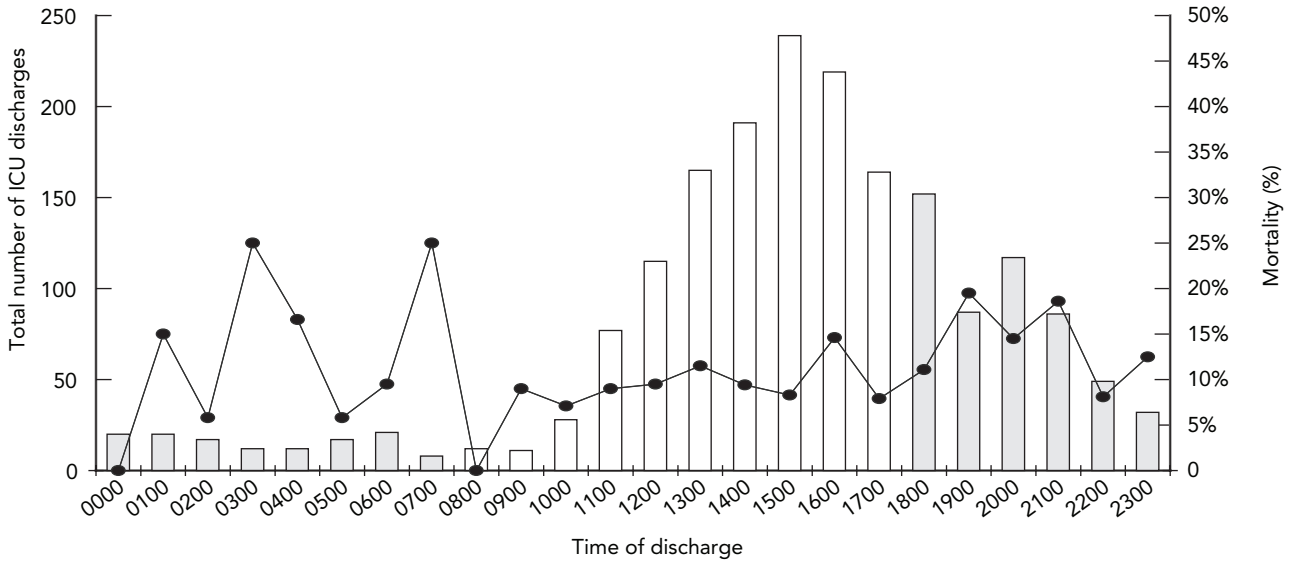
ICU = intensive care unit.

Table 1. Baseline characteristics of the study population ($n = 1871$)

Characteristic	After hours discharge	Work hours discharge	Total
Mean age in years (SD)	57.0 (19.6)	56.5 (19.7)	
Sex, *n* (%)			
Male	413 (63.5%)	733 (60.0%)	1146
Female	237 (36.5%)	488 (40.0%)	725
Median APACHE II (IQR)	18 (12–24)	18 (13–23)	1871
Admission category, *n* (%)			
Elective	123 (18.9%)	214 (17.5%)	337
Emergency	527 (81.1%)	1007 (82.5%)	1534
Median ICU stay in days (IQR)	4 (2–8)	4 (2–8)	1871
Day of discharge, *n* (%)			
Weekday	510 (78.5%)	857 (70.1%)	1367
Weekend	140 (21.5%)	364 (29.9%)	504
Discharge ward, *n* (%)			
General ward	138 (21.2%)	280 (22.9%)	418
HDU	512 (78.8%)	941 (77.1%)	1453

APACHE = Acute Physiology and Chronic Health Evaluation. HDU = high-dependency unit. IQR = interquartile range.

Figure 2. Mortality of patients discharged from the ICU according to time of discharge*



* Number of discharges is indicated by the bar graph and mortality by the point graph.

25% of patients had a score of 23 or higher at admission to the ICU. Most patients were admitted after an emergency, either in the emergency department (42.8%), on the wards (26.6%) or in the operating suite (10.5%) (Table 1).

Outcome according to time of discharge

650 patients (34.7%) were discharged alive from the ICU after-hours and 1221 patients (65.3%) were discharged alive from ICU during work hours. Eighty-nine of the 650 patients discharged after-hours (13.7%) died in hospital, compared with 123 of the 1221 patients discharged during work hours (10.1%). Discharge of patients from the ICU was evenly distributed across all days of the week, including weekends. Most of the patients were discharged to high-dependency wards (surgical, medical, neurosurgery/trauma or cardiac). Overall, 212 patients died in hospital after ICU discharge. More than 80% of those deaths occurred among patients aged $\geqslant 60$ years or patients with an APACHE score of $\geqslant 19$.

Variation in post-ICU hospital mortality according to the time of discharge was evident (Figure 2). The mortality among those discharged between 00:00 and 07:59 hours was 11.0% (14/127 patients). This was not significantly different from mortality among those discharged between 18:00 and 23:59 hours.

Multivariate analysis

After controlling for other covariates, after-hours discharge was associated with a statistically significant risk of increased post-ICU mortality (adjusted odds ratio [OR], 1.38 [95% CI, 1.01–1.88]; $P<0.05$). Age, severity of illness and discharge destination (general ward or high-dependency unit) emerged as important covariates in the relationship between after-hours discharge and post-ICU mortality (Table 2).

After adjusting for other covariates, every 1-year increment in age was associated with a 3% increase in the risk of death (adjusted OR, 1.03 [95% CI, 1.02–1.04]; $P<0.0001$). Whether modelled as a continuous variable or as a categorical variable (age groups according to quartiles), age remained a strong predictor of post-ICU mortality. Although an effect modification of age on after-hours discharge was suspected, this was found to be non-significant. APACHE II score had a near linear relationship with post-ICU mortality, and was used to adjust the OR of association between after-hours discharge and post-ICU mortality. Disease severity scores have face validity and were expected to have a strong association with post-ICU mortality. Odds ratio used as a measure of risk indicated that, after controlling for other factors, every one-point increase in APACHE score was associated with an increase in post-ICU mortality of 9% (adjusted OR, 1.09 [95% CI, 1.06–1.11]; $P<0.0001$). The final multivariate model was stable and fitted the data well (Hosmer–Lemeshow goodness of fit $\chi^2=6.70$, 8 df; $P=0.57$).

Discussion

We found that patients who were discharged after-hours from the ICU were at significantly higher risk of mortality than those who left the ICU during work hours. Similar observations have been described by authors of other single

Table 2. Factors associated with mortality among patients discharged from the ICU

Factor	Number	Odds ratio (95% CI)	Adjusted odds ratio* (95% CI)	$P^{\dagger}$
Age	1871	1.04 (1.03–1.05)	1.03 (1.02–1.04)‡	**< 0.0001**
Sex				0.22
Male§	1146	1.00	1.00	
Female	725	1.36 (1.02–1.81)	1.22 (0.88–1.64)	
APACHE II score	1871	1.11 (1.09–1.13)	1.09 (1.06–1.11)‡	**< 0.0001**
Admission				0.86
Elective§	337	1.00	1.00	
Emergency	1534	1.50 (0.99–2.28)	0.98 (0.66–1.53)	
Intensive care unit stay				0.69¶
⩽ 2 days§	706	1.00	1.00	
3–4 days	337	1.04 (0.69–1.65)	0.80 (0.50–1.28)	
5–8 days	385	1.42 (0.96–2.10)	1.02 (0.67–1.55)	
⩾ 9 days	443	1.55 (1.07–2.24)	1.06 (0.70–1.60)	
Day of discharge				0.85
Weekday§	1304	1.00	1.00	
Weekend	567	0.97 (0.70–1.34)	1.04 (0.73–1.46)	
Discharge ward				**< 0.0001**
General§	418	1.00	1.00	
High-dependency unit	1453	0.41 (0.30–0.56)	0.33 (0.24–0.46)	
Discharge time				**< 0.05**
Work hours§	1221	1.00	1.00	
After hours	650	1.42 (1.06–1.90)	1.38 (1.01–1.88)	

APACHE = Acute Physiology and Chronic Health Evaluation. * Adjusted for age, APACHE II score and discharge ward, as applicable. † *P* values indicating significant differences are shown in bold. ‡ Risk increment for each year (age) or every 1-point increase in APACHE score, respectively. § Reference category. ¶ *P* value based on Wald's χ^2 (for class variable) in multivariate logistic regression analysis.

and multicentre studies from Australia, and although comparisons are difficult, all have reported an increase in mortality among patients discharged from the ICU after-hours. The excess risk of mortality expressed as an OR has been estimated in these studies to range from 1.38 to 1.70.[4-6] The absolute increase in crude mortality after discharge from the ICU has been estimated to range from 2.7% to 3.6%.[5,6]

Current guidelines recommend that patients can be discharged from the ICU when their physiological status is considered to be stable and ICU monitoring is no longer felt to be necessary.[11] These guidelines, although conceptually sound, are difficult to put into practice.[12] Up to 30% of patients discharged alive out of the ICU do not survive to hospital discharge.[13] While some are not expected to survive because of limitation of treatment or NFR orders, up to 75% of patients who die in hospital after ICU discharge are actually expected to make a recovery.[14] Nearly half of those who die on the ward do so within the first week after discharge from the ICU.[15] A number of factors appear to play a role. Staffing levels at the discharge destination are generally low, but are invariably lower at night or late in the day.[16-18] As a direct result of this or due to a change in the intensity of monitoring, patient outcomes may be adversely affected. In critically ill patients, residual organ dysfunction at the time of discharge[19] or ICU-acquired infection[20] influences post-ICU mortality. Inadequate handover of clinical information or a poor appraisal of patient needs, particularly of those transferred late in the day, may compromise the quality of ongoing care. Although a difficult area of study, a recent publication[21] on untoward events within 72 hours of discharge has reported a higher frequency of adverse events occurring among patients discharged after-hours or over the weekend.

Irrespective of the reason, evidence from large observational studies from around the world now exists to support the view that after-hours discharge of patients from the ICU is unsafe. Over the past few years, an additional concern about rising trends in the proportion of patients leaving ICU after-hours has been raised by authors in the United Kingdom[1] and Australia.[5,6] Goldfrad and Rowan[1] reported a 2.2-fold increase in night-time discharges across ICUs in the UK, from 2.7% in 1988–1990 to 6.0% in 1995–1998. Tobin et al[5] observed more than a doubling of the proportion of patients discharged from the ICU after-hours in a 2000–2002

cohort (12.3%) compared with a 1992–1994 cohort (5.1%). Similar trends were reported by Pilcher et al[6] in a multicentre study involving 40 ICUs across Australia. In our cohort, we observed an unusually high proportion of patients discharged after-hours (34.7%).

For many years, readmissions to the ICU have served as a useful measure of health care quality.[22] However, after-hours discharge from the ICU appears to be an equally robust indicator of quality. Developed initially as a proxy measure of inappropriate early discharge from the ICU,[1,23] this parameter has yielded important insights into a health care system under strain. There are two well recognised reasons for patients to be discharged from ICU after hours. The first is a planned discharge of a patient who is not transferred during work hours due to non-availability of beds on the wards. The second is an unplanned discharge of a patient to make way for a more acutely sick patient due to limited bed capacity in the ICU. After-hours discharge of patients from Australian ICUs is increasingly recognised to be the result of non-availability of beds on the wards, so that a planned transfer of a patient electively identified as no longer requiring an ICU bed happens only late in the day or at night.[24] Efforts to limit this problem have not begun in earnest, despite the results of a large multicentre study[6] showing after-hours discharge to be the only risk factor amenable to intervention among those identified to be associated with post-ICU mortality.

Our study included consecutive admissions to a tertiary care ICU in a busy metropolitan hospital over a 3-year period. Being an observational study, our results suggest but do not prove a causal relationship between discharge time and patient outcome. Generalisability of our results is limited to ICUs in Australia with a similar organisational structure. High-dependency units (HDUs) in our hospital are geographically distinct and are supervised by the primary medical or surgical team. All HDUs in our hospital have physiological monitoring, a higher nurse-to-patient ratio (1 : 2 or 1 : 4) compared with the general wards, and availability of resident medical staff on a roster separate from the ICU. This unique feature allowed an enquiry into the role of post-ICU care on mortality among patients discharged after hours. Mortality among patients discharged to an HDU was lower than mortality in patients discharged to general wards (adjusted OR, 0.33 [95% CI, 0.24–0.46]; $P < 0.0001$). This observation suggests that ongoing physiological monitoring and high nurse-to-patient ratio in wards receiving ICU patients may allow for a safer transition of care. However, our study is limited by the lack of adjustment for advanced care directives and NFR orders. We hope to resolve this and other questions related to the influence of premature or delayed discharge in an ongoing prospective study.

The value of a single-centre observational study like our lies in its ability to look at a cohort of patients within a single health care environment. By pooling data from several sources, multicentre observational studies[3,6-9] do not allow meaningful comparisons to be made among hospitals with different organisational structure, staffing and governance patterns. What is more, retrospective multicentre studies involve enquiries into regional and national databases and are disadvantaged by inaccuracies related to missing and inconsistent data. In our single-centre study, we were able to overcome these difficulties by carefully eliminating missing data prior to analysis.

Conclusion

In our study, after-hours discharge from the ICU was associated with an increased risk of in-hospital mortality. The proportion of patients discharged after-hours from the ICU (34.7%) was one of the highest observed so far. Post-ICU mortality was associated with older age of patient and a higher APACHE II score at admission. Discharge to an HDU was associated with a lower risk of mortality compared with discharge directly to a general ward. While these findings are consistent with earlier observations, they provide useful insights into the transition of care arrangements for critically ill patients in our health care system.

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