Delayed discharges from an adult intensive care unit

Teresa Williams and Gavin Leslie

Abstract

Objective: Intensive Care Unit (ICU) services are expensive, and therefore appropriate utilisation is imperative. Delayed discharges impact on the efficiency and effectiveness of ICU services. This study examines the prevalence and reasons for delayed discharge.

Method: Cross sectional study. We enrolled a prospective sample of all patients admitted to a 22-bed ICU over a 6-month period. Medical staff in ICU informed nursing shift coordinators when patients could be discharged. Nursing shift coordinators maintained a record of discharge times, delays and reasons for delay. Discharge was considered delayed if the patient was not relocated from the ICU within 8 hours of being considered eligible by ICU medical staff.

Results: Of 652 recorded discharges, 176 were delayed (27%). Unavailable ward beds (81%) were cited as the main reason for delay in discharge. Median delay time was 21.3 hours (range, 10 minutes to 26 days). These delays were predicted by greater patient acuity on ICU admission, patient deterioration while waiting for transfer to the ward, principal admitting diagnosis, discharge destination and weekend discharge.

Conclusion: Improvement in bed management and discharge processes (the only factors directly controllable by the hospital) is essential to reduce delays in discharge from ICU. Reducing discharge delays would free up beds for other admissions; may result in a cost saving for the hospital through more efficient resource utilisation; and, ultimately, would benefit patients.

Aust Health Rev 2004: 28(1): 87–96

Teresa Williams, Clinical Nurse.
Intensive Care Unit, Royal Perth Hospital, Perth, WA.
Gavin Leslie, Associate Professor of Critical Care Nursing.
School of Nursing and Public Health, Edith Cowan University, Perth, WA.

Correspondence: Ms Teresa Williams, Intensive Care Unit, Royal Perth Hospital, 212-214 Wellington Street, Perth, WA 6000, Australia. **Teresa.Williams@health.wa.gov.au**

What is known about the topic?
ICU services are vital and costly. Delays in discharge compromise access and efficiency.

What does this paper add?
Twenty-seven percent of patients in a tertiary ICU experienced delays in discharge, mainly because of lack of available ward beds (81%). APACHE II score, DRG, day of week and discharge destination were predictive for delay. Most delays occurred during the weekend.

What are the implications for practitioners?
Improvement in bed management and discharge processes is essential to reduce delays in discharge from ICU, including more effective arrangements to enable transfer out of hours and on weekends.

INTENSIVE CARE UNITS (ICUs) aim to restore vital organ functioning in critically ill patients in order to gain time to treat the underlying cause of the critical illness (Acute Health Division 1997). Staff with highly developed knowledge and skills, supported by advanced technology, care for this heterogeneous population who often suffer from multiple system dysfunctions and coexisting medical problems (Weissman 1997). In striving to provide the highest achievable standard of care, ICUs require substantial investment in personnel, space and equipment and significant physical and emotional effort (Cullen 1977; Hanson et al. 1999; Vincent 1990). Since ICU services account for a significant proportion of hospital costs and resources, maximising efficient and effective use of ICU is a prime concern to health care planners (Cerra 1993; Cooper et al.1999; Jacobs P & Noseworthy 1990).

Patients should be discharged from ICU when this specialised care is no longer needed (Levin & Sprung 2001). Patients ready for discharge but remaining in ICU block beds for impending admissions and unnecessarily utilise costly and scarce resources (Fox, Owen-Smith & Spiers

1999; Groeger et al. 1993; Levin & Sprung 2001; Southgate 1999). By remaining in a stressful environment, patients may experience negative psychological and social effects detrimental to their recovery (Franklin & Jackson 1983; Jacobs CJ et al. 1988; Lawless et al. 1991).

To date, there are few published studies that focus specifically on delayed discharges from the ICU, although issues of cost, benefit, length of stay and admission/triage/discharge to ICU have been addressed. Groeger et al. (1993), Levin & Sprung (2001) and Southgate (1999) have noted that reducing discharge delays may result in a cost saving for the health care facility and the release of ICU beds in a more timely fashion. However, the extent of delay in the Australian setting has not been quantified, either in terms of frequency, duration or reason for delay. This observational study was undertaken to determine the occurrence of delays in ICU discharge and the reasons for these delays.

Methods

Objectives

To determine the occurrence of delays in ICU discharge and to identify the reasons for the delays.

Design

A cross sectional design was chosen. Patients were enrolled in the study when they were eligible for discharge. If their discharge was delayed then the reason for delay was recorded. Discharge was considered delayed if the patient was not relocated from the ICU within 8 hours of being considered eligible for discharge by ICU medical staff. The 8-hour time period was chosen based on expert opinion of senior nurses and bed managers in the ICU as a reasonable time period to locate and discharge the patient to an appropriate destination. An overview of the ICU discharge process is shown in Box 1.

Setting

The study was conducted in a metropolitan tertiary teaching hospital of 955 beds. The ICU has 22 combined medical and surgical beds.

Participants

A prospective convenience sample of all patients admitted to ICU in the six-month period 18 September 2000 to 18 March 2001 was selected.

Data collection tool

A collaborative team approach was used to develop definitions, and the data collection tool was modified from the existing bed-list record that was in use in the ICU before the time of the study.

Pilot study

An 11-week pilot study ($n = 268$) was conducted. The need to clarify terminology and augment training relating to the data collection tool was identified and addressed. Interrater reliability of 96% was established during the pilot study. Face validity was established by a panel of expert ICU nurses who reviewed the tool to determine if the items included were suitable to obtain the data required to measure delays.

Method of data collection

ICU nursing shift coordinators, who were experienced senior ICU registered nurses, were trained in the use of the tool before commencement of data collection to facilitate consistency and accuracy. Unit medical staff identified patients ready for discharge from the ICU and the nursing shift coordinators documented these patient discharges and reasons for delay on the data collection sheet. Several assumptions were made when the notification time was not documented (see Box 2).

Ethical considerations

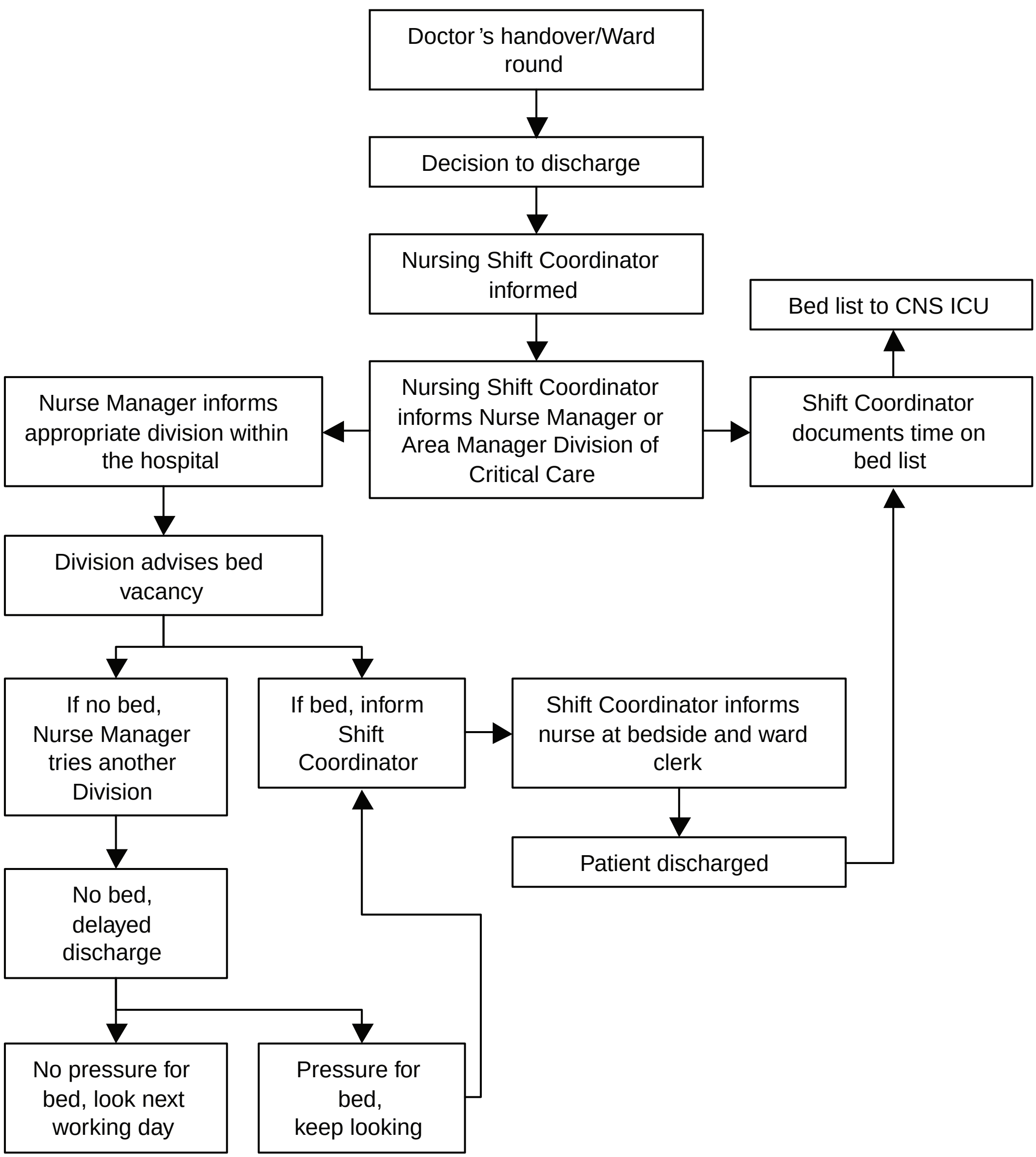
Institutional reviews included approval from the hospital Nursing Research Review Committee that monitors all nursing research in the hospital. The ICU medical and nursing heads of department approved this study.

Statistical analysis

Statistical analyses of the data were performed utilising the Statistical Package for the Social Sciences (SPSS) version 10.0 software (Chicago, Illinios, 1999) and SAS version 8.2 (Cary, NC, USA, 1999-2001). Descriptive analyses of the independent variables were made using Pearson chi square for categorical data, the Mann-Whitney non-parametric test for continuous data not normally distributed, and the Student's *t* test for comparing means in normally distributed continuous data. The outcome variable in this study was delayed discharge, statistical significance was set at $P < 0.05$ and the confidence interval at 95%. The denominator used in expressing discharges as a percentage was the number of patient discharges rather than number of patients, as patients may have had more than one discharge.

A backwards stepwise logistic regression analysis was undertaken to remove non-contributory

1 Intensive Care Unit discharge process



explanatory variables (Knuiman & Divitini 2002). Some variables were reclassified for this analysis. Collapsing of variables into categories was based on distinct grouping in bivariate analysis because of variable interdependence. The regrouping of variables did not change their statistical significance. Primary admitting diagnosis was not included in the model as it is closely related to primary organ system failure and specialty. Patients often have multiple diagnoses on admission to ICU and the primary admitting diagnosis may be confusing. The diagnoses were regrouped into three categories which are clinically important and less ambiguous — medical, elective surgical and non-elective surgical. Day of eligible discharge was regrouped into weekend and non-weekend. Non-significant variables ($P = 0.2$) with the weakest association were removed one by one from the model. The more stringent P value of 0.01 was chosen for the final model because of the large number of comparisons, which increase the likelihood that a few variables may be significant due to chance even when no real association existed. Discrimination was tested using the receiver operating characteristic (ROC) curve and the calibration was measured by the Hosmer-Lemeshow statistic.

2 Assumptions

If a patient was admitted to the intensive care unit (ICU) following elective neurosurgical or cardiothoracic surgery, the earliest that they could be discharged from the ICU would be the day following surgery. If patients were discharged during business hours on the day following surgery, they were coded as no delay in this instance.

If a patient was admitted to the ICU and discharged within eight hours they were coded as no delay.

Patients transferred to the rehabilitation campus were considered discharged from the acute care facility, as they were discharged on the hospital's computerised TOPAS system.

If the patient was discharged alive from the ICU (regardless of whether they died on a subsequent admission) the "alive" discharge was included in the data analysis.

Results

There were 652 discharges (609 patients) from ICU in the study period. There were more males than females (61% v 39%). Surgical admissions accounted for 58% of admissions, with 70% of these being elective.

The prevalence of ICU discharge delays was 27% ($n = 176/652$; 95% CI, 24%–31%). The main reason (Box 3) for delay in discharge was unavailable ward beds (81%). Medical reasons, affecting patients initially deemed suitable for discharge and subsequently (after 8 hours post eligibility) deemed no longer medically fit to be discharged, accounted for 8.5% ($n = 15$) of delays. Excluding these patients, the prevalence of discharge delays

3 Reasons for delay

	Number	Percentage of delays	Percentage of total
No ward bed	132	75.0	20.5
Ward bed delayed	10	5.7	1.6
Medical complications	15	8.5	2.3
Environment	1	0.6	0.2
Lack of medical cover	1	0.6	0.2
Transport	1	0.6	0.2
No reason cited	10	5.7	1.5
Closure of cardiothoracic ward	3	1.7	0.5
Other	3	1.7	0.5
Total	176	100%	27.3%

was 25% ($n = 161$). Other reasons for delay included lack of a single room (required for infection control purposes), transport (transferring to another facility), lack of medical cover, no psychiatric nurse being available, and ward nursing staff with inadequate skills. In 10 delayed patient discharges, no reason was cited (5.7%). Patients' ICU discharge delay time (ie, above the 8-hour accepted timeframe) ranged from 10 minutes to 26 days (mean, 42 hours; SD, 70.8 hours; median, 21 hours). The longest delay time was due to medical complications. Excluding this group, delay times ranged from 10 minutes to 18 days. Some of the patients who were delayed because of medical complications were later further delayed due to lack of ward beds. Only the initial cause of delay was included in data analysis. The majority of delayed patients ($n = 115$) were discharged within 24 hours of the decision to discharge.

The delay times were grouped into 8-hourly time periods (Box 4). The most frequent delay length was between 16 and 24 hours (36.4%), followed by delays of less than 8 hours above the threshold (21.0%).

4 Eight-hourly delay time groups for delayed discharges from ICU

Period	Number	Percentage
First 8 hours (after classification of delayed)	37	21.0
8 to 16 hours	14	8.0
16 to 24 hours	64	36.4
24 to 32 hours	9	5.1
32 to 40 hours	1	0.6
40 to 48 hours	17	9.7
48 hours to 168 hours (1 week)	27	15.3
More than 168 hours (1 week)	7	4.0
Totals	176	100

Factors associated with delayed discharge

Delayed discharges were compared with non-delayed discharges (Box 5). Factors significantly associated with delay included APACHE II score (an internationally accepted measure of ICU severity of illness and outcome — see Knaus et al. 1985) on admission, worst APACHE II score in first 24 hours, ICU admitting diagnosis, primary organ system failure, discharge destination, specialty and day of eligible discharge. Although ICU occupancy was not statistically significant (median, 82% for both groups; range, 41%–100%, $P = 0.082$), an interesting trend was observed. When occupancy exceeded 70%, delays in discharge increased. This trend reversed when occupancy exceeded 80%, with a substantial decrease in delays as bed occupancy increased to maximum capacity (Box 6).

To investigate the relationship between combinations of factors and delay in discharge, the factors associated with delay were included in a logistic regression analysis (Box 7). Other variables including age, gender, and unit occupancy were added to different models during the model development process. Occupancy was included in initial models because it has been found in other studies to influence discharge decisions (Levin & Sprung 2001; Strauss et al. 1986). Results of the analysis of maximum likelihood estimates and odds ratio estimates are shown in Box 7.

The final model, after adjusting for confounding factors and effect modifiers, showed that APACHE II score ($P < 0.0001$), diagnosis group ($P = 0.0041$), day-of-week group when eligible for discharge ($P < 0.0001$), and discharge destination ($P < 0.0001$) were predictive for delay. The discrimination of the final model using the ROC curve (Box 8) was moderately good (0.741, $P < 0.0001$; 95% CI, 0.698–0.784). Model calibration measured by the Hosmer-Lemeshow statistic was good ($P = 0.964$) (Box 8).

Discussion

The purpose of this study was to determine whether delays in discharge from ICU occurred and, if this were so, what the reasons for these delays were. Anecdotal reports from the study hospital's ICU staff supported the premise that

5 Sample characteristics of non-delayed and delayed ICU patient discharges

	Non-delayed (n=468)	Delayed (n=176)	Test	Significance
Age in years (median)	57 (range 13–91)	55 (range 15–87)	$z = 1.105$	$P = 0.269$
Gender (n, male/female)	294/100	194/76	$\chi^2_1 = 1.940$	$P = 0.164$
Mean APACHE II score on admission	10.8	12.8	$t = -3.824$ (642)	$P < 0.0001$
Worst APACHE II score in first 24 hours	12.8	15.6	$t = -5.123$(642)	$P < 0.0001$
Median length of stay*(range).	23 hours (0.3 to 40 days)	43 hours (0.8 to 61 days)	$z = -3.848$	$P < 0.0001$
Median delay time (range)		21 hours (10 minutes to 26 days)		
Median delay time excluding medical reasons for delay (range)		21 hours (10 minutes to 18 days)		
Occupancy (mean)	80.3%	78.2%	$t = 1.739$ (642)	$P = 0.082$.
Month			$\chi^2_6 = 11.39$	$P < 0.077$
September	6% (27/468)	7% (12/176)		
October	17% (79/468)	13% (22/176)		
November	20% (95/468)	13% (23/176)		
December	18% (84/468)	18% (32/176)		
January	15% (68/468)	15% (27/176)		
February	14% (64/468)	22% (39/176)		
March	11% (51/468)	12% (21/176)		
ICU admitting diagnosis			$\chi^2_2 = 22.97$	$P < 0.0001$
Medical	38% (179/468)	51% (89/176)		
Elective surgical	47% (218/468)	26% (46/176)		
Emergency surgical	15% (71/468)	23% (41/176)		
Day of eligible discharge			$\chi^2_1 = 24.21$	$P < 0.0001$
Tues to Fri	72% (338/468)	52% (91/176)		
Sat to Mon	28% (130/468)	48% (85/176)		
Discharge destination			$\chi^2_4 = 48.29$	$P < 0.0001$
Medical	14% (66/468)	35% (62/176)		
Cardiovascular	41% (190/468)	20% (35/176)		
Critical care	29% (137/468)	27% (47/176)		
Surgical	11% (53/468)	10% (17/176)		
External facility	5% (22/468)	9% (15/176)		
Primary organ system failure			$\chi^2_3 = 9.05$	$P = 0.029$
Cardiovascular	42% (197/468)	31% (54/176)		
Neuro	33% (153/468)	35% (61/176)		
Respiratory	21% (96/468)	27% (47/176)		
Other	5% (22/468)	8% (14/176)		
Specialty			$\chi^2_4 = 35.17$	$P < 0.0001$
Medical	19% (91/468)	42% (73/176)		
Cardiovascular	41% (190/468)	24% (43/176)		
Surgical	14% (66/468)	14% (24/176)		
Neuro	21% (97/468)	17% (29/176)		
Orthopaedic	5% (24/468)	4% (7/176)		
Source of admission			$\chi^2_4 = 9.08$	$P = 0.059$
Theatre	55% (259/468)	43% (76/176)		
Recovery room	6% (27/468)	6% (10/176)		
Emergency	24% (110/468)	28% (50/176)		
Other ward	7% (32/468)	9% (16/176)		
External facility	9% (40/468)	14% (24/176)		

*Length of stay defined from time of admission to ICU to time eligible for discharge delays in discharge did occur, but the extent and reasons for delay were not clear. During the 6-month study period, there were 652 discharges (609 patients) from ICU, with a substantial proportion (27%) of these patient discharges being delayed (ie, discharged more than 8 hours after being deemed eligible for discharge by ICU medical staff), confirming the hospital staff's concerns.

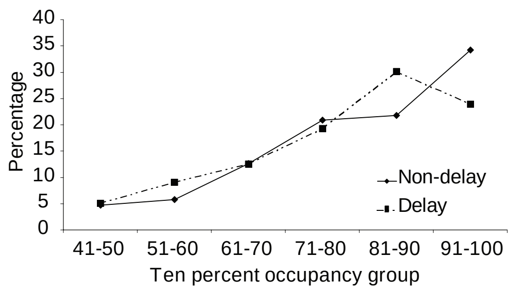
Lack of availability of ward beds accounted for nearly 81% of delays. There may be many reasons for bed unavailability, including bed-management practices, unpredictable emergency admissions, ward-discharge processes and unavailability of aged care beds (Alexander 2000; Commonwealth Department of Health and Aged Care 1999; Comptroller & Auditor General & National Audit Office 2000). The predominance of delays due to bed unavailability suggests that improvement in bed management and discharge processes (the only factors directly controllable by the hospital) is essential to reduce discharge delays from ICU.

Medical reasons (ie, loss of readiness for discharge subsequent to deeming as ready) accounted for 8.5% of the patient delays from the ICU. This factor may be due to differences in the clinical judgement of different intensivists, but this study did not allow the causes to be determined. Pressure on ICU beds may encourage reduction in the ICU length of stay (Strauss et al. 1986). This may result in premature discharge from the ICU (Baigelman, Katz & Geary 1983; Franklin & Jackson 1983; Keenan et al. 1997; Snow, Bergin & Horrigan 1985). Patients who are discharged too early from ICU may experience worse outcomes (Goldfrad & Rowan 2000). Delays due to medical reasons only comprised a very small number of patients (n=15) and removal of these patients from analysis did not reduce the delay incidence significantly (25% v 27%).

Patients with delayed discharge differed from those who were not delayed in a number of ways, including clinical and organisational factors. The sicker or more complex patients tended to be those who experienced delays in their discharge.

The patient's severity of illness on admission to ICU (as measured by the APACHE II score) should not, in theory, have influenced delay status. However, we found patients who were more severely ill

6 Occupancy in ten percent groupings for all non-delayed and delayed discharges



on admission were more likely to be delayed. ICU length of stay (to eligibility for discharge) was also longer for patients whose discharges were delayed. Although discharge decisions were made using objective criteria, subjective factors may have influenced discharge outcomes. Before a patient's discharge from the ICU, experienced nurses from the appropriate ward area assessed the patient in ICU. Bias could have been introduced if patients who had been less sick or required fewer nursing resources on the ward were given preference for admission to the ward.

Organisational factors associated with discharge delay included the day of notification of readiness for discharge from the ICU, and discharge destination. Although the study hospital has 24-hour, 7-day service facilities, it was noted anecdotally before the study that those patients who were not discharged by Saturday often remained in the ICU until Monday. Other investigators have found similar results (Moyer 1994). Within the study hospital, admissions from the emergency department were responsible for pressure on ward beds particularly at weekends. Pressures on hospital resources, especially when hospital occupancy was at capacity, may have influenced patient delays in the ICU. Keeping patients in ICU beds when there was no pressure on these beds while hospital beds were fully occupied was seen as a better alternative than finding ways to discharge patients from the ICU.

7 Analysis of maximum likelihood estimates and odds ratio estimates

						95% CI	
	df	Estimate	SE	*P*	OR	Lower	Upper
Intercept	1	–1.30	0.29	< 0.0001			
APACHE II worst in 24 Hours Group 21 or more	1	1.28	0.33	0.0001	3.59	1.88	6.85
APACHE II Worst in 24 Hours Group 11–20	1	0.89	0.23	0.0001	2.44	1.54	3.86
APACHE II Worst in 24 Hours Group 0–10	0	0					
Diagnosis Elective Surgical	1	0.50	0.29	0.0895	1.64	0.93	2.91
Diagnosis Emergency Surgical	1	0.97	0.29	0.0009	2.62	1.48	4.64
Diagnosis Medical	0	0					
Day Group Sat to Mon	1	0.78	0.20	< 0.0001	2.17	1.47	3.21
Day Group Tues to Fri	0	0					
Discharge Destination External	1	–0.29	0.40	0.4735	0.75	0.34	1.65
Discharge Destination Surg Specialties	1	–1.28	0.37	0.0006	0.28	0.13	0.58
Discharge Destination Cardiovascular	1	–1.84	0.33	0.0001	0.16	0.08	0.31
Discharge Destination Critical Care	1	–1.08	0.29	0.0002	0.34	0.19	0.60
Discharge Destination Medical	0	0					

Most delays occurred during the weekend (Saturday to Monday). Clear guidelines and processes for discharge management from ICU are necessary to facilitate transfer after hours and on weekends.

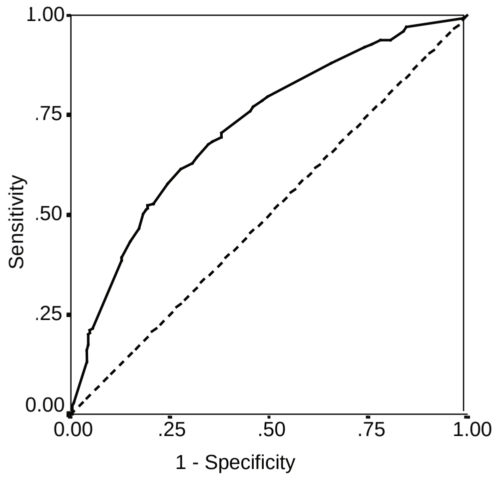
It was expected that the discharge destination and the patients' specialty would influence ICU discharge: both were found to be statistically significant. This is not surprising, as it is difficult to separate destination from specialty. Wards tend to group similar specialties within their area, promoting expertise in nursing care for particular kinds of patients, and facilitating access for medical staff. Only when the beds in the division which included the patient's specialty were unavailable were other discharge destinations sought. That is, surgical patients were normally discharged to surgical ward beds and medical patients to medical ward beds. It was more difficult to place patients in ward beds outside their clinical division. If a particular division was operating at or near full capacity with admissions exceeding discharges, particularly from the emergency department, there may be less manoeuvrability to accept patient discharges from the ICU. The most common discharge destination from the ICU was the cardiovascular division, but this division experienced fewest delays, possibly related to the number of elective procedures. Patients discharged to the Critical Care division (neurosurgery and orthopaedics) and the Medical Specialities division experienced most delays. Medical beds may have been occupied by patients who were unable to be discharged to suitable accommodation in aged care facilities (Government of Western Australia 2002).

The increasing demand for ICU services is reflected in increasing bed occupancy and admission rates. The demands for these services often exceed supply, resulting in pressure on ICU beds (Society of Critical Care Medicine Ethics Committee 1994). It would therefore be logical that occupancy could sway discharge decisions. Occupancy was not found to be a statistically significant factor in discharge decisions in our study, but there was an increase in the number of delays when bed occupancy was between 70% and 80%. Delays decreased as occupancy increased to maximum capacity, which may reflect increasing discharge effort in order to ensure beds were available for new ICU admissions. The factors predictive of delay from the logistic regression analysis were: worst APACHE II score in first 24 hours; diagnostic category; discharge destination (particularly to the orthopaedic, neurosurgery and medical wards) and day-of-week eligibility for discharge. Attention to factors influencing delay is probably more useful at the time of patient admission, so that measures may be implemented to minimise the possibility of delay. However, the most robust model included the day when patients were ready for discharge, and this is often unknown at the time of admission. What the model does demonstrate is that, even after adjusting for confounders and effect modifiers, patients with these factors are much more likely to be delayed from the ICU.

Delays in discharge have cost implications. In an attempt to illustrate cost implications, additional nursing time incurred by delayed patients (excluding those delayed by medical complications, and those delayed for less than a full shift above the 8-hour threshold) was estimated (5500 hours). Using the average nursing cost per hour ($30.77; personal communication, L Brearley 2002), this equates to a total additional nursing cost of $169 235.

Although average bed-day costs are not an accurate method to cost or compare ICU services (Gyldmark 1995), they are used by hospitals as a rough estimate. The average daily cost of ICU beds in the study hospital for the financial year 2000–2001 was $1950 (personal communication, J Harris 2000). The cost of the115 additional bed-days notionally incurred by those patients who were delayed for less than a day beyond the 8-hour threshold is an additional $189 750. This estimate excludes the 61 patients who were delayed for more than a day. While these are rough estimates, which undoubtedly understate the real cost, they indicate that the potential savings from reducing delayed discharges are significant.

8 Area under the receiver operating curve



Diagonal segments are produced by ties.

The study hospital's ICU is typical of tertiary ICUs in Australia. However, it is unknown whether results can be generalised given the differences in patient acuity and casemix. The lack of a step down unit may have increased the delays of the sickest patients, although this study produced no evidence of this. The study was limited by lack of data on patient acuity and nurse-dependency at the time of the discharge decision.

This study highlights several future research directions. Research is needed into the most appropriate admission and discharge criteria, as well as to determine the effect of hospital occupancy on discharge processes, and the factors precipitating diversion of patients from one critical care service to another. Information which could be used to determine the optimal number of ICU and intermediate care unit beds would be valuable for health care managers.

Acknowledgement

We would like to thank Dr Geoff Dobb for his support and encouragement and the ICU nursing shift coordinators for acting as data collectors for the study.

References

Acute Health Division 1997, Review of intensive care in Victoria [Phase 1 report], Department of Human Services, Melbourne.

Alexander A 2000, The National Demonstration Hospitals Program, *Australian Health Review,* vol. 23, pp. 198-204.

Baigelman W, Katz R & Geary G 1983, Patient readmission to critical care units during the same hospitalization at a community teaching hospital, *Intensive Care Medicine*, vol. 9, pp. 253-6.

Cerra FB 1993, Healthcare reform: the role of coordinated critical care, *Critical Care Medicine,* vol. 21, pp. 457-64.

Commonwealth Department of Health and Aged Care 1999, Managing beds better. Balancing supply and demand. The NDHP-2 experience July 1997 to June 1998, Australian Government Printing Service, Canberra.

Comptroller & Auditor General & National Audit Office 2000, Inpatient admissions and bed management in NHS acute hospitals, The Stationery Office, London.

Cooper GS, Sirio CA, Rotondi AJ, Shepardson LB & Rosenthal GE 1999, Are readmissions to the intensive care unit a useful measure of hospital performance? *Medical Care,* vol. 37, pp. 399-408.

Cullen DJ 1977, Results and costs of intensive care, *Anesthesiology*, vol. 47, pp. 203-16.

Fox AJ, Owen-Smith O & Spiers P 1999, The immediate impact of opening an adult high dependency unit on intensive care unit occupancy, *Anaesthesia,* vol. 54, pp. 280-3.

Franklin C & Jackson D 1983, Discharge decision-making in a medical ICU: characteristics of unexpected readmissions, *Critical Care Medicine,* vol. 11, pp. 61-6.

Goldfrad C & Rowan K 2000, Consequences of discharges from intensive care at night, *Lancet,* vol. 355, pp. 1138-42.

Government of Western Australia 2002, Annual Report 2000/2001, vol. 1, Health Department of Western Australia, 4 February.

Groeger JS, Guntupalli KK, Strosberg M, Halpern N, Raphaely RC, Cerra F & Kaye W 1993, Descriptive analysis of critical care units in the United States: patient characteristics and intensive care unit utilization [comment], *Critical Care Medicine,* vol. 21, pp. 279-91.

Gyldmark M 1995, A review of cost studies of intensive care units: problems with the cost concept, *Critical Care Medicine,* vol. 23, pp. 964-72.

Hanson CW 3rd, Deutschman CS, Anderson HL 3rd, Reilly PM, Behringer EC, Schwab CW & Price J 1999, Effects of an organized critical care service on outcomes and resource utilization: a cohort study, *Critical Care Medicine,* vol. 27, pp. 270-4.

Jacobs CJ, van der Vliet JA, van Roozendaal MT & van der Linden CJ 1988, Mortality and quality of life after intensive care for critical illness, *Intensive Care Medicine,* vol. 14, pp. 217-220.

Jacobs P & Noseworthy TW 1990, National estimates of intensive care utilization and costs: Canada and the United States, *Critical Care Medicine,* vol. 18, pp. 1282-6.

Keenan SP, Doig GS, Martin CM, Inman KJ & Sibbald WJ 1997, Assessing the efficiency of the admission process to a critical care unit: does the literature allow the use of benchmarking? *Intensive Care Medicine,* vol. 23, pp. 574-80.

Knaus WA, Draper EA, Wagner DP & Zimmerman JE 1985, APACHE II: a severity of disease classification system, *Critical Care Medicine,* vol. 13, pp. 818-29.

Knuiman M & Divitini M 2002, *Biostatistics II. Statistical methods in epidemiological and clinical research*, University of Western Australia, Perth.

Lawless S, Zaritsky A, Phipps J & Riley-Lawless K 1991, Characteristics of pediatric intermediate care units in pediatric training programs, *Critical Care Medicine,* vol. 19, pp. 1004-7.

Levin PD & Sprung CL 2001, The process of intensive care triage, *Intensive Care Medicine,* vol. 27, pp. 1441-5.

Moyer JA 1994, Factors related to length of ICU stay for CABG patients, *Dimensions of Critical Care Nursing*: *DCCN,* vol. 13, pp. 194-200.

Snow N, Bergin KT & Horrigan TP 1985, Readmission of patients to the surgical intensive care unit: patient profiles and possibilities for prevention, *Critical Care Medicine,* vol. 13, pp. 961-4.

Society of Critical Care Medicine Ethics Committee 1994, Consensus statement on the triage of critically ill patients, *JAMA: Journal of the American Medical Association,* vol. 271, pp. 1200-3.

Southgate HM 1999, Critical analysis of access to and availability of intensive care, *Intensive & Critical Care Nursing,* vol. 15, pp. 204-9.

Strauss MJ, LoGerfo JP, Yeltatzie JA, Temkin N & Hudson LD 1986, Rationing of intensive care unit services. An everyday occurrence, *JAMA: Journal of the American Medical Association,* vol. 255, pp. 1143-6.

Vincent JL 1990, European attitudes towards ethical problems in intensive care medicine: results of an ethical questionnaire, *Intensive Care Medicine,* vol. 16, pp. 256-64.

Weissman C 1997, Analyzing intensive care unit length of stay data: problems and possible solutions, *Critical Care Medicine,* vol. 25, pp. 1594-1600.

(Received 20 Nov 2003, accepted 30 Jun 2004)