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Long-Term Outcome of Long Stay ICU and HDU Patients in a New Zealand Hospital

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Abstract

***Objective*: The objective of the study is to determine factors that influence the outcome of long stay patients in a general intensive care unit (ICU) and/or high-dependency unit (HDU) in a New Zealand teaching hospital.**

***Setting*: 10-bed general ICU and 4-bed surgical HDU in a 400-bed hospital.**

***Study type*: Population based retrospective cohort study.**

***Methods*: All patients with prolonged stay in a high resource area (>7 days in the ICU or >14 days in either the ICU or HDU) between 2000 and 2003 were reviewed. Demographic data, co-morbidities, diagnoses, clinical events, hospital and 1-year mortality data were obtained using available databases and patient records. Multiple logistic regression analysis was performed to identify which variables are associated with death among patients with a prolonged stay in a high-resource unit (ICU/HDU).**

***Results*: 207 patients were included in the study. Twenty eight percent died before hospital discharge and 40% died within one year of their admission. Univariate analysis showed that increasing age, APACHE II score, admission post cardiac arrest, inpatient cardiac arrest, development of sepsis and requirement for renal support therapy were all risk factors for increased mortality. However, when adjusted for age, gender and APACHE II score the only risk factor strongly associated with death was having a cardiac arrest in the ICU.**

***Conclusions*: Prolonged ICU and/or HDU stay is associated with a high mortality rate particularly in patients with advancing age and increasing severity of illness. In this study, only cardiac arrest after a prolonged stay in the ICU and/or HDU is a strong predictor of death independent of the age and the APACHE II score.**

Introduction

ICU and HDU care expend a large proportion of hospital resources, despite the relatively low proportion of beds dedicated to these areas. Dunedin hospital is a 400-bed teaching hospital, with 10 ICU beds, 4 general surgery HDU beds and 3 beds dedicated to neurosurgery and surgical subspecialties. Despite the large resource consumption the mortality and morbidity after discharge from these areas is high. Studies looking at long term survival after ICU admission range between 60-75% at one year [1-4]. There are several patient factors that have been identified that affect clinical outcome. Patients over 75 years have a survival of 55% at one year in one study [5]. In another paper, patients admitted with malignancy requiring ICU admission have a survival as low as 23% at one year [6]. Presence of shock and sepsis doubles the hospital mortality of cardiothoracic surgery patients [7]. A prolonged ICU stay increases the risk of readmission for cardiac

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diagnoses [8] and respiratory failure, and is associated with increased risk of dialysis dependent renal failure [9-11].

The cost of ICU treatment is very high. Mean costs have been reported at approximately US$1,500 per day [12,13] and up to $50,000 for the entire ICU admission of prolonged stay patients. Although only approximately 10% of ICU patients spend more than seven days in the ICU [14], this group of patients accounts for 40 to 50% of total ICU costs. They are also the most resource-intensive. In one study, these patients consumed 53.4% of all Therapeutic Intervention Scoring System (TISS) points provided [15].

Given the economic and resource cost of the long stay group of patients, this study aims to identify factors that may more reliably predict the prognosis of this group. Many studies have focused on predicting outcome of specific groups of ICU patients irrespective of the length-of-stay [16]. The long stay ICU patients were specifically targeted because the risk-benefit ratio of an ICU admission is different among these patients compared to the high throughput patients. The variables studies included the admitting diagnosis, the co-morbidities, and the complications that developed during their ICU/HDU stay.

Methods

Facility:

The ICU facility was a 10-bed combined medical and surgical ICU in a tertiary hospital service, which also provides support for patients after cardiothoracic surgery. The surgical HDU is a general surgical facility with 4 beds, excluding neurosurgical patients.

Patient selection:

The subjects were all patients of Dunedin hospital. The ORACARE, hospital admission database, was searched for patients who had an ICU length of stay (LOS) greater than 7 days, or combined ICU and HDU LOS greater than 14days. The LOS data was recorded routinely on this database for the purpose of cost allocation. All patients admitted between 1999 and 2004 were included in the study. The patients' medical records were searched and admission criteria, co-morbidities, and complications were coded (**Table 1**). Standard definitions were developed for all the variables prior to the database and chart reviews and are shown in **Appendix A**. The APACHE II scoring was also obtained from the ICU STATIC database where present. Mortality data was available from the hospital ORACARE system. The death of a patient is initially recorded in the register of births, deaths and marriages. This information is entered routinely into the hospital ORACARE database with a lag time of up to three months.

Data analysis:

Univariate analysis was performed on the variables selected followed by multivariate analysis adjusting for age, gender and APACHE. The p value and chi square was obtained for each variable. A p-value less than 0.05 was considered to be significant.

Results

Over the study period there were 3240 patients admitted to the ICU of which 1074 had cardiac surgery. Two hundred and seven patients fulfilled the criteria for entry. The demographic data was listed in **Table 2**.

Of the 207 patients, 60 (28%) were dead before discharge from hospital. Eighty-four (40%) of participants were dead within one year of hospitalisation. **Table 1** shows the reasons for admission criteria and the relative numbers. Patients could have more than one reasons for admission.

During their stay in the ICU, 16 patients of the 207 long stay patients had a cardiac arrest, 26 had acute coronary syndrome, 80 had sepsis, 79 developed pneumonia, 47 required a repeat surgical intervention, 5 had pulmonary embolus, 2 developed cardiac tamponade, 41 had haemorrhage requiring transfusion, and 72 developed acute renal failure with 32 of these patients undergoing renal support therapy. Forty-seven out of the 207 patients were readmitted to the ICU.

The results from the univariate analysis comparing patients who were dead at one year and those who were alive were detailed in **Table 1**. Older patients are more likely to be dead at one year (p =0.001). The results revealed that those admitted post cardiac arrest were more likely to be dead at one year (p =0.012). There was also a significant difference in the mean APACHE score in the patients alive and dead at one year: 18.43 vs. 22.47 respectively (p =0.001). If a long stay patient had a cardiac arrest in the ICU (p =0.001), developed sepsis (p =0.002) or renal failure not suitable for renal support therapy (p =0.0001), they were more likely to be dead in one year. Not surprisingly, long stay patients with no medical history were more likely to be alive at one year (p =0.013). Interestingly, patients who were admitted with a diagnosis of multiple traumatic injuries (p =0.007) were also more likely to be alive at one year after discharge, with p =0.012 and p =0.007, respectively. Of the patient comorbidities, coexisting hypertension was the only variable indicative of increased likelihood of death within one year.

Multivariate analysis was performed adjusting for age, gender and APACHE score. The only factor that significantly affected outcome at 1 year for long stay patients after adjustment was having a cardiac arrest in the ICU. These patients were much more likely to be dead at one year (OR 17.0; p =0.008). The correlation seen with the other factors identified by univariate analysis to be predictive of 1-year outcome among long stay patients was not statistically significant when multivariate analysis was performed adjusting for age, gender and APACHE II score.

Discussion

The overall mortality of these resource intensive patients in the ICU and surgical HDU is very high as shown in this study, with 40% mortality at one year. Of the deceased patients 72% died even before discharge from hospital. This result is similar to other studies which report a 60-75% survival at one year for similar long stay ICU patients [1-3].

Those long stay ICU/HDU patients admitted for multiple traumatic injuries were also more likely to be alive at 1 year. This variable lost significance however when adjusted for age, suggesting that patients admitted with multiple traumatic injuries who survive more than a week stay in the ICU tend to be younger. Other studies have similarly shown advancing age, APACHE and severity scores adversely affecting the outcome of prolonged ICU stay patients [14,17,18]. The same studies also showed that those patients who did not have any significant pre-morbid conditions also had significantly lower mortality, although again the variable lost significance when adjusted for age. The results contrast with another long-stay study showed that immunosuppression, prolonged mechanical ventilation and after 30 days acute renal failure requiring dialysis and the use of vasopressors had higher mortality after adjustment for age and APACHE II scoring [19].

When adjusting for illness severity using the APACHE II scoring all the factors lost significance except for the development of cardiac arrest in the ICU. It is easy to understand why among the long stay patients, cardiac arrest during ICU/HDU admission predicted mortality. But the finding that none of the other ICU/HDU complication, such as acute renal failure requiring renal support therapy, life-threatening haemorrhage or other complications such as cardiac tamponade or tension pneumothorax, independently correlated with increased 1-year mortality among long stay patients was not expected.

A major confounder in this study is an inherent selection bias based on the fact that patients who survive to a week stay in the ICU or two weeks in the ICU and HDU have been deemed by the clinicians to have a realistic chance of recovery. In a socialised health care system with limited resources, both financial and specialist availability, a “therapeutic trial of ICU” is provided to patients with significant co-morbidities. During this period of maximal ICU support, response to treatment is monitored and patients are constantly assessed in their ability to survive a prolonged hospitalisation and rehabilitation and their complications. If despite maximal level of physiologic support and treatment, the patient continues to develop worsening organ failures, discussion among the clinicians and the family may be re-directed towards switching the focus of care from cure to palliation. It is difficult to quantitate the degree to which such an approach may affect clinical outcomes such as LOS and mortality of patients in an ICU. But it is clear how this approach would affect the results of a study like ours in identifying factors that predict long-term outcome among long-stay patients.

While the struggle against death is an important goal of medicine, it would be a mistake to over-emphasize this struggle; medicine is unable to delay death indefinitely. The struggle against death needs to be cautiously balanced against the realisation that the role of medicine is not to prevent death or prolong life at all costs, "but to help people live as healthy lives as possible within a finite life span" [20].

Respect for individual life does not demand an unlimited effort to use every technological possibility to prolong that life. The use of life-prolonging technology in the care of the critically ill, particularly patients who are terminally ill or irreversibly declining, requires two conditions to be met as defined by Callahan [21]. First, there is a good probability that the technology will significantly modify the course of the underlying illness. Second, the long-term outcome for the patient as a person promises to be a good one. Callahan calls the combination of these two conditions the 'benefit presumption test'; "meaning to suggest that to use a technology there should be a positive presumption that the patient will benefit". But because ICU clinicians cannot predict with 100% certainty which patients will survive to discharge with a functional outcome that is acceptable to the patient, critically ill patients are kept alive in the ICU even when they are not responding, or worse, continuing to deteriorate despite optimal ICU support. The degree to which this is practiced depends upon the personal beliefs of the clinicians, the health care system they work in, and socio-cultural factors including societal expectations, resource availability and medico-legal environment.

Conclusions

Based on this study, it would be reasonable that patients who have been in the ICU more than a week or in the ICU and/or HDU for more than 2 weeks should not be offered resuscitation in the event of a cardiac arrest unless it is very clear that the cause of the arrest is reversible. It is important to consider that cardiac arrests occurring later during the course of a prolonged ICU or HDU stay are more likely to be a reflection of the severity of illness rather than a result of a reversible event.

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Table 1. RESULTS-UNIVARIATE ANALYSIS

Variable	Number	Alive at one year	Deceased at one year	Percentage alive	P value
Reason for admission					
Gender male	127	76	51	59.8	0.876
Gender female	80	47	33	58.8	0.876
Post cardiac arrest	12	3	9	25	0.012
AAA/TAA	17	9	8	52.9	0.57
Severe sepsis/meningitis	40	19	21	47.5	0.087
Multiple trauma	38	30	8	78.9	0.007
Poisoning overdose	1	0	1	0	0.684
Respiratory failure	56	32	24	57.1	0.684
Seizure	7	5	2	71.4	0.51
SAH/ICB/SDH	22	15	7	68.1	0.376
GI bleed	1	1	0	100	0.407
Metabolic disorder	5	3	2	60	0.979
Cardiac bypass surgery	8	5	3	62.5	0.856
Cardiac valve surgery	5	3	2	60	0.979
Bowel resection	16	7	9	43.8	0.184
Other vascular surgery	5	2	3	40	0.371
Other surgery	37	25	12	67.6	0.265
Other	25	17	8	68	0.351
Complications					
Atrial fibrillation	78	38	40	48.7	0.015
Cardiac arrest	16	3	13	18.8	0.01
Myocardial infarction	26	13	13	50	0.296
Cerebrovascular event	11	4	7	36.4	0.11
Sepsis	80	37	43	46.3	0.002
Bacteraemia	70	37	33	52.9	0.169
Pneumonia	79	43	36	54.4	0.251
Surgical reintervention	47	28	19	59.6	0.981
PE	5	2	3	40	0.371
DVT	2	1	1	50	0.785
Cardiac tamponades	1	1	0	100	0.785
Haemorrhage/transfusion	41	24	17	58.5	0.898
Acute RF+support	33	17	16	51.5	0.313
Acute RF-support	39	12	27	30.8	0.001
Readmission to ICU/HDU	47	26	21	55.3	0.515
Comorbidities					
Diabetes	27	10	17	37.0	0.011
Smoker/ex smoker	86	45	41	52.3	0.08
Hypertension	83	40	43	48.2	0.007
Prev CVA/TIA	21	10	11	47.6	0.245
PVD	21	10	11	47.6	0.254
Chronic renal insufficiency	19	9	10	47.4	0.797
End stage renal failure	6	4	2	66.7	0.714
Previous major trauma	5	4	1	80	0.343
Malignancy	39	23	16	59.0	0.972
Respiratory disease	27	12	15	44.4	0.089
Coagulation disorder	7	4	3	57.1	0.901
No significant PMhx	39	30	9	76.9	0.013
Med Hx not available	18	13	5	72.2	0.247
Total number	207	123	84		

Table 2. DEMOGRAPHIC DATA

Mean age		58 yrs
Gender	Male	127
	Female	80
Average LOS ICU	ICU	14 days
	HDU	2 days
Ethnicity	European/ Pakeha	176
	Maori	8
	Pacific Island	1
	Asian	5

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Appendix A

Reason for admission	
Post cardiac arrest	Ventricular fibrillation, ventricular tachycardia, asystolic arrest, pulseless electrical activity.
AAA, TAA	Abdominal or thoracic aortic aneurysm (Pre and post-op patients)
Sepsis	Severe infectious process with circulatory compromise requiring vasoactive agents
Haemorrhage/hypovolaemia	Severe hypovolaemia requiring volume replacement, blood products and invasive monitoring
Multiple trauma	>1 site of severe trauma requiring sedation and ventilation
Poisoning/overdose	Ingestion of toxic substance that requires detoxification or support
Repiratory failure/pulmonary embolism	Respiratory failure requiring positive pressure airway support (PaO_2/FiO_2 <200 mmHg; type II: $PaCO_2$ >60 mmHg)
Seizure	History of idiopathic seizure without another aetiological diagnosis
SAH/ICB/SDH	Subarachnoid haemorrhage, intracerebral bleed, subdural haemorrhage. History and radiological dx
GI bleed	Gastrointestinal haemorrhage that requires blood products and invasive monitoring
Metabolic disorder	Primary metabolic abnormality not precipitated by another organ failure
Post operative	Any procedure
Post cardiac bypass surgery	Post cardiac bypass surgery
Post cardiac valve surgery	Post cardiac valve surgery
Bowel resection	Upper and lower gastrointestinal surgery
Neurosurgery	Any neurosurgical procedure
Other surgery	Surgery not already specified
Other admission reason	Other not already specified
Complications during admission	
Atrial fibrillation	ECG diagnosis
Cardiac arrest	Ventricular fibrillation, ventricular tachycardia, asystolic arrest, pulseless electrical activity
Myocardial infarction	2 of: i) ECG change consistent with MI, ii) Trop T +ve, iii) History consistent with MI
Cerebrovascular disease	Non traumatic ischaemic of haemorrhagic cerebral event with evidence on CT
Sepsis	An identified focus of infection with worsening haemodynamics
Bacteraemia	Any +ve blood culture, non contaminant
Pneumonia	Chest infection with radiographic evidence with 2 of: worsening oxygenation, increase in pulmonary secretions, fever/leucocytosis
Surgical reintervention	Reintervention required for revision of primary procedure or recognised complication of primary procedure
Pulmonary embolism	V/Q scan or CTPA positive
Significant deep vein thrombosis	Clinical evidence and U/S confirmation
Haemorrhage	Bleeding from procedure or post surgical requiring transfusion or surgical reintervention
Acute renal failure requiring renal support	Haemofiltration or dialysis

Acute renal failure not requiring renal support	Worsening renal function with significant rise in creatinine (>20% for 2 days)
Readmission to ICU/HDU	Within the 1 year follow up
Death before discharge from hospital	
LOS in the ICU/HDU	
Hospital LOS	
Demographic information	
Age	At the time of admission
Gender	M/F
Ethnicity	As recorded at the time of admission
Smoker	Current smoker
Diabetes	A diagnosis of diabetes based of recommended guidelines
HTN	A documented history of hypertension or medicated
IHD	History of angina with ECG and biochemical evidence or previous CABG
Previous CVA/TIA	A documented history
Peripheral vascular disease	A documented history through symptomatology or radiographic evidence
Moderate or severe LV impairment	By echocardiogram
Previous ICU/HDU	In the previous year
Chronic renal insufficiency	Not on renal replacement therapy but seen by renal service
End stage renal insufficiency	On renal replacement therapy
Previous major trauma	Requiring hospital admission
Malignancy	Any malignant neoplasm
Psychiatric diagnosis	A diagnosis of a major psychiatric disorder
Respiratory disease	Pre-existing diagnosis
Anaemia	Pre-existing anaemia (Hb <10)
Coagulation disorder	Pre-existing