How do Australian ICU survivors fare functionally 6 months after admission?

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ABSTRACT

Objectives: To determine the extent to which physical function is restored 6 months after intensive care unit admission, and whether this is associated with short or long ICU length of stay (LOS).

Design, setting and participants: We conducted a prospective observational study between April and June 2010. All patients admitted for more than 48 hours to the general ICU at Sir Charles Gairdner Hospital, Perth, Western Australia, were eligible for inclusion. "Short" and "long" ICU LOS were defined as < 8 days and $\geqslant 8$ days, respectively. Six months after ICU admission, an investigator (blinded to baseline data) contacted participants by telephone to administer a follow-up questionnaire based on the Functional Independence Measure (FIM).

Outcome measures: The primary measure was FIM score; secondary measures were rehabilitation requirement, readmission rate, and whether or not patients had returned to work and driving.

Results: 77 patients consented to take part in the study, and 71 were followed up. Median total FIM score (124) and motor (89) and cognitive (35) subscores suggested high-level functional independence at follow-up. Fifty per cent of patients who were workers at baseline had returned to work, and 76% of drivers had returned to driving at follow-up. Paired *t* tests of the changes in total FIM and its subscales showed that only the motor subscore showed a significant deterioration (mean change, –3.7; $P = 0.04$). Changes for the total FIM did not appear to be correlated with any demographic or baseline data. Furthermore, there appeared to be no difference in FIM between patients with short or long ICU LOS.

Conclusions: Our study showed that patients who survive treatment for life-threatening illness in an Australian ICU for more than 48 hours and are subsequently able to communicate are likely to return to their premorbid functional level (as defined by FIM score) within 6 months.

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Intensive care unit services account for a significant proportion of hospital costs and resources, requiring substantial investment in personnel, space and equipment.[1-3] Despite this, little is known about patient functional outcome.[4] Medical research in the ICU has traditionally focused on outcomes such as length of stay (LOS), length of ventilation and mortality; in fact, the term "outcome" has often been used interchangeably with "survival".[5] ICU physiotherapists also historically neglected research on patient functional outcomes and instead focused on out-of-hours service use surveys, specific treatment techniques, and physiological outcome measures (such as pulmonary function, gas exchange, compliance, and wet weight of sputum aspirated).[6]

The problem is that physiological variables may not correlate with clinical outcome or patient function, and there is a need for more research on patient-centred outcomes. The Glasgow Outcome Score, which has been used to follow up ICU survivors,[7,8] provides a global indication of recovery akin to a Rankin Score,[9] but is not functionally specific. There have also been studies of quality-of-life outcomes,[10-14] but few studies have used activities of daily living (ADL)[15-18] to quantify the functional level of ICU survivors. Using the modified Functional Independence Measure (FIM), Livingston and colleagues[18] found that ICU survivors had significant impairment more than 3 years after severe injury, including inability to return to work (49%). However, half the patients in the cohort they studied had severe traumatic brain injury, and thus their patient population was probably not comparable to the average patient composition of an Australian mixed medical/surgical ICU. In their review of long-term ICU survival, Williams and colleagues[2] concluded that well designed studies on long-term outcomes were needed to demonstrate the value of ICUs.

Abbreviations

ADL	Activities of daily living
APACHE	Acute Physiology and Chronic Health Evaluation
FIM	Functional Independence Measure
LOS	Length of stay
SCGH	Sir Charles Gairdner Hospital
SIP	Sickness Impact Profile

Differences in functional outcome based on ICU LOS have also not been explored, and there remains the question of whether LOS (short or long) may be associated with differ-

ences in outcome. A further complication is that there are various definitions of what constitutes "prolonged" LOS, ranging from greater than 96 hours to 60 days.[7,19-22]

The primary aim of our study was to determine the extent to which normal physical function was restored 6 months after admission to a representative Australian mixed medical/surgical ICU. The secondary aim was to determine whether there was a difference between patients having a short (< 8 days) or long (⩾ 8 days) ICU LOS.

Methods

Setting and participants

We conducted a prospective observational study at Sir Charles Gairdner Hospital (SCGH) in Perth, Western Australia — a 600-bed tertiary university hospital with a 23-bed mixed medical/surgical ICU. All patients over the age of 18 who were admitted to the ICU for more than 48 hours over the period April to June 2010 were considered for inclusion in our study. Patients were excluded if they were expected to survive less than 48 hours, if they spoke or understood little English, or if social circumstances rendered research participation unlikely (eg, patients admitted after a suicide attempt, or violent patients requiring restraint).

Patient consent

Patients were identified as having passed the critical 48-hour LOS by the senior physiotherapist, and their capacity for consent was discussed with the attending medical consultant. If and when they were deemed capable of consenting, they were invited to participate in the study and asked to provide written consent. In circumstances where patients were unable to provide informed consent while an inpatient, but it was anticipated that they would develop the capacity in the ensuing 6-month period, they were flagged at the time of hospital discharge to be contacted 6 months after ICU admission. At this time, their capacity was assessed by the physiotherapist in conjunction with attending medical staff (if an inpatient) or next of kin, and they were interviewed in person or mailed an information sheet and consent form. On receipt of consent they were recruited into the study.

Patients who had given consent and required readmission to the ICU remained in the study. Only data from the initial ICU stay were considered for data analysis. Patients subsequently readmitted to the ICU for longer than 48 hours after an initial stay of less than 48 hours were included as a new patient in the trial, with their clinical history noted.

Data collection

Baseline data consisted of information already collected across disciplines in the normal course of an ICU inpatient stay, including sociodemographic data, pre-hospital functional status, medical co-morbidities, admission category and source, and APACHE (Acute Physiology and Chronic Health Evaluation) II score within the first 24 hours of admission. No new data were collected until 6 months after ICU admission. In this pragmatic trial, all treatments received were considered standard for the facility, and were undertaken by the incumbent staff. There was no extraordinary intervention related to the study. At 6 months after ICU admission, a telephone interview with the patient was undertaken by one of the authors (DMD), who was blinded to baseline data collection.

Outcome measures

The primary outcome measure was the FIM (Figure 1), a measure of disability and handicap in a range of functional activities commonly used in Australian health care facilities since the early 1990s. It was designed for use in any discipline and is suitable for a wide range of diagnoses.[23] The measure consists of 18 items, each assessed on seven levels. The FIM

Figure 1. Functional independence measure (FIM) scaleScoring key:

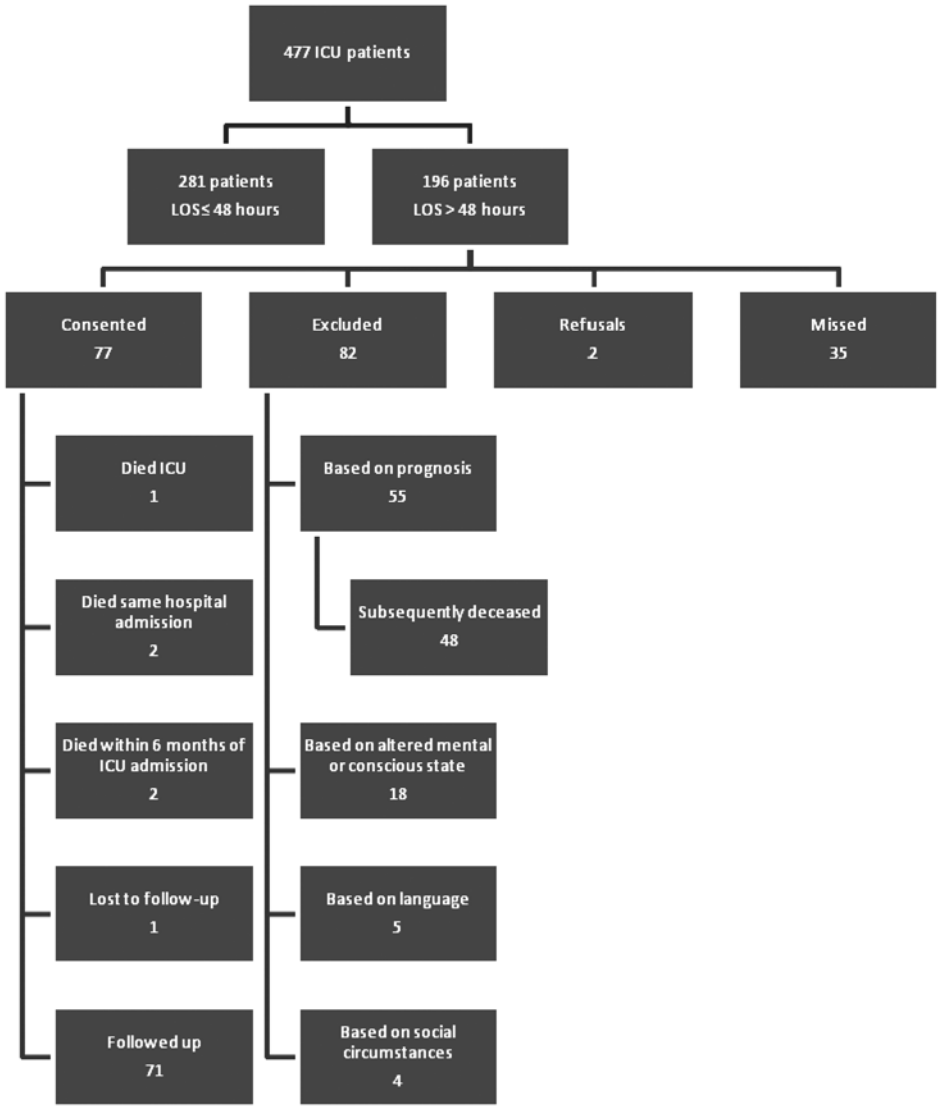
1 Maximal assistance
2 Total assistance
3 Moderate assistance
4 Minimal assistance
5 Supervision
6 Modified independence
7 Complete independence

MOTOR COMPONENT		COGNITIVE COMPONENT	
Self care:		Comprehension	
Eating	___	auditory/visual	___
Grooming	___	Expression	
Bathing	___	verbal/non-verbal	___
Dressing upper body	___	Social cognition	
Dressing lower body	___	Social interaction	___
Toiletting	___	Problem solving	___
Sphincter control:		Memory	___
Bladder management	___		
Bowel management	___	COGNITIVE SUBSCORE	
Transfers:			___/35
Bed/chair/wheelchair	___		
Toilet	___		
Bath/shower	___		
Locomotion:			
Walking/wheelchair	___		
Stairs	___		
MOTOR SUBSCORE		TOTAL FIM SCORE	
	___/91		___/126

score can be used to estimate a person's need for assistance or resource cost of disability. Possible scores range from 18 to 126 (with higher scores indicating greater independence). In addition to a total score, the FIM provides two subscores (motor and cognitive). It is a minimal dataset, and does not include domestic or community ADL.[23] It was designed to create a more sensitive tool to detect important clinical change,[24] and has been shown to be valid and reliable.[25,26]

Other variables collected from the medical record included ICU LOS, length of ventilation, ICU readmission, length of time of having a tracheostomy in situ (if applicable), hospital LOS, hospital discharge destination, and mortality. Secondary outcomes collected at 6 months included hospital readmission, rehabilitation LOS, outpatient physiotherapy, return to work and return to driving.

Figure 2. Patient inclusions



ICU = intensive care unit. LOS = length of stay.

Statistical methods

Descriptive statistics were used to summarise the baseline data overall (frequencies and percentages for categorical variables, and medians and ranges for continuous variables), and also after dividing the subjects into the two groups based on ICU LOS (> 48 hours and < 8 days versus > 48 hours and ⩾ 8 days). Any differences in baseline variables between these two groups were assessed for statistical significance using the χ^2 test for categorical variables (or Fisher's exact test when the numbers were small), and the non-parametric Wilcoxon two-sample test for continuous variables.

Changes from baseline to follow-up in the motor subscore, cognitive subscore and total FIM were calculated and described (mean changes and ranges). These were compared between the groups based on the ICU LOS using *t* tests and Wilcoxon signed rank tests (non-parametric). They were also compared by calculating the proportion of patients experiencing a deterioration in these scores (negative change) with the proportion who returned to the same or an improved score (positive change), with χ^2 tests giving the *P* values for comparisons. A logistic regression model was used to determine whether any of the baseline data (or ICU LOS) were associated with decay in total FIM score. A "backwards elimination" strategy was used to find the best model (the least significant independent variable was dropped one at a time from the model as long as its *P* value was greater than 0.05). For all statistical tests, a *P* value < 0.05 was interpreted as indicating a statistically significant association.

Ethics approval

Our study was approved by the SCGH Human Research Ethics Committee.

Results

Between April and June 2009, 477 patients were admitted to the ICU. Of these, 196 were admitted for more than 48 hours and 77 of these consented to take part in the trial (Figure 2). Admission characteristics of consenting patients are summarised in Table 1. There was no significant difference between short and long LOS groups at admission.

Characteristics of hospital stay and discharge are summarised in Table 2. Patients in the short ICU LOS group were more likely to have a shorter stay in the acute hospital ($P = 0.04$). They were also less likely to require mechanical ventilation ($P < 0.006$), tracheostomy ($P = 0.001$) or bilevel positive airway pressure via tracheostomy ($P = 0.04$). If ventilated, they had a shorter length of ventilation ($P < 0.001$), but if undergoing non-invasive ventilation, there was no significant difference between groups as to how long it remained ($P = 0.14$). At hospital discharge, patients in the short ICU LOS group were more likely to go home, whereas the long ICU LOS patients were more often discharged to a rehabilitation facility ($P = 0.03$).

At 6 months after ICU admission, 71 patients were followed up, five had died, and one was lost to follow-up (Figure 2), with no significant differences between ICU LOS groups (Table 3). There were also no significant differences between the ICU LOS groups across any measured domains (Table 4), but there was a non-significant trend towards long ICU LOS patients having more outpatient physiotherapy than short ICU LOS patients (42% v 24%; $P = 0.09$). Almost half the cohort (49%) were transferred for inpatient rehabilitation, with a mean LOS of 26 days, and a similar proportion (48%) required readmission to hospital within 6 months, although subsequent LOS was short (median 2 days). Median total FIM score (124) and motor (89) and cognitive (35) subscores suggested high-level functional independence at follow-up, although at 6 months only 50% of patients who were workers at baseline had returned to work and 76% of drivers had returned to driving.

Paired *t* tests of the changes in total FIM (mean change, –2.3; $P = 0.20$) and its subscales showed that only the motor subscore showed a significant deterioration (mean change, –3.7; $P = 0.044$). The statistical significance of these changes, based on the Wilcoxon signed rank test, was in agreement with the results of the *t* tests (total FIM [$P = 0.10$]; motor subscale [$P = 0.03$]; cognitive subscale [$P = 0.19$]). Median changes for all these measures were zero.

When patients were divided, based on these scores, into those who deteriorated and those who improved or remained the same (two categories only), there appeared to be no difference in changes between those with a short ICU LOS and those with a long ICU LOS (Table 5). Grouping patients into those who deteriorated (or not) is coarse, but it provides a measure on which to compare the short and long

Table 1. Baseline characteristics of patients at inclusion ($n = 77$)*

		Length of ICU stay		
	Total patients ($n = 77$)	Short (> 48 hours to < 8 days) ($n = 40$)	Long (⩾ 8 days) ($n = 37$)	*P*
Mean age in years (SD)	54 (18)	52 (19)	56 (16)	0.31†
Male sex	45 (58%)	23 (58%)	22 (59%)	0.86‡
Admission category				0.37‡
Medical	28 (36%)	14 (36%)	14 (38%)	
Elective surgical	20 (26%)	13 (32%)	7 (19%)	
Trauma (including non-elective surgical)	29 (38%)	13 (32%)	16 (43%)	
Admission source				0.25‡
Emergency department	14 (18%)	9 (22%)	5 (14%)	
Operating theatres	36 (47%)	20 (50%)	16 (43%)	
Other SCGH wards	13 (17%)	7 (18%)	6 (16%)	
Other hospitals	14 (18%)	4 (10%)	10 (27%)	
APACHE II score	18 (3–35)	15 (3–31)	19 (12–35)	0.05†
Premorbid FIM				
Total score	125 (77–126)	125 (84–126)	124 (77–126)	0.53†
Motor subscore	90 (53–91)	90 (61–91)	90 (53–91)	0.56†
Cognitive subscore	35 (23–35)	35 (23–35)	35 (24–35)	0.49†

APACHE = Acute Physiology and Chronic Health Evaluation. FIM = Functional Independence Measure. ICU = intensive care unit. SCGH = Sir Charles Gairdner Hospital. * All data except age are presented as number of patients (%) or median (range). † *P* values calculated using *t* tests. ‡ *P* values calculated using χ^2 tests.

Table 2. Characteristics of hospital stay and discharge*

	Total patients ($n = 77$)	Length of ICU stay: Short (> 48 hours to < 8 days) ($n = 40$)	Length of ICU stay: Long (⩾ 8 days) ($n = 37$)	*P*
Invasive ventilation required	69 (90%)	32 (80%)	37 (100%)	0.006†
Days of ventilation ($n = 69$)	7 (2–51)	3 (2–6)	10 (3–51)	< 0.001‡
Reintubation required	2 (3)	0 (0)	2 (5)	0.50†
Tracheostomy required	15 (19%)	2 (5%)	13 (35%)	0.001§
Days of tracheostomy ($n = 15$)	35 (9–200)	120 (41–200)	30 (9–59)	0.17‡
Synchrony BiPAP required (in ICU or ward)	7 (9%)	0	7 (19%)	0.004†
Days of Synchrony BiPAP	21 (4–26)	0	21 (4–26)	—¶
Non-invasive ventilation required	7 (9%)	3 (8%)	4 (11%)	0.70†
Days of non-invasive ventilation ($n = 7$)	2 (1–3)	3 (2–3)	2 (1–2)	0.14‡
Median length of stay in ICU	7 (3–51)	5 (3–7)	13 (8–51)	< 0.001‡
ICU readmission	3 (4%)	1 (2%)	2 (5%)	1.0†
Median length of acute hospital stay at SCGH	28 (4–172)	21 (4–172)	31 (10–102)	0.04‡
Died in hospital as an acute patient	3 (4%)	1 (2%)	2 (5%)	0.60†
Discharge destination (patients discharged alive)				0.02†
Home	38 (49%)	25 (63%)	13 (35%)	
Rehabilitation facility (SCGH or other)	34 (45%)	14 (35%)	20 (57%)	
Nursing home/hostel	1 (1%)	0	1 (3%)	

BiPAP = bilevel positive airway pressure. ICU = intensive care unit. SCGH = Sir Charles Gairdner Hospital. * Data are presented as number of patients (%) or median number of days (range). *P* values were calculated using Fisher's exact test (†), Wilcoxon two-sample test (‡) or χ^2 test (§), as appropriate. ¶ *P* value not calculable (no data for one group).

ICU stay patients. The logistic regression model aimed to identify any association between deterioration in total FIM (dependent variable) and baseline variables (sex, age, admission category, admission source, admission APACHE II score and baseline total FIM). The modelling procedure failed to find any variables significantly associated with the change in FIM. The final variable remaining in the model was a high APACHE II score (⩾ 22), but the *P* value associated with it was 0.07. The odds ratio associated with this variable was 0.343 (95% CI, 0.11–1.10), indicating that a high APACHE II score was weakly indicative of a return to baseline total FIM (or an improvement). ICU LOS was not significant in this model. We concluded that there was not much change in total FIM and its subscores overall, and any changes that did appear for the total FIM did not seem to be correlated with any demographic or baseline data for the patients.

Discussion

The FIM may serve several purposes as a generic assessment tool, ranging from outcomes research to program evaluation. It presents rehabilitation providers with a common language for discussing disability in terms of functional activities.[27] Our study detected a mild but clinically insignificant[28] deteriora-

Table 3. Patient status 6 months after ICU admission*

	Total patients ($n = 77$)	Length of ICU stay: Short (> 48 hours to < 8 days) ($n = 40$)	Length of ICU stay: Long (⩾ 8 days) ($n = 37$)	*P*
Death	5 (6.5%)	1 (2.5%)	4 (10.8%)	
During acute hospital stay	3 (3.9%)	1 (2.5%)	2 (5.4%)	
During subsequent 6 months	2 (2.6%)	0	2 (5.4%)	1.0†
Lost to follow-up	1 (1.3%)	1 (2.5%)	0	
Followed up	71 (92.2%)	38 (95.0%)	33 (89.2%)	0.42†

ICU = intensive care unit. * Data are presented as number of patients (%). † *P* values were calculated using Fisher's exact test.

Table 4. Follow-up data 6 months after ICU admission*

	Total patients ($n = 71$)	Length of ICU stay: Short (> 48 hours to < 8 days) ($n = 38$)	Length of ICU stay: Long (⩾ 8 days) ($n = 33$)	*P*
Rehabilitation patients	35 (49%)	14 (40%)	21 (60%)	0.02†
Length of stay at rehabilitation facility	27 (4–160)	28 (9–160)	26 (4–127)	0.47‡
Remaining inpatient at transfer facility	3 (4%)	3 (7.9%)	0	0.24§
Readmission to hospital within 6 months (number of patients)	34 (48%)	22 (58%)	12 (36%)	0.07†
Current inpatient — new episode	5 (7.0%)	3 (7.9%)	2 (6.1%)	1.0§
Readmission to hospital within 6 months (number of episodes)	1 (1–27)	1 (1–21)	2 (1–27)	0.62‡
Length of readmission	2 (1–66)	2 (1–46)	3 (1–66)	0.78‡
Patients receiving outpatient physiotherapy within 6 months or inpatient physiotherapy at time of follow-up	23 (32%)	9(24%)	14 (42%)	0.09†
FIM (follow-up measurements)				
Total score	124 (50–126)	124 (50–126)	123 (64–126)	0.75‡
Motor subscore	89 (17–91)	90 (17–91)	89 (29–91)	0.88‡
Cognitive subscore	35 (19–35)	35 (19–35)	35 (25–35)	0.15‡
Handicap				
Returned to work/previously working	16/32 (50%)	7 (39%)	9 (64%)	0.15†
Returned to independent driving/previously driving	38/50 (76%)	18 (75%)	20 (77%)	0.87†

FIM = Functional Independence Measure. ICU = intensive care unit. * Data are presented as number of patients (%) or median number of days (range). *P* values were calculated using the χ^2 test (†), Wilcoxon two-sample test (‡) or Fisher's exact test (§), as appropriate.

Table 5. Changes in FIM from ICU admission to follow-up at 6 months

Measure	Number of patients (%)	Length of ICU stay: Short (> 48 hours to < 8 days) ($n = 38$)	Length of ICU stay: Long (⩾ 8 days) ($n = 33$)	*P**
Total FIM ($n = 70$)				0.44
Worse than baseline	31 (44%)	18 (49%)	13 (39%)	
No change or improved	39 (57%)	19 (53%)	20 (61%)	
Total motor subscore ($n = 71$)				0.65
Worse than baseline	30 (42%)	17 (45%)	13 (39%)	
No change or improved	41 (59%)	21 (55%)	20 (61%)	
Total cognitive subscore ($n = 70$)				0.38
Worse than baseline	16 (23%)	10 (27%)	6 (18%)	
No change or improved	54 (77%)	27 (73%)	27 (82%)	

FIM = Functional Independence Measure. ICU = intensive care unit. * *P* values were calculated using the χ^2 test.

tion in the motor subscore of the FIM in patients 6 months after ICU admission. There was no change in the total score or cognitive subscore, suggesting good functional recovery. These findings differ from those of a recent Dutch study of a comparable cohort,[29] which demonstrated a high prevalence of functional restriction among patients 12 months after ICU admission, as measured by the Sickness Impact Profile (SIP). Another Dutch study[30] of a similar cohort, also using the SIP, found that 69% of patients remained restricted in ADL after 12 months. Whereas the FIM measures functional independence and predicts the need for rehabilitation services, the SIP was developed to provide a descriptive profile of changes in a person's behaviour and quality of life due to sickness, and this may partially account for the differences.

In the second Dutch study,[30] there was a 50% return-to-work rate at 12 months, whereas our study demonstrated the same return-to-work rate within just 6 months. As no data were collected in our study on reasons for patients not

working, our ability to draw conclusions about this is limited.

Differences in overall functional outcome and rate of return to work may relate to the extent to which coordinated rehabilitation was applied to ICU survivors. In our study, 49% of the cohort was transferred for structured inpatient rehabilitation on discharge from acute care, and 32% accessed outpatient physiotherapy services within the follow-up period. In the first Dutch study,[29] patients did not receive standardised care on ICU discharge and the authors concluded that more multidisciplinary therapies needed to be developed and evaluated in order to improve outcome.

Although FIM is recognised as a sensitive tool for detecting important clinical changes during rehabilitation,[24] our study showed no significant difference in functional outcome between patients with short and long ICU LOS. It may be that a more respiratory-based outcome measure (such as the 6-minute walk test or functional vital capacity) is required in an ICU population that is able to access rehabilitation services in order to detect differences between the two groups at 6 months.

The ability of our clinicians to accurately predict likely death as early as 48 hours after ICU admission was reflected in the exclusion of patients considered to have poor immediate prognosis ($n = 55$) and the fact that 87% of these died within the follow-up period.

A significant limitation of our study was the fact that some patients were unable to provide consent because of their ongoing altered mental or conscious state (these patients represented 9% of the total cohort considered for inclusion and 22% of all patients excluded). Guidelines on ethical conduct of human research in WA preclude the recruitment of unconscious subjects into clinical studies that are not deemed therapeutic, as such patients cannot be informed about the research and their wishes cannot be determined. Of the 24 patients initially excluded based on mental or conscious state, 13 were flagged to be reconsidered at 6 months after ICU admission, as it was anticipated that they may regain their capacity to understand and be capable of consent within that timeframe. Consent was subsequently obtained from six of these patients. The number unable to provide consent may have resulted in significant under-reporting of both motor and cognitive functional incapacity.

Another limitation of our study was that 35 eligible patients were missed. This was unavoidable, as clinical workload precluded recruiting subjects and collecting data 7 days a week. Accordingly, ICU LOS was shorter in this group (median, 4 days [range 3–15 days]), although demographic data indicate that this cohort had the same mean age as the consented cohort (54 years [SD, 21 years]), was mostly male (68%) had a median APACHE II score of 20 (range, 7–36). Their admission category was most commonly medical (51%), and they were more often transferred to the ICU from other wards (34%) and from theatre (34%). The number of patients missed may have skewed data towards a poorer apparent outcome, as a fast ICU turnaround may indicate good return to function and less handicap (return to work and driving) in this group.

Conclusion

Our study demonstrated that most patients who survive treatment for life-threatening illness in an Australian ICU for longer than 48 hours are likely to return to their premorbid functional level within 6 months. Differences between hospitals in different countries in terms of casemix and streams of care, including step-down arrangement, hospital transfer networks and the availability of rehabilitation, make comparison and generalisation of outcome data problematic and the identification of common predictors more difficult.[31]

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