Outcomes for dialysis patients with end-stage renal failure admitted to an intensive care unit or high dependency unit

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ABSTRACT

Objective: To assess the outcomes for chronic dialysis patients requiring admission to an intensive care unit (ICU) or high dependency unit (HDU).

Design: Retrospective audit of prospectively collected data from local and national databases.

Setting: The ICU and HDU at a tertiary referral hospital.

Participants: 70 chronic dialysis patients admitted between 2001 and 2006.

Main outcome measures: Unit and hospital mortality, recurrent admission patterns and median survival after discharge from hospital.

Results: For patients' last admissions, mortality in the ICU or HDU was 17% and in hospital was 29%. The 12 deaths in the ICU or HDU occurred a median of 18 hours (range, 3–203 hours) after admission, reflecting the severity of their underlying illness. The independent predictors of death in hospital were age and the number of non-renal organ systems failing. Patients with pulmonary oedema had a lower risk of death than patients admitted for other reasons. Although 21 patients accounted for 55 of 104 admissions (53%), recurrent admissions to the ICU or HDU generally occurred during different hospital admissions. They were not associated with a higher risk of death in hospital. Patients discharged home had a median survival of 2.25 years, and a median survival of 3.5 years from starting dialysis. The median survival for patients on dialysis in Australia in general is 4.5 years (Australia and New Zealand Dialysis and Transplant Registry).

Conclusion: Dialysis patients discharged home after an ICU or HDU admission have survival similar to that of Australian dialysis patients generally.

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At 31 December 2004, 7952 patients in Australia were on chronic dialysis (peritoneal dialysis or haemodialysis).[1] About 1900 patients start dialysis every year. Dialysis patients in Australia have a 5-year survival of 47% and have multiple comorbidities. Among those starting haemodialysis in 2004, 87% had hypertension, 51% had coronary artery disease, 34% had diabetes and 21% had cerebrovascular disease.[1]

There has been concern that, as outcome data are lacking, when these patients become critically ill, therapeutic nihilism may limit their access to intensive care.[2,3] The only Australian study to date reported on 38 chronic dialysis patients receiving renal replacement therapies in 81 intensive care units (ICUs) over a 3-month period. ICU mortality was 18% and hospital mortality 34%.[2] A severity-matched cohort of patients with acute renal failure had a hospital mortality of 37.5%.

We retrospectively reviewed all dialysis patients admitted to our ICU or our high dependency unit (HDU) to determine their demographic characteristics, unit and hospital mortality, pattern of recurrent admissions and their median survival after discharge from hospital.

METHODS

This study was conducted at the Royal Brisbane and Women's Hospital, a tertiary referral centre serving all specialties except cardiac surgery. The Department of Intensive Care Medicine comprises an 18-bed ICU and a 9-bed HDU, averaging 1800 admissions per year.

We identified all dialysis patients admitted to the ICU or HDU between 15 February 2001 and 15 February 2006, using existing hospital databases cross-referenced with the Australia and New Zealand Dialysis and Transplant Registry database (ANZDATA). Patients were excluded if they were not already on dialysis at the time of admission or if the reason for being on dialysis was not deemed to be end-stage renal failure (defined as irreversible severe renal dysfunction for over 3 months). Recurrent admissions over the study period were characterised. The final dataset was derived from databases as well as the paper medical records, which were hand searched when required.

Follow-up was complete to 15 April 2006. Patients were classified as alive if they had a blood test performed on or after this date. Dates of deaths were obtained from the respective dialysis centres if death occurred outside our hospital. Where there were multiple admissions, last admissions were used to calculate mortality and the median survival after discharge home.

We defined cardiovascular failure as the need for vasoactive drugs (adrenalin, noradrenalin or dobutamine), respiratory failure as a $Pa_{O_2}/F_{IO_2} < 250$ mmHg, neurological failure as a Glasgow Coma Score < 8 and liver failure as bilirubin > 100 µmol/L.[4]

The need for informed consent was waived by the hospital's ethics committee.

Statistical analysis

Univariate analysis used Student's *t* test, analysis of variance, χ^2 and Fisher's exact test, as appropriate. We combined mortality for ICU and HDU admissions, as patients who were admitted to the HDU would have required ICU admission in the absence of an HDU facility. Factors contributing to mortality were assessed by forward stepwise logistic regression, with goodness of fit determined by the method of Hosmer and Lemeshow.[5] Mortality predictors from previous studies were evaluated in addition to those associated with $P \leq 0.2$. Survival time after hospital discharge used Kaplan–Meier analysis. Statistical analyses used Stata, version 9 (StataCorp, College Station, Tex, USA).

RESULTS

Seventy patients were enrolled in the study and accounted for 104 admissions (Box 1, Box 2). The median age was 59 years, and about half were men. For all last admissions ($n = 70$), the combined ICU and HDU mortality was 17% (12 patients) and in-hospital mortality was 29% (20 patients). For the 50

1 Characteristics of 104 hospital admissions of 70 dialysis patients admitted to the ICU or HDU, February 2001 to February 2006

Characteristic	Admitted to ICU (*n* = 72)	Admitted to HDU (*n* = 32)	All admissions (*n* = 104)
Age (years): mean ± SD (range)	55.7 ± 15.6 (17–81)	55.5 ± 18.1 (18–84)	57.4 ± 16.3 (17–84)
Sex female	36 (50%)	14 (44%)	50 (48%)
APACHE II score: mean ± SD (range)	26.5 ± 9.3 (5–44)	20.9 ± 6.3 (7–32)	24.8 ± 8.8 (5–44)
SAPS II score: mean ± SD (range)	41 ± 16.4 (7–85)	32 ± 9.3 (17–53)	38 ± 15.1 (7–85)
Median stay in ICU or HDU (days) (range)	2 (1–27)	2 (1–55)	2 (1–55)
Median hospital stay (days) (range)	12 (1–136)	15 (2–59)	12.5 (1–136)
Admission source			
Emergency department	23 (32%)	5 (16%)	28 (27%)
Operating theatre	18 (25%)	11 (34%)	29 (27%)
Ward	25 (35%)	12 (38%)	37 (36%)
Another hospital	6 (8%)	4 (12%)	10 (10%)
Admission type			
Medical (all emergencies)	58 (81%)	18 (56%)	76 (73%)
Surgical (emergency)	8 (11%)	8 (25%)	16 (15%)
Surgical (non-urgent elective)	6 (8%)	6 (19%)	12 (12%)
Outcome after this admission*			
Died in ICU or HDU	11 (15%)	1 (3%)	12 (12%)
Died in hospital (including ICU and HDU)	17 (24%)	3 (9%)	20 (19%)
Reasons for admission			
Pulmonary oedema	19 (26%)	4 (13%)	23 (22%)
Sepsis	15 (21%)	3 (9%)	18 (17%)
After bowel surgery	10 (14%)	2 (6%)	12 (11%)
Cardiac arrest	9 (12%)	1 (3%)	10 (10%)
Neurological	5 (7%)	3 (9%)	8 (8%)
After other medical	5 (7%)	3 (9%)	8 (8%)
After vascular surgery	0	5 (16%)	5 (5%)
Hyperkalaemia	2 (3%)	2 (6%)	4 (4%)
After other surgery	7 (10%)	6 (19%)	13 (13%)
Other cardiac	0	3 (9%)	3 (3%)

Numbers are *n* except where specified. ICU = intensive care unit. HDU = high dependency unit. APACHE = Acute Physiology and Chronic Health Evaluation. SAPS = Simplified Acute Physiology Score.
* Some patients were admitted more than once. ◆

2 Treatment and disease characteristics of 70 dialysis patients during last admission to the ICU or HDU

Characteristic	(*n* = 70)
Median duration (months) of dialysis before this admission (range)	27 (0.48–278)
Dialysis type	
Haemodialysis	54 (77%)
Peritoneal dialysis	16 (23%)
Cause of renal failure	
Diabetes mellitus	20 (29%)
Glomerulonephritis	19 (27%)
Renovascular disease*	10 (14%)
Analgesic use	7 (10%)
Reflux nephropathy	5 (7%)
Unknown	4 (6%)
Other	2 (3%)
Interstitial nephritis	1 (1%)
Obstructive nephropathy	1 (1%)
Polycystic kidney	1 (1%)
Renal support in ICU or HDU†	
CVVHDF	23 (33%)
IHD	19 (27%)
Continuous ambulatory peritoneal dialysis	2 (3%)
IHD and CVVHDF	1 (1%)
Automated peritoneal dialysis	1 (1%)
None	24 (34%)

Numbers are *n* except where specified. ICU = intensive care unit. HDU = high dependency unit. IHD = intermittent haemodialysis. CVVHDF = continuous veno-venous haemodiafiltration. * Hypertension or renal artery stenosis. † For all 104 admissions, CVVHDF, 30%; IHD, 27%; continuous ambulatory peritoneal dialysis, 3%; IHD and CVVHDF, 2%; automated peritoneal dialysis, 1%; none, 37%. ◆

patients discharged from hospital after the final admission, the median survival was 2.25 years, or 27 months (interquartile range, 12.1–33.1 months). The median survival for this discharged cohort, from the start of their dialysis, was 42 months (3.5 years).

Twenty-one patients (30%) had recurrent admissions to the ICU or HDU and accounted for 55 of the 104 admissions. Five of 21 patients (24%) had readmissions to intensive care within a single hospital admission and contributed 10 of the 55 (18%) recurrent admissions. Most patients had their recurrent admissions to ICU or HDU during entirely different hospital admissions. The need for recurrent admissions was not associated with in-hospital mortality. Of the 55 recurrent admissions, only 10 were due to pulmonary oedema, with one patient accounting for five of these admissions. The remaining admissions all had different causes.

The features distinguishing survivors and those who died in the ICU or HDU are compared in Box 3.

In the stepwise forward logistic regression model, the independent predictors of ICU and HDU mortality were age (adjusted odds ratio [AOR], 1.10; 95% confidence interval [CI], 1.01–1.17; $P = 0.03$) and number of non-renal organ failures (AOR, 9.10; 95% CI, 2.03–40.60; $P = 0.004$; Hosmer–Leme-

3 Patient and treatment characteristics of 70 patients during their last admissions to the ICU or HDU, and survival, by univariate analysis

Characteristic	Survived ($n = 58$)	Died ($n = 12$)	All patients ($n = 70$)	P
Age (years): mean ± SD	56 ± 16	66 ± 10	57 ± 15	0.04
Sex, female	26 (44%)	8 (67%)	34 (48%)	0.17
APACHE II score: mean ± SD	25 ± 8.6	30.8 ± 8.3	26.1 ± 8.9	0.05
SAPS II score: mean ± SD	39.1 ± 14.4	52.9 ± 14.0	41.5 ± 15.4	0.004
Median body temperature (°C) (range)	36.3 (32.0–42.1)	35.5 (32.8–39.9)	36.3 (32.0–42.1)	0.01
Median arterial blood pH (range)	7.42 (7.16–7.58)	7.26 (7.01–7.53)	7.39 (7.01–7.58)	0.003
Diabetes mellitus	26 (44%)	5 (41%)	31 (44%)	0.84
Sepsis	11 (19%)	5 (42%)	16 (23%)	0.09
Cardiovascular system failure	16 (28%)	7 (58%)	23 (33%)	0.04
Liver system failure	1 (2%)	1 (8%)	2 (3%)	0.32
Respiratory system failure	25 (43%)	10 (83%)	35 (50%)	0.01
Central nervous system failure	7 (12%)	6 (50%)	13 (19%)	0.002
Mechanical ventilation: non-invasive	8 (14%)	1 (8%)	9 (13%)	> 0.99
Mechanical ventilation: invasive	22 (38%)	8 (67%)	30 (43%)	0.11
Median ventilation duration (hours)	36	12		0.03
Admission for surgery (emergency)	12 (21%)	2 (17%)	14 (20%)	0.75
Admission for surgery (elective)	6 (10%)	0 (0%)	6 (8%)	0.58
Use of vasoactive drugs	16 (28%)	7 (58%)	23 (32%)	0.04
Admission PaO_2/FIO_2				0.02
< 50	20 (35%)	8 (67%)	28 (40%)	
50–250	10 (17%)	3 (25%)	13 (19%)	
> 250	28 (48%)	1 (8%)	29 (41%)	
Number of organ failures (non-renal)				< 0.001
0	26 (44%)	0 (0%)	26 (37%)	
1	16 (28%)	2 (17%)	18 (26%)	
2	15 (26%)	8 (67%)	23 (33%)	
3	1 (2%)	2 (17%)	3 (4%)	

Numbers are *n* (%) except where specified. ICU = intensive care unit. HDU = high dependency unit. APACHE = Acute Physiology and Chronic Health Evaluation. SAPS = Simplified Acute Physiology Score. ◆

show goodness of fit $\chi^2 = 9.94$; $P = 0.27$). The independent predictors of hospital mortality were also age (AOR, 1.08; 95% CI, 1.02–1.15; $P = 0.007$) and number of organ failures (AOR, 3.30; 95% CI, 1.42–7.63; $P = 0.005$). Patients admitted for pulmonary oedema had a lower in-hospital mortality than patients admitted for other reasons (AOR, 0.05; 95% CI, 0.03–0.78; $P = 0.03$; Hosmer–Lemeshow goodness of fit χ^2=10.99; $P = 0.20$).

Of the 12 patients dying in the ICU or HDU, nine received mechanical ventilation. The median time to death after admission for the 12 patients was 18 hours (range, 3–203 hours). Seven of these patients had limitations placed on their therapy in the event of further deterioration because of their perceived poor prognosis. Of the remaining five patients who died despite active therapy, only one patient deteriorated and died unexpectedly. None of the electively admitted patients died.

DISCUSSION

Mortality in the ICU or HDU was 17% and in-hospital mortality was 29%. These may be overestimates, because we used the final admission for calculation, to capture all deaths. The only other Australian study reported 18% ICU mortality and 34% hospital mortality in dialysis patients needing renal replacement therapies, of whom 77% were ventilated. As a result, they were likely to be sicker than our group.[2] Of our 104 admissions, 88% were through emergency and 27% followed surgery. Thirty-seven per cent of patients did not require dialysis during their last critical care stay.

The crude mortality for dialysis patients is comparable to that of other critical care patient groups, such as those with severe sepsis (26.5%)[6] and acute renal failure (39.5%).[7]

As in other studies of dialysis patients, the independent predictors of ICU and hospital mortality were age and the number of organ failures.[3,8,9] Patients who died in the ICU or HDU had a shorter duration of invasive ventilation and lower core temperatures. This is probably explained by the severity of their underlying illness, as the median time to death was 18 hours, with seven of the 12 patients who died having limitations placed on their therapy. This suggests that dying dialysis patients are relatively easily identified and consume fewer resources.

A small number of patients (21 of 70) accounted for most admissions (55 of 104). Recurrent admission did not predict death in hospital, but only five of 21 patients were readmitted within a single hospital episode. Although readmission to the ICU within a hospital episode carries a higher risk of death,[10] we found no study that explored the prognostic implications of recurrent admissions during different hospital episodes, as was common for our patients. Intensive care specialists must guard against familiarity with a small group of dialysis patients needing recurrent ICU admissions resulting in pessimistic prognostication.

The median survival after discharge home was 27 months. A French study showed survival of 52.2% after 6 months, but did not report longer-term follow-up.[8] ANZDATA quotes a median survival of 4.5 years in Australia across all age groups of dialysis patients on peritoneal or haemodialysis (Brian Livingston, data analyst, ANZDATA, personal communication, 10 September 2006). The median survival from the start of dialysis for our discharged patients was 3.5 years. We believe this suggests an acceptable survival following ICU or HDU admission.

A major limitation of our study is that, as it was a retrospective study in a single centre, referral and admission bias cannot be excluded. While no study has specifically explored the attitudes of intensive care specialists to admitting dialysis patients, we believe it is unlikely that dialysis patients in Australia are denied ICU admission purely on the basis of chronic renal failure or its recognised comorbidities. Although we selected patients with end-stage renal disease, our definition of a dialysis modality did not stipulate the minimum of 3 months required by the nephrology literature.[1] We decided that our approach is reasonable in the ICU context, where the preceding duration and modality of dialysis is not considered relevant to a decision about admission. Research on dialysis patients requiring ICU or HDU admission is hampered by lack of adequate numbers. A multicentre study is required to better define prognostic features. Analysis of the Australia and New Zealand Intensive Care Society's adult patient database, similar to what has been done by the Intensive Care National Audit and Research Centre in the United Kingdom, might give more insight into ICU outcomes for this group.[3] International comparisons should allow for the differences in health systems and demographic distributions in populations.

CONCLUSIONS

Dialysis patients should not be discriminated against when needing ICU or HDU admission. Patients who survived to discharge from hospital have an acceptable survival in comparison with overall survival of Australian dialysis patients.

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COMPETING INTERESTS

None identified.

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