The outcome of critically ill Indigenous patients

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Intensive care services in Western Australia are very centralised, with all public and private level II and III intensive care units (ICUs) located in the Perth metropolitan area.[1] Many Indigenous Western Australians live in non-metropolitan areas, and about three-quarters of this group live at least 50 km from the nearest hospital or community health care centre.[2] This pattern of habitation and critical care service means all critically ill Indigenous patients from remote WA must be transferred to metropolitan tertiary hospitals for further treatment. Indigenous Australians are over-represented in ICU admissions in the Northern Territory (28% of the population but 45% of all ICU admissions),[3] but there is little information on the outcome of critically ill Indigenous Australians in other parts of Australia.

We aimed to investigate the short-term outcome of critically ill Indigenous patients and the factors associated with outcome in a tertiary ICU in WA.

METHODS

Participants

This retrospective cohort study used data from the audit database of the ICU at Royal Perth Hospital. This tertiary hospital ICU admits critically ill adult patients in all clinical specialties. The database includes age and sex of the patients, severity of illness (APACHE II) scores and associated predicted mortality, admission diagnosis and source, chronic health evaluation as defined by the APACHE II prognostic model,[4] ICU and hospital length of stay, and ICU and hospital mortality. The data are collected by the duty ICU consultant and are entered by designated trained clerical staff. Twelve ICU consultants, of whom seven were involved throughout the study period, were involved in collecting data using a standardised data dictionary in the 11-year period from 1 January 1993 to 31 December 2003. During this time, a single data custodian has been responsible for ensuring data quality. The data were reviewed for internal consistency annually, and there were no patients lost to follow-up or with missing data. The data used had the patients' names and addresses removed.

ABSTRACT

Objective: To investigate the short-term outcome of critically ill Indigenous patients.

Design and participants: Retrospective cohort study using de-identified audit data from a tertiary intensive care unit (ICU) in Western Australia for the 11-year period 1 January 1993 to 31 December 2003.

Main outcome measures: Hospital mortality (crude, and adjusted for severity of illness).

Results: Of 16 757 ICU patients, 1076 (6.4%) were identified as Indigenous. The Indigenous patients were younger and more commonly had chronic liver and renal diseases. Indigenous people represented 3.2% of the population of Western Australia in 2001, but represented 3.1% and 9.5% of all elective and emergency ICU admissions, respectively. Diagnoses of sepsis, pneumonia, trauma, and cardiopulmonary arrest were common among critically ill Indigenous patients. Following emergency admission, the crude hospital mortality for Indigenous patients was higher (22.7% v 19.2%; crude odds ratio, 1.24; 95% CI, 1.04–1.47) than for non-Indigenous patients. The crude hospital mortality of critically ill Indigenous patients was lower than that predicted by the APACHE II prognostic model and was similar to that of non-Indigenous patients after adjusting for severity of illness and chronic health status.

Conclusions: The pattern of critical illness affecting Indigenous Australians in Western Australia was different from that affecting non-Indigenous patients. The crude hospital mortality was high, but similar to that of non-Indigenous Australians after adjusting for severity of illness and chronic health status.

This was deemed to be a "clinical audit" by the Hospital Ethics Committee and was approved by the Western Australian Aboriginal Health Information and Ethics Committee (WAAHIEC). All ICU admissions between 1 January 1993 and 31 December 2003 were included.

Statistical analysis

Continuous variables with near normal distribution were analysed by *t* test, and categorical variables and continuous variables with skewed distribution were analysed by χ^2 test and Mann–Whitney test, respectively. The outcome was stratified into elective surgical admissions or emergency admissions.

The APACHE II prognostic model measures severity of illness and predicts hospital mortality of critically ill adult patients. APACHE II scores are calculated using the patient's age, the worst measurements of 12 physiological variables within 24 hours of ICU admission, and the chronic health status of the patient.[4] The APACHE II predicted mortality of a patient is calculated using the APACHE II score and admission diagnosis. The APACHE II model has been validated and used widely for research and clinical audit purposes in many ICUs.[5,6] In this study, the hospital mortality of Indigenous patients was compared with the APACHE II predicted mortality across different risk strata, with the deviation from perfect prediction assessed by the Hosmer–Lemeshow H and C χ^2 statistics. Patients who were admitted to the ICU after cardiac surgery were excluded from the multivariate analysis because the published APACHE II prediction model equation was not derived from patients who had undergone coronary artery bypass graft.[4]

The ICU admissions were categorised into four time periods to evaluate changes in hospital mortality over time. Hospital survival of Indigenous patients was compared with survival of other patients using logistic regression analysis, after adjustment for other potential predictors of hospital survival. Potential predictors included APACHE II predicted mortality, age, sex, admission source, elective or emergency admission, primary organ failure, and the calendar year of the ICU admission.

A *P* value less than 0.05 was regarded as statistically significant in all analyses. All statistical analyses were performed using SPSS version 11.0 (SPSS Inc, Chicago, Ill, USA) and confidence intervals were generated by Confidence Interval Analysis version 2.0.0 (BMJ, London, UK).

1 Characteristics of the intensive care unit (ICU) cohort (including cardiac surgical patients)

	Indigenous (n = 1076)	Non-Indigenous (n = 15 681)	P*
Mean age in years (SD)	42.2 (13.8)	57.9 (17.9)	0.001
Male/female	625/451 (58%/42%)	10 366/5315 (66%/34%)	0.001
Elective surgery	245 (22.8%)	7753 (49.4%)	0.001
Emergency admission	831 (77.2%)	7928 (50.6%)	
Source of admission to the ICU			0.001
Operating room	390 (36.2%)	9991 (63.7%)	
Recovery room	31 (2.9%)	758 (4.8%)	
Emergency department	277 (25.7%)	2699 (17.2%)	
Hospital ward	114 (10.6%)	1367 (8.7%)	
Another hospital	264 (24.5%)	866 (5.5%)	
Primary organ failure leading to ICU admission			0.001
Cardiovascular	407 (37.8%)	8922 (56.9%)	
Respiratory	283 (26.3%)	2409 (15.4%)	
Neurological	285 (26.5%)	3610 (23.0%)	
Renal	35 (3.3%)	132 (0.8%)	
Gastrointestinal	42 (3.9%)	359 (2.3%)	
Metabolic	20 (1.9%)	197 (1.3%)	
Haematological	4 (0.4%)	46 (0.3%)	
Major diagnostic categories			
Sepsis other than pneumonia	156 (14.5%)	634 (4.0%)	0.001
Pneumonia or respiratory infection	87 (8.1%)	335 (2.1%)	0.001
Cerebrovascular accident	62 (5.8%)	789 (5.0%)	0.282
Cardiopulmonary arrest	38 (3.5%)	357 (2.3%)	0.010
Multiple trauma	133 (12.4%)	1166 (7.4%)	0.001
Cardiac surgery	213 (19.8%)	5437 (34.7%)	0.001

*Non-parametric test was used for categorical outcome variables or variables with skewed distributions. ◆

2 Emergency and elective intensive care unit (ICU) admissions of Indigenous patients over an 11-year period

The first calendar year period, 1993 to 1994, only covered ICU admissions in 2 years rather than 3 years. Error bars indicate the 95% confidence intervals for emergency admissions. ◆

ferent calendar year periods, primary organ failure, ethnicity, sex, and the interaction term between admission source and ethnicity were not significant factors in determining hospital mortality in the multivariate analysis.

DISCUSSION

The distribution and severity of many illnesses differ between Indigenous and non-Indigenous Australians. The same is true of critical illness affecting Indigenous patients in Western Australia. Critically ill Indigenous patients admitted to the ICU were younger, more commonly had chronic liver and renal diseases, and were over-represented in emergency ICU admissions, especially with diseases of high acuity. The crude hospital survival of critically ill Indigenous patients was lower than that of non-Indigenous patients in emergency admissions because of the associated higher severity of illness. However, the survival of Indigenous patients was no different after adjustment for age, severity of illness, and admission source.

Intensive care treatment can be described as an "ambulance at the bottom of a cliff" with many patients admitted to the ICU only after other layers of the health care system have failed to reverse or prevent the critical illness. It is not surprising that the well described differences in the access that Indigenous patients have to primary health care, chronic disease screening and treatment, vaccination, and specialist care are reflected in a different pattern of critical
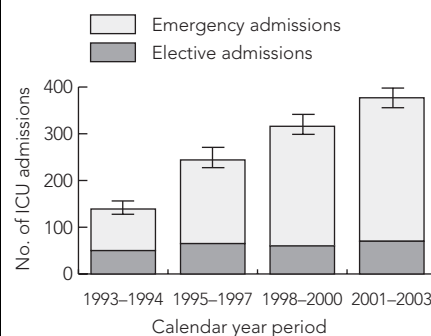
RESULTS

There were 16 757 ICU patients, of whom 1076 (6.4%) were identified as Indigenous Australians, in the 11 years from 1 January 1993 to 31 December 2003. Compared with non-Indigenous patients, the Indigenous patients were younger and more likely to be transferred from another hospital (Box 1). ICU admissions due to respiratory or renal failure, and the diagnoses of sepsis, pneumonia, trauma, and cardiopulmonary arrest were more common among Indigenous patients (Box 1). Indigenous people represented 3.2% of the population of WA in 2001,[7] and accounted for 3.1% of all elective admissions and 9.5% of all emergency admissions. The total number of Indigenous patients admitted to the ICU each year increased over the 11-year period, mainly because of a progressive increase in emergency admissions (Box 2). Chronic liver and renal diseases were more common among Indigenous patients, and chronic cardiovascular diseases were more common among non-Indigenous patients (Box 3).

Indigenous patients admitted for elective non-cardiac surgery had a higher severity of illness, as reflected by the APACHE II predicted mortality, and higher crude ICU mortality and hospital mortality than non-Indigenous patients (Box 4).

Indigenous patients who had emergency admissions had a higher severity of illness (APACHE II scores and predicted mortality), a longer ICU stay, and higher crude ICU mortality (crude odds ratio, 1.24; 95% CI, 1.02–1.50) and hospital mortality (crude OR, 1.24; 95% CI, 1.04–1.47) than non-Indigenous patients (Box 4). The crude hospital mortality rates of both Indigenous and non-Indigenous patients were lower than predicted by the APACHE II prognostic model (Box 5).

A higher APACHE II predicted mortality, admission from the operating theatre (rather than recovery room, emergency department or other hospital), an older age, and emergency admission were significant predictors of hospital mortality in the multivariate analysis (Box 6). ICU admission during dif-

3 Differences in chronic health status between Indigenous and non-Indigenous patients

	Indigenous (n = 1076)	Non-Indigenous (n = 15 681)	P
Chronic cardiovascular disease*	57 (5.3%)	1479 (9.4%)	0.001
Chronic cardiovascular disease†	17 (2.0%)	328 (3.2%)	0.045
Chronic respiratory disease‡	20 (1.9%)	320 (2.0%)	0.680
Chronic liver disease§	25 (2.3%)	108 (0.7%)	0.001
Chronic renal disease¶	75 (7.0%)	159 (1.0%)	0.001
Immunocompromised state**	13 (1.2%)	301 (1.9%)	0.100

* New York Heart Association class IV status (ie, angina or symptoms at rest or minimal exertion). † Analysis after excluding patients undergoing cardiac surgery. ‡ Chronic obstructive, restrictive, vascular disease resulting in severe exercise restriction (ie, unable to climb stairs or perform household duties) or documented chronic hypoxia, hypercapnia, secondary polycythaemia, severe pulmonary hypertension (> 40 mmHg) or respirator dependency. § Biopsy-proven cirrhosis and documented portal hypertension; or episodes of past upper gastrointestinal bleeding attributed to portal hypertension; or prior episodes of hepatic failure or encephalopathy. ¶ Receiving chronic haemo or peritoneal dialysis. ** The patient has a disease that is sufficiently advanced to suppress resistance to infection (eg, leukaemia, lymphoma, AIDS, documented metastatic cancer); or the patient has received therapy that suppresses resistance to infection (eg, chemotherapy, radiation) during 30 days before hospitalisation; or the patient has received recent high dose steroid (> 15 mg/kg for five or more days). ◆

illness.[8-12] It is hoped that if improvements in access to comprehensive medical care occur, this will be reflected in a reduction in the severity of illness and crude mortality in ICU admissions.

The high prevalence of high acuity acute illnesses, such as sepsis, pneumonia, injuries, and cardiopulmonary arrest, among critically ill Indigenous patients is consistent with the results of other Australian studies,[2,3,13-15] and very similar to data of indigenous groups from other countries.[16-18] This could be due to a long delay following the onset of symptoms and reduced access to primary health care facilities or emergency departments, as most Indigenous patients reside in rural locations where primary health care facilities or staffed emergency departments are often not available.[2] Furthermore, many chronic health conditions, including severe coronary heart disease, might not have been diagnosed until the patients presented to the ICU with life-threatening complications of these chronic illnesses.

There are some limitations to this study. First, this was a single centre cohort study and the results may not be generalisable to all ICUs in Australia. Royal Perth Hospital is the largest cardiothoracic surgery, cardiology, and trauma unit in WA. This may explain the large numbers of cardiac surgical and trauma admissions in this cohort and the high prevalence of chronic cardiovascular diseases among the non-Indigenous patients. Furthermore, critically ill Indigenous patients will also have been admitted to one of the other two adult tertiary public ICUs in WA, and whether the pattern of critical illness affecting these Indigenous patients is similar to our cohort remains unknown. Second, there is evidence that identification of Indigenous hospital inpatients is only 85.8% complete in WA.[19] It is possible that some Indigenous patients were not identified. Third, the geographic origin of the patients was not available in the database and we cannot exclude the potential confounding effect of this factor in our results. Finally, the accuracy of the APACHE II prediction model can be affected by lead time bias when patients are referred from different sources. Many of our critically ill Indigenous patients were referred and transferred from other, usually rural or regional, hospitals. This could have created bias in the APACHE II predicted mortality, making our adjustment for hospital mortality inaccurate.[20-22]
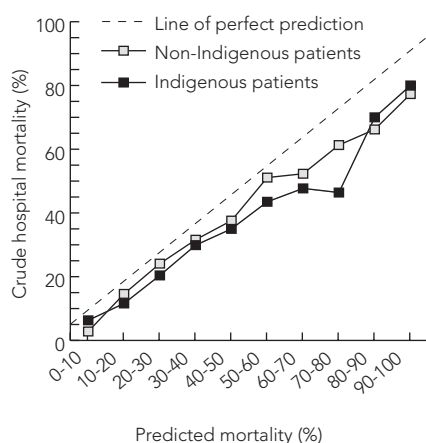
Nevertheless, our findings suggest that the poor outcomes of critically ill Indigenous people are related to the high burden of chronic illness. Reduction in the burden of chronic illnesses and the incidence of high acuity acute illnesses is likely to require an improvement in primary health care, screening and early treatment of chronic diseases, vaccination, and health promotion in remote communities.[8-12] There are 83 communities in WA with fewer than 50 people that are more than 50 km from a community health clinic.[2] Three-quarters of these communities are not visited at least once a month by any health care professionals.[2] Indigenous patients who might benefit from chronic disease screening and primary health care should have access to these health care services. Training more Indigenous health care workers for the Indigenous community has been suggested as an important step to improve the effectiveness of health care programs to Indigenous communities.[23] Further improvement in the outcomes of critically ill Indigenous patients

4 Short-term outcome of critically ill Indigenous and non-Indigenous patients in elective and emergency admissions (excluding cardiac surgery)

	Indigenous	Non-Indigenous	P*
Elective surgery	n = 56	n = 2956	
Mean ICU stay in days (median, SD)	3.4 (2, 4.3)	2.5 (2, 4.0)	0.665
Mean hospital stay in days (median, SD)	35.2 (16, 41.4)	17.4 (11, 25.2)	0.001
Mean APACHE II score (median, SD)	10.9 (10, 4.7)	10.7 (10, 4.8)	0.681
APACHE II predicted mortality (median, SD)	8.5% (6.0%, 7.3%)	6.0% (3.8%, 7.8%)	0.001
Crude ICU mortality	4 (7.1%)	59 (2.0%)	0.027
Crude hospital mortality	6 (10.7%)	148 (5.0%)	0.049
Emergency admissions	n = 831	n = 7928	
Mean ICU stay in days (median, SD)	7.0 (4, 9.1)	5.8 (3, 8.4)	0.001
Mean hospital stay in days (median, SD)	23.6 (14, 32.6)	21.9 (13, 29.5)	0.320
Mean APACHE II score (median, SD)	18.6 (18, 8.3)	16.9 (16, 7.9)	0.001
APACHE II predicted mortality (median, SD)	29.1% (21.3%, 25.3%)	23.2% (15.5%, 22.7%)	0.001
Crude ICU mortality	140 (16.8%)	1115 (14.1%)	0.033
Crude hospital mortality	189 (22.7%)	1525 (19.2%)	0.017

* Non-parametric test was used for categorical outcome variables or variables with skewed distributions. ◆

5 Relationship between APACHE II predicted and actual hospital mortality across different risk strata (excluding cardiac surgical patients)

Hosmer–Lemeshow goodness of fit: H χ^2 = 41.7, df = 9 (P < 0.001); C χ^2 = 14.6, df = 9 (P = 0.067). ◆

6 Multivariate analysis showing the predictors of hospital mortality in the entire cohort after excluding cardiac surgery admissions (n = 11 107)

	Number of patients	Adjusted odds ratio (95% CI)	P
APACHE II predicted mortality*	11 107	1.60 (1.56–1.64)	0.001
Emergency admissions	8 095	1.94 (1.57–2.39)	0.001
Age*	11 107	1.05 (1.01–1.09)	0.017
Admission source			0.001
Operating theatre	4 885	1.00	
Recovery room	638	0.57 (0.40–0.83)	0.003
Emergency department	2 976	0.78 (0.66–0.91)	0.002
Ward	1 481	1.16 (0.98–1.38)	0.079
Other hospital	1 127	0.67 (0.54–0.82)	0.001

* The odds ratios represent a 10% increase in APACHE II predicted mortality or 10-year increase in the age of the patient. Hosmer–Lemeshow goodness of fit: χ^2 = 122.7, df = 8, P = 0.001. The classification was correct for 85.3% of the cohort when a cut-off value of 0.5 was used in the final multivariate model. ◆

relies on a sustained improvement in access and effectiveness of preventive and primary health care services to Indigenous communities in rural Australia.[12] A reduction in severity of illness and crude mortality rate in critically ill Indigenous patients may be a useful indicator of improving health outcomes in Indigenous Australians.

In conclusion, as for many other illnesses, the pattern of ICU utilisation differs between Indigenous and non-Indigenous Australians. Critical illnesses requiring emergency ICU admission are increasing among Indigenous Western Australians. They are sicker than non-Indigenous patients when they are admitted to the ICU, but their short-term outcome is similar after adjustment for the severity of their illness.

COMPETING INTERESTS

None identified.

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