

A unique snapshot of intensive care resources in Australia and New Zealand

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SUMMARY

The objective of this study was to analyse and report on the distribution and attributes of intensive care services in Australia and New Zealand for the 2005/2006 financial year. A survey was mailed to 155 Australian and 26 New Zealand intensive care units (ICU) listed on the database of the Australian and New Zealand Intensive Care Society. A descriptive analytical approach was used. Of the 181 ICUs, 177 provided data. In Australia there were 100 public sector and 51 private sector ICUs and in New Zealand, 24 public sector and two private sector ICUs. These units contain 1485 available beds in the public sector and 538 available beds in the private sector. Calculations to determine beds per 100,000 population, medical specialists per 1000 patient days and registered nurses per 1000 patient days showed wide variation. International comparisons are limited by lack of data; however it does appear that intensive care patients in Australia and New Zealand have very good outcomes.

Key Words: intensive care, critical care, workforce, capacity, critical care beds, resources

The Australian and New Zealand Intensive Care Society (ANZICS) established the intensive care unit (ICU) Registry in 1993 which is now part of the Centre for Outcomes and Resource Evaluation. It is one of the three affiliated databases administered by the ANZICS Centre for Outcomes and Resource Evaluation and is located at ANZICS House in Melbourne. As a result of its research activities, the Critical Care Resources (CCR) section holds a significant collection of data on intensive care resources. This research is quality-oriented and is directed toward intensive care infrastructure, workforce profiles and processes of care. The annual surveys completed by ICU staff assist in monitoring trends in intensive care service delivery.

This paper provides an overview of the key findings of the 2005/2006 survey. It provides data not available from any other source and can be used

for intensive care planning in Australia and New Zealand. ANZICS is the only agency to compile bi-national statistics on distribution of critical care resources in Australia and New Zealand¹⁻⁹.

The key findings presented in this paper include ICU levels, types and bed numbers and medical and nursing workforce data by region for Australia and New Zealand.

Intensive care is a generic term for a range of diverse health care services. The terms critical care and intensive care are frequently used interchangeably in contexts of care in Australia and New Zealand. Critical care services encompass adult and paediatric intensive care, high dependency care, accident and emergency, coronary care, neonatal intensive care and emergency retrieval services. However the focus for this study was adult and paediatric intensive care services that provide observation, care and treatment for critically ill patients with single or multiple organ dysfunctions. Intensive care services in this study are categorised as general ICU (combined medical and surgical care), combined ICU, coronary care unit and high dependency unit (ICU/CCU/HDU), paediatric ICU (PICU) and specialty ICU (cardiothoracic, neurological, oncology).

MATERIALS AND METHODS

The 2005/2006 survey instrument was based on previous surveys conducted by the Centre for Outcomes and Resource Evaluation.

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Accompanying the survey was an explanatory letter to the ICU director, a glossary of key terms and an extract on standards for intensive care training by the Joint Faculty of Intensive Care Medicine (JFICM)¹⁰. The survey was mailed to all Australian and New Zealand hospitals listed in the CCR database in July 2006 for return by 29 September 2006, although the return of surveys was accepted until May 2007. The overall response rate was 97.79%; 97.42% for Australia and 100% for New Zealand. In Australia, 100 public sector ICUs (including seven ICUs in privately-managed public acute care hospitals) and 51 private sector ICUs were included in the dataset. In New Zealand, 24 public sector ICUs and two private sector ICUs were included. A number of ICUs in Australia and New Zealand included in previous surveys were no longer eligible for inclusion due to infrastructure and service delivery changes.

For inclusion in this survey, a critical care unit must possess ventilator capability and have the resources to provide continuous care. ICUs should also invasively ventilate 20 or more patients per annum. A number of smaller units submitted data but some of these have now been excluded. The exclusion applied where it could be established that fewer than 20 patients were invasively ventilated per annum in each of the units over three consecutive survey periods. It appears that some of these smaller ICUs function primarily as HDUs or serve as sites for resuscitation and retrieval of the critically ill. These ICUs will continue to be monitored in forthcoming surveys to capture any changes to their status and to ensure ongoing comprehensive coverage of critical care services across Australia and New Zealand.

Bed data includes the number of physical, available and ventilator beds. A physical bed is defined as a single patient location configured to ICU standards whereas an available bed is one that is in use or immediately available for use, fully staffed and funded. A ventilator bed is defined as a physical ICU bed plus ventilator. Workforce data was collected for medical and nursing staff. Medical staff included intensivists (specialist qualification in intensive care), other specialists working in intensive care, senior registrars, registrars and residents. Nursing staff focused on registered nurses (RN). A full time equivalent (FTE) has been defined in Australia as >35 hours per week¹¹ and in New Zealand as >30 hours per week¹² of paid employment. Units self-reported their ICU level (with category 1 being the lowest and 3 being the highest level of support capability) using the JFICM standards¹⁰. Total patient

hours were requested or total patient days if this was not possible.

International data for comparison was sought from peer-reviewed journals, medical society and government publications, websites, internet searches and personal correspondence.

Given the scope of the survey and the type of data collected, a descriptive analytical approach was viewed as the most suitable method. Data was entered into SPSS (Statistical Package for the Social Sciences) version 15.0¹³ and Microsoft Excel 2003¹⁴ software.

RESULTS

ICU level

In Australia, the majority of units were level 3 (47.7%); whereas in New Zealand the majority were level 2 (42.3%). Figure 1 shows the distribution of ICUs in Australia and New Zealand by ICU level.

Some state and territory health departments have an established hierarchy of acute care service levels; however, these generally correspond with the JFICM standards.

Despite the application of JFICM standards, it may be difficult to distinguish between ICU levels in some instances. Moreover, ICU levels for an individual ICU may vary over time. Additionally, there were a small number of quaternary ICUs in each state and territory that offer super-specialty services and which may also serve as regional retrieval or referral centres. This latter group were categorised as level 3 ICUs.

ICU type

In Australia, most ICUs were general (56.3%), followed by ICU/CCU/HDU (36.4%), PICU (5.3%) and specialty (1.9%). In New Zealand, the majority of units were general ICU (46.1%) followed by ICU/CCU/HDU (42.3%), specialty ICU (7.7%) and PICU (3.9%).

ICU bed status

Critical care bed status examined three components: physical beds (an actual bed configured to ICU standards); available beds (a physical bed that is fully staffed and funded); and ventilated beds (physical bed plus ventilator). The majority of beds in Australia and New Zealand are in the public system (73.5%, 95.5% respectively).

In Australia, there were 1990 physical beds (1452 public sector, 538 private sector), 1794 available beds (1267 public sector, 527 private sector) and 1314 ventilator beds (934 public sector, 380 private sector). In New Zealand, there were 280 physical

beds (269 public sector, 11 private sector), 229 available beds (218 public sector, 11 private sector) and 172 ventilator beds (164 public sector, eight private sector). Furthermore, calculations can be performed to determine the beds per 100,000 population using population statistics from the Australian Bureau of Statistics (ABS)¹⁵ and Statistics New Zealand¹⁶. This data is summarised in Tables 1,

2 and 3. From these calculations, it can be estimated that the total available beds per 100,000 population is greater in Australia (8.9 beds/100,000) than in New Zealand (5.5 beds/100,000). In addition, the ventilator beds per 100,000 was greater in Australia (6.5 beds/100,000) than New Zealand (4.2 beds/100,000). However, there are variations in beds per 100,000 population throughout Australia,

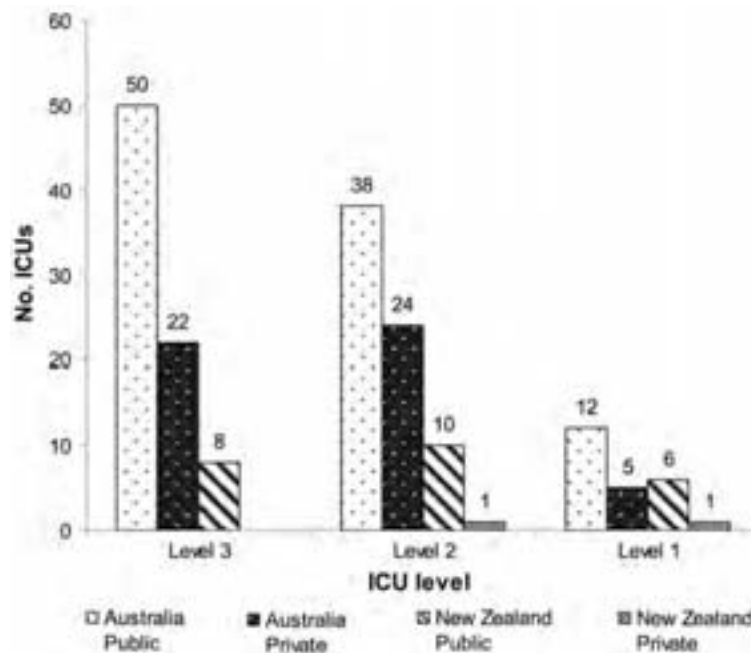


FIGURE 1: Distribution of intensive care units (ICU) in Australia and New Zealand by ICU level.

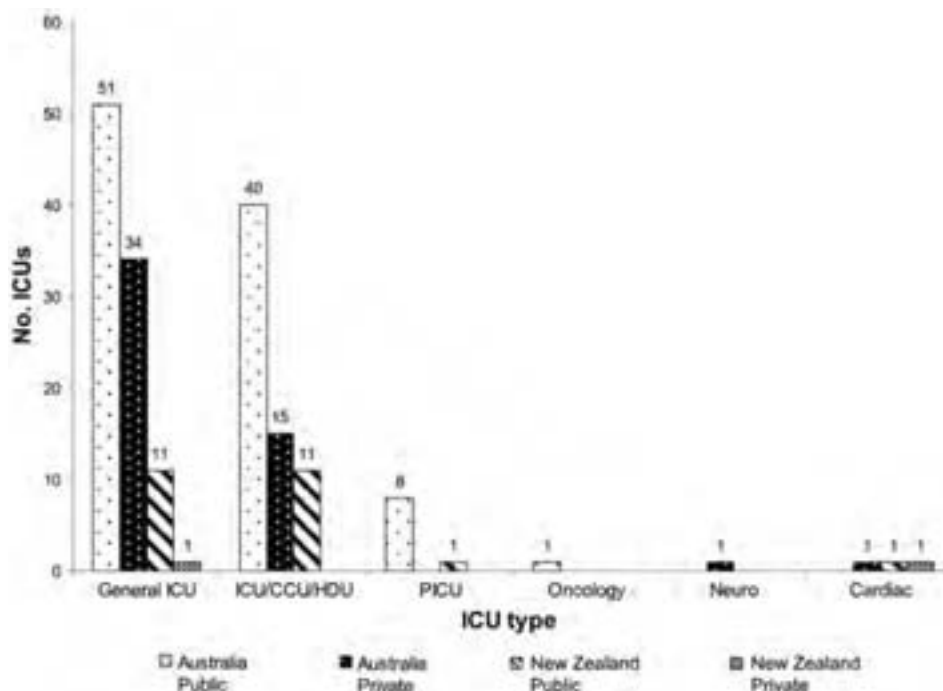


FIGURE 2: Intensive care unit (ICU) type by sector, Australia and New Zealand. CCU=coronary care unit, HDU=high dependency unit, PICU=paediatric intensive care unit, neuro=neurological, cardiac=cardiothoracic.

ranging from 5.9 available beds/100,000 in Western Australia to 12.6 available beds/100,000 in the Northern Territory.

Table 4 shows a comparison of international critical care bed data. This data is very limited and does not allow for comparisons in great detail.

TABLE 1
Demographic distribution of ICU beds, Australia

Sector	Bed category	Region/number of ICUs and beds							
		NSW, n=35	Vic., n=23	Qld, n=22	SA, n=7	WA, n=5	Tas., n=4	ACT, n=2	NT, n=2
Public	Physical beds	552	320	259	134	84	42	34	27
	Available beds	488	272	215	122	80	41	23	26
	Ventilator beds	320	239	167	86	67	25	16	14
	Subtotal	Physical beds: 1452							
		Available beds: 1267							
		Ventilator beds: 934							
		NSW, n=15	Vic., n=11	Qld, n=13	SA, n=6	WA, n=4	Tas., n=1	ACT, n=1	NT, n=0
Private	Physical beds	148	107	153	67	40	17	6	n/a
	Available beds	146	107	150	67	40	11	6	n/a
	Ventilator beds	92	89	119	45	27	5	3	n/a
	Subtotal	Physical beds: 538							
		Available beds: 527							
		Ventilator beds: 380							
Australia	Physical beds: 1990								
	Available beds: 1794								
	Ventilator beds: 1314								

TABLE 2
Demographic distribution of ICU beds, New Zealand

	Units	Physical beds	Available beds	Ventilator beds
Public	24	269	218	164
Private	2	11	11	8
Total	26	280	229	172

TABLE 3
Population distribution of public and private sector ICU beds, Australia and New Zealand

Region	Population*	Physical beds	Available beds	Ventilator beds	Available beds/100,000	Ventilator beds/100,000
NSW	6,827,694	700	634	412	9.29	6.03
Vic.	5,091,666	427	379	328	7.44	6.44
Qld	4,053,444	412	365	286	9.00	7.06
SA	1,554,656	201	189	131	12.16	8.43
WA	2,050,884	124	120	94	5.85	4.58
Tas.	488,948	59	52	30	10.64	6.14
ACT	328,817	40	29	19	8.82	5.78
NT	206,688	27	26	14	12.58	6.77
Australia	20,062,797	1990	1794	1314	8.94	6.54
New Zealand	4,139,500	280	229	172	5.53	4.15

* Source: ABS (2007) Regional Population Growth, Australia, 2005-2006¹⁵; Statistics New Zealand 2006¹⁶.

TABLE 4
International comparison of critical care beds

Author	Region	Publication year	ICU beds	ICU beds as % hospital beds	ICU beds/100,000 population
Martin et al ⁹	Australia	2007	1794	1.4*	8.9
Martin et al ⁹	New Zealand	2007	280	0.7#	5.5
Halpern et al ¹⁷	USA	2004	87,400	13.4	29.2‡
Department of Health ^{18,19}	England	2006	3775	2.1	7.4
Scottish Intensive Care Society ²⁰	Scotland	2005	146.8	0.8†	2.9
Offenstadt et al ²¹	Europe – Austria	2006	1914*	3.8	23.2‡
	Europe – Denmark		481	–	8.9‡
	Europe – France		–	–	~6.5-20.9
	Europe – Germany		–	4.5	–
	Europe – Spain		3500	–	8.0‡

Includes intermediate care beds; data is only for public hospitals. * Calculated from AIHW bed numbers²². # Calculated from NZHIS bed numbers²³. † Calculated from ISD Scotland Acute Care Hospital Bed Statistics²⁴. ‡ Calculated from World Bank population data and statistics for 2006²⁵.

However, publications of national measurements for medical and nursing staffing are not prevalent. Calculations for the number of beds per 100,000 population were performed by the CCR using population data sourced elsewhere, as referenced. It is important to note that the definition for critical care beds is different in each country and this should be taken into account when examining the comparisons.

Activity

Information on admissions was provided by 176 units. Australian units had 140,444 admissions and New Zealand had 22,791 admissions. One hundred and thirty-three units were able to divide them into the number of elective or emergency admissions.

TABLE 5
Total patient days by region, Australia

Region	Public	Private
NSW	119,253	26,026
Vic.	70,974	17,489
Qld	47,685	29,558
SA	26,690	9318
WA	16,540	3090
Tas.	7853	–
ACT	5154	790
NT	5636	–
No. of units providing data	93/100	44/51
Australia	299,789	86,274

The Australian public sector admitted 21,365 elective and 43,444 emergency patients from 79 units and the private sector admitted 20,006 elective and 6394 emergency patients from 35 units. New Zealand public sector had 4035 elective and 6783 emergency admissions from 17 units and 972 elective and 36 emergency admissions from two units.

Patient (bed) day data were collected for 2005/2006. The public and private sector data are summarised in Tables 5 and 6. One hundred and sixty-six units reported deaths. It was reported that 7362 patients died from a total of 132,943 admissions in Australia (6.8% in public and 2.8% private, all 5.5%) and 1180 patients died from 21,785 admissions in New Zealand (5.4% in public, private not reported).

Intensive care workforce data

It was established that in the 2005/2006 financial year there was a total of 553 FTE specialists working in ICUs in Australia and New Zealand. In Australia, there were 306 FTE intensivists and 39.9 other FTE specialists. In New Zealand, there

TABLE 6
Total patient days by region, New Zealand

Region	Public	Private
North Island	30,350	1094
South Island	8765	–
No. of units providing data	22/24	2/2
New Zealand	39,115	1094

were 48.6 FTE intensivists and 33.6 other FTE specialists. Specialists may hold permanent positions in more than one unit and our data does not identify individual specialists' names. We cannot estimate the total number of specialists as we would be double-counting some individuals. Calculations can be performed to determine the FTE specialists per 1000 patient days. There are more FTE specialists/1000 patient days in New Zealand than Australia in the public sector.

Nursing data (public sector)

A total of 9718 RNs are employed as 7435 FTEs, working in Australia and New Zealand. This total

consists of 5517 public and 1114 private sector FTEs in Australia and 795 public FTEs in New Zealand (only one private unit reported nursing FTEs in New Zealand). The FTEs per 1000 patient days and FTEs per bed are shown in Table 8.

DISCUSSION

This is the first paper to comprehensively describe the attributes and distribution of intensive care in Australia and New Zealand. The data provided in this review should enable international comparisons to be made. By standardising the data by either 1000 patient days or 100,000 population, it was anticipated

TABLE 7
Distribution of specialists by region and sector

Region population*	Public		Private		All
	Total FTE specialists	FTE specialists/1000 patient days	Total FTE specialists	FTE specialist/1000 patient days	FTEs/1000 patient days range
NSW: 6,827,694	126.8	1.03	39.5	1.51	0.38-4.5
Vic.: 5,091,666	67.60	1.05	21.95	1.40	0.47-2.3
Qld: 4,053,444	75.27	1.46	28.75	0.84	0.35-5.4
SA: 1,554,656	27.30	1.06	11.5	1.02	0.70-1.6
WA: 2,050,884	28.25	1.7	15.6	2.5	1.2-4.3
Tas.: 488,948	10.00	1.27	5	–	0.43-1.80
ACT: 328,817	5.00	0.96	1	1.26	0.70-1.07
NT: 206,688	5.50	0.97	–	–	0.80-1.30
Australia: 20,062,797	345.72	1.13	123.3	1.39	0.35-5.4
New Zealand: 4,139,500	82.25	1.99	2	1.83	0.84-3.35

FTE=full time equivalent. * Source: ABS (2007) Regional Population Growth, Australia, 2005-2006¹⁵, Statistics New Zealand 2006¹⁶.

TABLE 8
Distribution of RNs by region and sector

Region	FTE RNs	Public			Private		All	
		FTE RNs/1000 patient days	FTE RNs/available bed	FTE RNs	FTE RNs/1000 patient days	FTE RNs/available bed	FTE RNs/1000 patient days range	FTE RNs/available bed range
NSW	1995.49	16.7	4.1	247.1	9.5	1.7	3.9-25.7	1.0-7.8
Vic.	1224.75	17.3	4.5	247.4	14.2	2.3	5.6-24.7	1.3-6.6
Qld	995.64	20.9	4.6	348.0	11.8	2.3	7.5-28.3	1.2-8.5
SA	558.36	20.9	4.9	154.3	16.6	2.3	5.5-27.2	1.8-6.8
WA	378.00	22.9	4.7	79.0	25.6	2.0	11.8-33.9	1.4-6.0
Tas.	165.60	21.1	4.0	26.5	–	2.4	13.6-29.1	2.4-5.1
ACT	110.11	21.4	4.8	12.0	15.2	2.0	15.1-22.8	2.0-5.9
NT	89.77	15.9	3.5	–	–	–	13.9-16.9	3.3-3.5
Australia	5517.72	18.4	4.4	1114.5	12.9	2.1	3.9-33.9	1.0-8.5
New Zealand	795.4	20.3	3.6	*	–	–	8.6-27.7	1.3-6.8

RN=registered nurse, FTE=full time equivalent. * Only one unit provided data.

that comparing a range of intensive care resources in various countries would be possible.

ICU beds

Measurement of the number of physical beds and ventilator beds is straightforward for units to undertake. However, the number of available beds has been difficult for units to report. This number can vary on a daily basis as the number of available staff change. It may be averaged over the 12-month period (as the CCR requests in its definition) or some units may calculate the available beds from the staffing establishments. There will be periods of high activity, when the number of patients exceeds the number of funded available beds (but not the number of physical beds).

There are differences in intensive care resources throughout the regions of Australia and New Zealand. There are no accepted guidelines in Australia or New Zealand for the number of intensive care beds required for a population. A United Kingdom paper has shown calculations for critical care beds required for their population²⁶; however, it indicated that there were limitations to the calculations. The number of beds required in any country will be affected by a variety of factors; cardiac surgery intervention rates, rates of chronic respiratory illness, ability to manage patients outside of an ICU (e.g. separate HDU or extended post-anaesthesia care unit facilities), cultural differences in end-of-life attitudes and medico-legal precedents.

Comparisons of intensive care beds between hospitals based on each hospital's catchment population are not valid because of the regionalised distribution of services within a health system. Cardiac surgery, trauma services, transplantation and neurosurgery are frequent users of intensive care services so a hospital's casemix will strongly influence its intensive care requirements. Regions or states must be considered as a whole system and the private sector capacity is an integral part of this system.

The ability to transfer patients between hospitals to manage high activity might influence the number of beds needed in a hospital. Having more units in a system or state may allow capacity for coping with peaks. However in our data, states with smaller numbers of units do not have more beds per 100,000 population.

In attempting to undertake international comparisons of intensive care services, a degree of caution is advised due to differences in infrastructure and definitions. It has been acknowledged previously that the definitions of critical care,

intensive care and high dependency beds are not consistent amongst countries^{27,28}. The composition of much of the international intensive care bed data is not clear in terms of bed nor service type, e.g. whether it incorporates adult and paediatric services. There is often inadequate explanation as to what constitutes a critical care bed. The Scottish Intensive Care Society publishes data about critical care beds as the number of intensive care beds only; high dependency beds are located in separate HDUs and these beds are not represented in Table 4. Australia and New Zealand admit high dependency patients to ICUs and the 'high dependency beds' are not separated from intensive care beds. When comparing international critical care bed data, it should be noted that Australian, New Zealand and English data included both adult and paediatric beds.

The large number of critical care beds available in the USA is clearly different from other countries. It is likely that this is due to definitional differences in what constitutes intensive care. Unfortunately, there was no accompanying data on the number of ventilated patients in the USA to allow a meaningful understanding of the proportion of intensive care patients and the proportion of high dependency patients or prospective patient monitoring without intervention. In addition, there are differing organisational aspects of intensive care with respect to 'closed' systems which are present in most European countries, compared to the USA where approximately one-third of ICU patients are treated by an intensivist²⁸ and units are frequently managed by referring doctors in an 'open' management structure.

Intensive care is expensive and its provision will be affected by available funding. There is a linear relationship between health funding and a country's gross domestic product which may explain the lower number of beds in New Zealand²⁹.

Activity

Only 115 from 124 public units and 46 from 53 private units supplied data of their patient days or hours. The missing data represents activity in 6.5% of the available beds. This limits the comparisons but approximately 20% of Australian intensive care activity is provided in the private sector. New Zealand has a different health funding system and only 3% of the activity occurs in the private sector. The public and private sector have a similar number of elective admissions in Australia. International data is not available for comparison. Our data does not allow comparisons of casemix or severity of

illness when examining public and private elective admissions, so we must be cautious with any inferences. However, it is clear that a significant proportion of the Australian health system is reliant of the private sector, particularly for major elective surgery.

ICU staffing

When examining critical care workforce figures, there was a large range of FTE specialists and FTE RNs per 1000 patient days. It is difficult to know how to interpret the staff per 100,000 population-based comparisons as these will be heavily influenced by the number of beds per population. The FTEs per 1000 patient days comparisons may provide a better reflection of staffing levels for the workload. New Zealand had the highest number of FTE specialists per 1000 patient days. The higher ratio may reflect the relative absence of private intensive care in New Zealand and thus a higher proportion of full-time employment in the public sector¹⁻⁹. International comparisons are difficult to make as there is little information available. The International Programme for Resource Use in Critical Care study reported rates for three European countries with ranges of 0.5 to 1.3 FTE per 1000 patient days³⁰. The number will reflect structural differences in intensive care staffing, with full-time public intensive care practice being the norm for specialists in tertiary units in New Zealand. Despite similarities in intensive care provision in Australia and New Zealand, there is a wide variation in specialist staffing levels which is not explained.

Registered nurse levels are often measured as a ratio per bed but this does not allow for the occupancy of the bed. RN ratios per 1000 patient days can be calculated from the total employed FTE RNs within a unit and the total patient days. This will be affected by the proportion of high dependency patients who may be nursed at a different (lower) nurse-to-patient ratio. This number will also vary with the differing mechanisms a unit has to manage peak demand. Easy availability of casual or agency staff, willingness to allocate two ventilated patients per nurse and the ability to transfer patients to other units or hospitals will reduce the total establishment needed. Wide fluctuation in a unit's occupancy over the survey period will reduce the total patient days relative to the established beds and staffing, and thus affect the ratio.

International comparisons were again difficult because of limited information and differences in defining an intensive care bed. The International Programme for Resource Use in Critical Care

study showed large differences between the United Kingdom, France and Hungary and this was thought to relate to different nurse-to-patient ratios for intensive care patients³⁰. Australia and New Zealand aim to maintain a one-to-one nurse-to-patient ratio for intensive care patients but still have widely varying staffing levels. The range of RN FTE per 1000 patient days or per ICU bed was wider than expected. It is not readily explained by workload or occupancy or proportion of high dependency admissions. It does not appear to correlate with measures of resource availability in intensive care such as cancelled elective operations or out-of-hours discharges. It is possible that our management of patients is not as uniform across units as we think. Total FTE will also include education, outreach and non-clinical managerial positions which would expect to be clustered in larger tertiary units.

Does any of this information allow us to comment on resource or staffing levels necessary for safe practice or better quality practice? The CCR survey does not include patient outcome data other than crude intensive care mortality and we have not compared staffing levels with other patient data sources. It was not possible to measure nurse-to-patient ratios which is the way the majority of nursing research has been conducted³¹⁻³³. One study has shown that lower RN-to-patient ratios have been associated with poorer patient outcomes³¹ and another has shown that increased RN staffing was associated with lower odds of adverse patient events and hospital-related mortality³². However, a recent review of nurse staffing levels in critical care and its correlation with hospital mortality have not conclusively shown a direct impact of nursing staff levels and patient outcomes³³.

It has been a frustrating exercise trying to find national data on intensive care resources and activities from other countries. The lack of information makes it difficult to place Australian and New Zealand intensive care resources in context. It is accepted that Australia and New Zealand have very good patient outcomes^{34,35} and it is unclear whether this is related to higher medical and nursing staff ratios or to the availability of beds. Other influences are the high quality of specialist medical training³⁶, intensive care nursing education³⁷ and research^{38,39}. Future work will try to link this resource information to patient outcomes. Perhaps the answer is self-evident. That we have 10 years of annual surveys with a greater than 90% unit response rate would indicate a mature critical care community that is interested in quality improvement.

CONCLUSION

This survey of intensive care resources and activity shows wide variations in bed numbers and staffing levels within regions. These variations are not simply explained. International comparisons are difficult because comparative data are almost absent and lack appropriate definitions. New Zealand and Australia appear to have high medical and nursing levels of staff per patient but average to lower numbers of beds per population.

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APPENDIX

Joint Faculty of Intensive Care Medicine Levels (Adapted from reference 10)

1. Capable of providing immediate resuscitation and short-term cardio-respiratory support for critically ill patients.
2. Admits more than 200 mechanically ventilated patients/year, unit director must have a intensive care qualification. There should be at least one other intensive care qualified specialist employed in the unit. Specialists are rostered exclusively to the intensive care when on duty or on call.
3. Admits more than 300 mechanically ventilated patients/year; the majority of specialists in the unit must be intensive care qualified and the director should hold a full-time appointment. Has dedicated junior medical staff rostered 24 hours a day exclusively to intensive care.