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Surge Capacity of Australian Intensive Care Units Associated with COVID-19 Admissions

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Version 1 is superseded by Version 2. Version 1 is retained in our records

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Objectives

To describe Australian intensive care unit (ICU) capacity to respond to predicted increased demand associated with pandemic COVID-19.

Design

Australian and New Zealand Intensive Care Society (ANZICS) registries data, supplemented with an ICU surge capacity survey and survey of veterinary facilities.

Settings

All Australian ICUs and veterinary facilities.

Participants

ICU directors, veterinary facility superintendents.

Main Outcome Measures

Reported baseline capacity for ICU beds, ventilators, dialysis machines, extra-corporeal membrane oxygenation (ECMO) machines, intravenous infusion (IV) pumps and workforce. Incremental, increasing capacity to surge, based on capacity to cancel elective surgery admissions and increase ICU beds. Available ventilators compared to ICU beds at each site. Numbers of ventilators in veterinary facilities.

Results

There are 191 ICUs in Australia with 2378 available intensive care beds during baseline activity, (9.4 ICU beds per 100,000 population). Of the 175 ICUs contributing to the March 2020 surge survey, representing 2228 (94%) of available intensive care beds, maximal surge would add an additional 4258 intensive care beds (191% increase) and 2631 invasive ventilators (120% increase). This could require up to an additional 4092 senior doctors (325% increase over baseline), and 42,720 registered ICU nurses (365% increase over baseline). An additional 188 ventilators in veterinary facilities were reported.

Conclusions

Australian ICUs report potential to nearly triple intensive care bed capacity in response to predicted increased demand associated with pandemic COVID-19. Maximal surge could result in an invasive ventilator shortfall and would require a large increase in workforce. There is variation between jurisdictions and greater capacity in tertiary ICUs.

Text word count	96

The known

There are 2378 available intensive care beds in Australia during baseline activity, equating to 9.4 ICU beds per 100,000 population.

The new

ICUs report capacity to increase intensive care beds by up to 191%. Overall, there are insufficient available invasive ventilators to meet maximal bed surge and associated workforce requirements are high. Surge capacity varies between ICU categories and jurisdictions.

The implications

Meeting intensive care bed surge capability will require the provision of invasive ventilators and additional trained workforce, in particular registered nurses. Strategies to address variability and consideration of alternative workforce models are required urgently.

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Introduction

The burden on health care resources associated with the global coronavirus disease 2019 (COVID-19) pandemic is unparalleled in modern times. Early experience in severely affected countries suggests that between 5 and 16% of laboratory-confirmed COVID-19 patients require admission to an Intensive Care Unit (ICU). (1, 2)

Whilst public health measures aimed at reducing virus transmission are the primary means to reduce the overall disease burden and ICU requirement, guidelines recommend that ICUs have a coordinated local and regional surge plan that is staged to respond to increased demand. (3)

The primary aim of this study was to describe reported intensive care bed and invasive ventilation surge capacity in Australia. A secondary aim was to describe variation in these capabilities according to ICU type (tertiary, metropolitan, regional/rural, or private) and jurisdiction as well as other ICU equipment and workforce.

Methods

Data were aggregated from a number of sources, primarily using existing data from the Australian and New Zealand Intensive Care Society (ANZICS) Critical Care Resources (CCR) registry, supplemented by a survey of ICU surge capacity distributed to each ICU in Australia.

Data extracted from the ANZICS CCR 2018/19 survey, or where not available 2017/18 data were used. This included baseline available beds for all ICUs in Australia, workforce data, including number of senior and junior medical staff plus nursing staff, and elective surgical, mechanical ventilation and total ICU bed days.

The surge survey was designed by the study investigators with feedback from other critical care clinicians and health policy makers with the aim of informing local, jurisdictional and national critical care capacity. The survey contained questions on the incremental capacity to increase ICU beds (baseline available beds, additional physical ICU beds not staffed or operational during baseline activity, surge beds already configured to ICU standards, and other beds that could rapidly be

converted to meet the minimal standards required for the provision of intensive care(4)). Equipment questions included those relevant to providing invasive mechanical ventilation (standard ICU ventilators, additional ICU ventilators such as transport ventilators, anaesthetic machine ventilators, non-invasive ventilators capable of providing invasive ventilator and others), dialysis machines, extra-corporeal membrane oxygenation (ECMO) machines, intravenous infusion (IV) pumps, and workforce (senior doctors defined as consultants working in ICU, and ICU registered nursing staff). The survey is provided in the supplementary appendix.

The survey was distributed via email to the ICU director of all Australian ICUs through the ANZICS registries mailing list. ICU directors, or when unavailable the nurse unit manager, were asked to complete and return the survey as a word document via email or link to an online survey. Surge intensive care beds and equipment were identified by each ICU within their hospital. Responses were collated into a spreadsheet by ANZICS Centre for Outcome and Resource Evaluation (CORE). Non-responders were contacted twice more by email for follow up. With the assistance of the Australian Veterinary Boards Council, the Veterinary Board in each state also surveyed superintendents of every veterinary hospital across Australia about model, number and location of all machines capable of invasive ventilation.

Findings were collated and analysed in Microsoft Excel and reported using descriptive statistics. No range was provided for absolute values (e.g. number of beds). Parametric data were described using mean and standard deviation (SD), and non-parametric data using median and interquartile range (IQR). Incremental, increasing capacity to surge based on the increase in ICU beds were compared to available ventilators and provided as both mean (SD) and median (IQR). Workforce surge were based on ANZICS CCR from respondent ICUs that was then extrapolated to all 2378 available Australian ICU beds to provide an estimated baseline senior medical staff (n=1671) and baseline registered nursing staff (n=15857) . The estimate for the total surge beds for all Australian ICUs were extrapolated from proportionate increase in beds in the 92% of respondent ICUs (i.e. maximal surge was 191% of baseline available beds). For senior medical staff, the 'Best Case' estimate assumed no increase in absenteeism and that the requirement for additional staffing could be reduced by 20% in the short term, by increasing the clinical full time equivalent (FTE) of available staff through reduced

leave, part-time employees increasing FTE and by temporarily delegating components of roles outside of ICU to ward staff (e.g. follow up clinics, tracheostomy and total parenteral nutrition rounds). Conversely, 'Worst Case' estimates made no allowance for available staff to increase FTE and assumed an additional 30% would be required to be added to the workforce to cover absenteeism. 'Worst Case' nursing staff estimate also included a 10% increase to account for an increase in 1:1 ratio for all patients receiving mechanical ventilation from a baseline of 50% to 70% under pandemic conditions. The study was approved by the Central Australian Human Research Ethics Committee (CAHREC-20-3687).

Results

ICU beds, ventilators and other equipment

There are 191 ICUs in Australia (119 public and 72 private) recorded in the ANZICS CCR database. At these sites there are 2378 ICU beds that are available during baseline activity. This equates to 9.4 ICU beds per 100,000 population in Australia. The surge survey was distributed between 13-24 March 2020. Responses were received from 175 (92%) of ICUs, accounting for 2228 (95%) of available beds. The results represent surge capacity for respondent ICUs (listed in the supplementary appendix).

The characteristics of respondent ICUs are presented in Table 1. At these 175 ICUs, there are a total of 4261 additional physical intensive care beds, surge beds outside of the ICU already configured to intensive care standards, and other beds that could rapidly be converted to meet the minimal requirements of providing intensive care (Table 2, Figure 1 and 2).

At the 175 respondent sites, there are 4815 machines capable of delivering invasive mechanical ventilation including 2184 standard ICU invasive ventilators, 532 additional ventilators (e.g. for transport), 1476 anaesthetic machine ventilators and 471 non-invasive ventilators capable of invasive ventilation. The proportion of ventilators to ICU beds during incremental surge capacity is provided in Table 3 (see supplementary appendix eTable 4 for ventilator to bed ratio by jurisdiction and ICU

category). The availability of other ICU equipment including to deliver renal replacement therapy, ECMO and IV infusion pumps are provided in the supplementary appendix eTables 5-7.

Elective surgery

In the 157 ICUs for whom elective surgery data were available in the ANZICS registries, elective surgery accounted for 62340 ICU admissions (38% of total ICU admissions) and 2801310 ICU bed days (25% of total ICU bed days). Elective surgery accounts for a substantially greater proportion of ICU admissions in tertiary compared with other public ICU types (supplementary appendix eTable 9).

Workforce

Based on current workforce data from the 175 respondent ICUs, maximal surge would require up to an additional 4092 senior medical staff (345% above baseline staffing), and an additional 42,720 registered nursing staff would be required (365% above baseline staffing) (Table 4).

Ventilators in veterinary facilities

There are 188 invasive ventilators in 120 Australian veterinary facilities (147 in metropolitan areas and 41 in rural/regional areas). Of these, 179 (95%) were human model ventilators (supplementary appendix eTable 10 Ventilators in veterinary hospitals).

Discussion

There are 191 ICUs in Australia with 2378 available intensive care beds during baseline activity, equating to 9.4 ICU beds per 100,000 population. The 175 (92%) ICUs that responded to our surge survey reported capacity to increase intensive care bed capacity by 4258 beds, a 191% increase over baseline capacity of 2228 at these sites, with 4815 machines identified at these sites capable of delivering invasive mechanical ventilation.

Compared to baseline available Australian ICU beds of 9.4 per 100,000 population, China and the UK are substantially lower (3.6 and 4.4 per 100,000 population respectively), whilst the US is substantially higher (25.8 per 100,000). (5, 6) However, our survey suggests substantial capacity for Australian ICUs to surge beds (up to the equivalent of 26.5 per 100,000 with the addition of only beds in the respondent sites). This demonstrates the value of additional time provided for planning compared to the remarkable achievement, but lower immediate surge capacity associated with

unexpected and sudden presentations in Northern Italy.(2) Furthermore, international comparisons are complex and require consideration of additional factors including the availability of suitably trained specialists. Intensive Care Specialists are present in nearly all Australian ICUs compared with only 48% of acute care hospitals in the US.(7, 8)

There are other important findings of our study. First, even under a 'Best Case' scenario, workforce requirements to meet maximal intensive care bed surge capacity are extremely high. Nursing workforce surge may be susceptible to strain due to a requirement for a bedside nurse to care for each additional surge patient receiving mechanical ventilation. Strategies and resources to rapidly upskill registered nurses to manage mechanically ventilated patients are required urgently. Similarly, senior ICU doctors may be required to adopt a supervisory role over multiple 'pods' of patients, assisted by other senior clinicians with overlapping skill sets such as anaesthetists in order to maintain safe patient to physician ratios. The optimal alterations to standard ICU workforce models during surge are likely to vary by site and according to local capabilities. The association with resource use and patient outcomes is uncertain will require further investigation.

Secondly, cross-disciplinary collaboration allowed identification of potential additional veterinary ventilators. The majority were models already in use in ICUs in Australia. These ventilators with appropriate preparation may be lower risk to use than non-ICU capable ventilators or equipment that is unfamiliar to critical care staff. In addition, the veterinary sector may also contain additional physical capacity, pharmaceutical resources and staff who could assist provision of intensive care.

Finally, our survey demonstrates substantial differences in capacity to surge between ICU category and between jurisdictions. Paediatric ICUs appear to have relatively little capacity to surge. Rural/regional ICUs have more capacity for surge than metropolitan but much less than Private and Tertiary ICUs. Rural/regional ICUs have a high proportion of vulnerable patients and are reliant on interhospital transfer systems that may become overwhelmed.(9) Whilst it is unlikely that transfer of patients can occur between jurisdictions, our study demonstrates that equipment and workforce may be a greater limiter. National real-time monitoring of ICU bed capacity could provide a mechanism to rapidly redeploy resources to areas of need.

There are limitations of this study. Most importantly, surge capacity represents those beds identified at the time of reporting. Further beds could potentially be created over time and additional facilities explored both to take over urgent elective surgical ICUs admission or other critical care admissions. Equally, invasive ventilator capacity did not include state, commonwealth, Australian Defence Force stores or health care facilities which do not have an ICU. Reported surge capacity may also be greater or less than actual capacity. Finally, response rate to our surge survey was incomplete. However, a response rate of 92% including all tertiary ICUs is likely to be nationally representative.

Conclusion

Australian ICUs report potential to nearly triple intensive care bed capacity in response to predicted increased demand associated with pandemic COVID-19. Maximal surge could result in an invasive ventilator shortfall and would require a large increase in workforce. There is variation between jurisdictions and greater capacity in tertiary ICUs.

References

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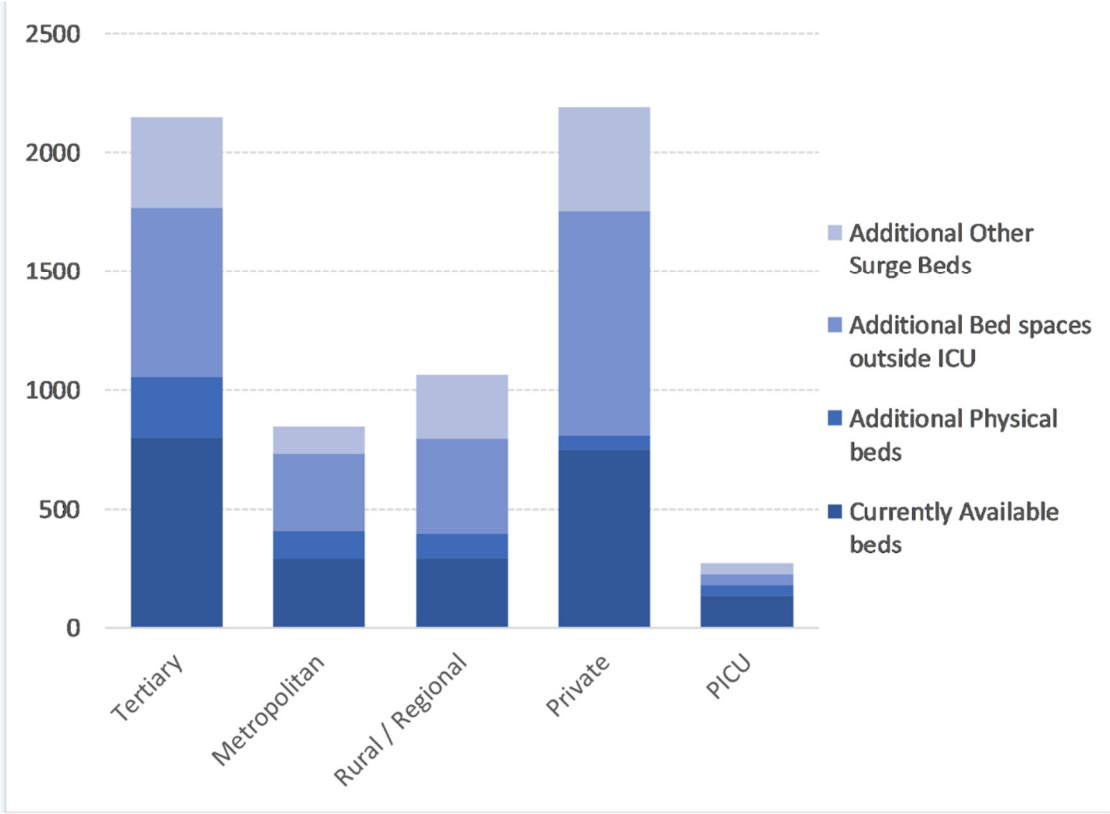
Legend for Figure 1

Available and Surge ICU beds by hospital type at 175 ICUs



Legend for Figure 2

ICU beds per 100,000 population by region of Australia. Baseline ICU beds at all 191 sites are included and surge ICU beds at 175 respondent sites.

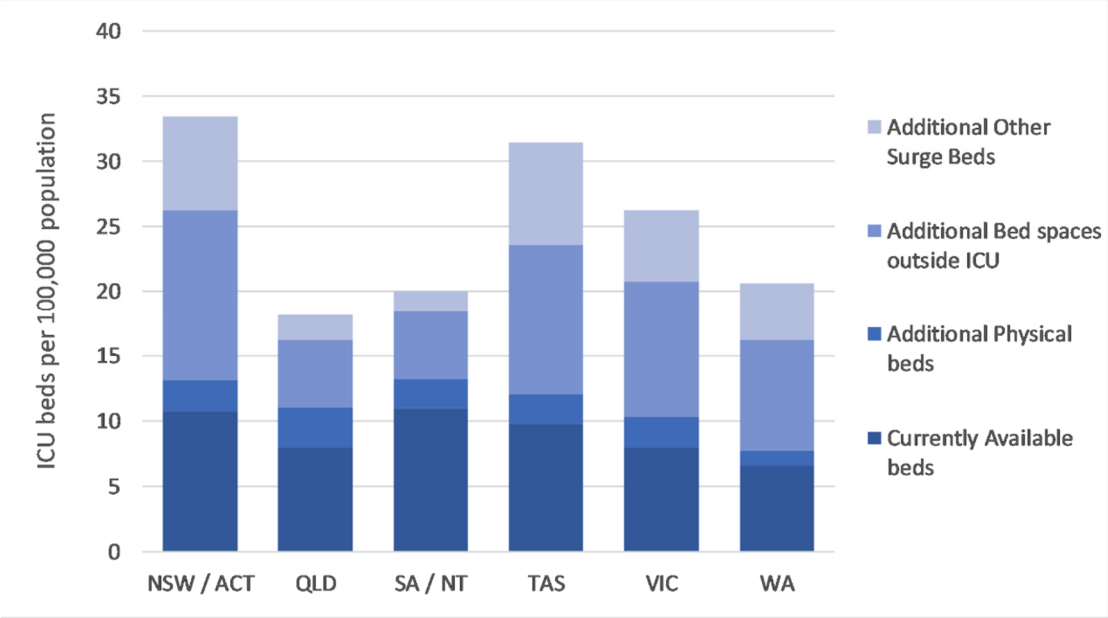


Table 1. Characteristics of Surge Survey ICUs

	Total	Tertiary	Metropolitan	Rural/Regional	Private	Paediatric
Survey respondents/total ICUs– n (%)	175/191 (92)	35/35 (100)	31/32 (97)	36/43 (84)	65/72 (90)	8/9 (89)
Admissions per year –mean number (SD)	1058 (744)	1914 (905)	770 (428)	773 (404)	896 (597)	1031 (614)
Bed days per year – mean number (SD)	3118 (3001)	6825 (4045)	2322 (2475)	2113 (1427)	1932 (1381)	4146 (3039)
MV days per year – mean number (SD)	752 (1204)	2188 (1677)	550 (492)	367 (540)	195 (246)	1509 (1270)

ICU intensive care unit, MV mechanical ventilation, SD standard deviation

Table 2 Beds capacity by ICU category and jurisdiction*

	Currently Available beds	Additional Physical beds	Additional Bed spaces outside ICU	Additional Other Surge Beds	Total
ICU Category Tertiary	799	257	711	380	2147
Metropolitan	285	127	321	114	847
Rural/Regional	291	105	398	270	1064
Private	725	58	947	436	2166
Paediatric	128	40	46	48	262
Jurisdiction ACT	52	17	67	95	231
NSW	854	179	1034	512	2579
NT	24	4	9	10	47
QLD	376	154	262	99	891
SA	193	41	93	21	348
TAS	51	12	60	41	164
VIC	499	149	666	351	1665
WA	179	31	232	119	561
All Australia	2228	587	2423	1248	6486

*Data based on 175 out of 191 ICUs in Australia

Table 3 Fraction of Ventilator per bed*

Total Ventilators /Beds Mean (SD) [Median, IQR]	Available beds N=2228	Available + additional physical beds N=2815	Available + additional physical + Bed spaces outside ICU N=5238	Available + additional physical + Bed spaces outside ICU + Others N=6486
Standard ICU ventilators N= 2184	1 (0.7) [0.9, 0.5 - 1.14]	0.8 (0.4) [0.6, 0.42 - 0.93]	0.4 (0.3) [0.4, 0.2 - 0.56]	0.3 (0.3) [0.3, 0.16 - 0.49]
Standard ICU ventilators + other ventilators N=2716	1.2 (0.8) [1, 0.7 - 1.43]	1 (0.4) [0.8, 0.6 - 1.11]	0.5 (0.3) [0.5, 0.26 - 0.69]	0.4 (0.3) [0.4, 0.2 - 0.6]
Standard ICU ventilators + other ventilators + anaesthetic machine ventilators N=4192	1.9 (1.3) [1.7, 1.2 - 2.25]	1.5 (0.7) [1.4, 1 - 1.83]	0.8 (0.4) [0.8, 0.5 – 1]	0.6 (0.4) [0.6, 0.42 - 0.86]
Standard ICU ventilators + other ventilators + anaesthetic machine Ventilators + non-invasive ventilators N=4663	2.1 (1.5) [1.9, 1.4 - 2.5]	1.7 (0.8) [1.5, 1.11 - 2.03]	0.9 (0.5) [0.8, 0.58 - 1.1]	0.7 (0.5) [0.7, 0.47 - 0.96]
Standard ICU ventilators + other ventilators + anaesthetic machine Ventilators + non-invasive ventilators + Other N=4815	2.2 (1.6) [1.9, 1.4 - 2.67]	1.7 (0.9) [1.5, 1.11 - 2.06]	0.9 (0.5) [0.9, 0.59 - 1.13]	0.7 (0.5) [0.7, 0.48 – 1]

*Data based on 175 out of 191 ICUs in Australia, SD standard deviation, IQR interquartile range

Table 4 Estimated Additional ICU Staff Number for ALL Australian ICUs*

	Surge requiring only additional physical ICU beds	Surge requiring additional physical beds and bed spaces outside ICU	Surge Requiring for all identified surge beds
Additional Senior Medical Staff Best Case - n (% increase from baseline staffing)	363 (22)	1856 (111)	2623 (257)
Worst Case - n (% increase from baseline staffing)	568 (34)	2896 (273)	4092 (345)
Additional Registered Nursing Staff Best Case - n (% increase from baseline staffing)	3449 (22)	17614 (211)	24895 (257)
Worst Case - n (% increase from baseline staffing)	5918 (37)	30158 (290)	42720 (369)

*See methods for assumptions used to estimate best case and worst case staff numbers

Electronic Only Supplementary Appendix

Content

ANZICS Surge Survey

In your <u>hospital</u> today, how many of the following are there?	
ICU bed capacity	
1	Available staffed ICU beds (staffed equipped bed space presently available)
2	Physical ICU bed spaces (this should include available staffed beds PLUS any additional physical bed spaces not currently staffed)
3	Bed spaces outside of ICU capable of looking after invasively ventilated patients (e.g. in OT recovery areas and ED)
4	Bed spaces, not counted above, which, could be used currently or with minor modification to provide care for invasively ventilated patients (e.g. in ward areas with existing wall oxygen, air and other mandatory requirements to deliver mechanical ventilation)
Ventilators	
5	Standard 'ICU-style' ventilators capable of providing ongoing invasive mechanical ventilation
6	Other ventilators (e.g. for transports) capable of providing invasive mechanical ventilation
7	Anaesthetic machine ventilators
8	Non-invasive ventilators capable of delivering invasive ventilation
9	Others
Renal replacement	
10	Haemofilters/dialysis machines available for routine use in ICU
11	Machines for haemodialysis used for patients with chronic renal failure
Others	
12	ECMO machines (allocated for use in your ICU)
13	Machines being used for cardiopulmonary bypass which could deliver ECMO in ICU
14	IV infusion pumps

Sites that contributed to the Surge Survey

Alfred Hospital ICU, Austin Hospital ICU, Canberra Hospital ICU, Concord Hospital (Sydney) ICU, Flinders Medical Centre ICU, Gold Coast University Hospital ICU, Gold Coast University Hospital ICU - paeds, John Hunter Hospital ICU, Launceston General Hospital ICU, Liverpool Hospital ICU, Mater Adults Hospital (Brisbane) ICU, Monash Medical Centre-Clayton Campus ICU, Nepean Hospital ICU, Prince of Wales Hospital Sydney) ICU, Princess Alexandra Hospital ICU, Royal Adelaide ICU, Royal Brisbane and Women's Hospital ICU, Royal Hobart Hospital ICU, Royal Hobart Hospital NICU/PICU, Royal Melbourne Hospital ICU, Royal North Shore Hospital ICU, Royal Perth Hospital ICU, Royal Prince Alfred Hospital ICU, Sir Charles Gairdner Hospital ICU, St Vincent's Hospital (Melbourne) ICU, St Vincent's Hospital (Sydney) ICU, Sunshine Coast University Hospital ICU, Sunshine Coast University Hospital ICU-paeds, The Prince Charles Hospital ICU, The Queen Elizabeth (Adelaide) ICU, Townsville University Hospital ICU, Townsville University Hospital ICU-paeds, University Hospital Geelong ICU, Westmead Hospital ICU, Wollongong Hospital ICU, Women's and Children's Hospital PICU, Angliss Hospital ICU, Armadale Health Service ICU, Bankstown-Lidcombe Hospital ICU, ox Hill Hospital ICU, Caboolture Hospital ICU, Calvary Hospital (Canberra) ICU, Calvary Mater Newcastle ICU, Campbelltown Hospital ICU, Canterbury Hospital ICU, Dandenong Hospital ICU, Fairfield Hospital ICU, Footscray Hospital ICU, Frankston Hospital ICU, Gosford Hospital ICU, Holmesglen Private Hospital ICU, Hornsby Hospital , Ipswich Hospital ICU, Joondalup Health Campus ICU, Logan Hospital ICU, Lyell McEwin Hospital ICU, Maroondah Hospital ICU, Northern Beaches, Queen Elizabeth II Jubilee Hospital ICU, Redcliffe Hospital ICU, Robina Hospital ICU, Rockingham General Hospital ICU, Royal Darwin Hospital ICU, Northern Hospital ICU, Werribee Mercy Hospital ICU, Albury Wodonga Health ICU, Alice Springs Hospital ICU, Ballarat Health Services ICU, Bathurst Base Hospital ICU, Bendigo Health Care Group ICU, Bowral Hospital HDU, Broken Hill Base Hospital & Health Services ICU, Bunbury Regional Hospital ICU, Bundaberg Base Hospital ICU, Cairns Hospital ICU, Central Gippsland Health Service (Sale) ICU, Coffs Harbour Health Campus ICU, Dubbo Base Hospital ICU, Fiona Stanley Hospital ICU, Goulburn Base Hospital ICU, Goulburn Valley Health ICU, Grafton Base Hospital ICU, Hervey Bay Hospital ICU, Latrobe Regional Hospital ICU, Lismore Base Hospital ICU, Mackay Base Hospital ICU, Maitland Hospital ICU, Manning Rural Referral Hospital ICU, Mildura Base Hospital ICU, Mount Isa Hospital ICU, Orange Base Hospital ICU, Port Macquarie Base Hospital ICU, Rockhampton Hospital ICU Shoalhaven Hospital ICU, South East Regional Hospital ICU, South West Healthcare (Warrnambool) ICU, Tamworth Base Hospital ICU, Toowoomba Hospital ICU, Tweed Heads District Hospital ICU, Western District Health Service (Hamilton) ICU, Wyong Hospital ICU, Ashford Private , Buderim Private Hospital ICU, Cabrini Hospital ICU, Calvary Bruce Private Hospital HDU, Calvary Hospital (Lenah Valley) ICU, Calvary John James Hospital ICU, Calvary North Adelaide Hospital ICU, Calvary Wakefield , Epworth Eastern Private Hospital ICU, Epworth Freemasons Hospital ICU, Epworth Geelong ICU, Epworth Hospital (Richmond) ICU, Flinders Private , Gold Coast Private Hospital ICU, Gosford Private Hospital ICU, Greenslopes Private Hospital ICU, Hollywood Private Hospital ICU, Hurstville Private Hospital ICU, John Fawkner Hospital ICU, John Flynn Private Hospital ICU, Kareena Private Hospital ICU, Knox Private Hospital ICU, Lake Macquarie Private Hospital ICU, Lingard Private Hospital ICU, Macquarie University Private Hospital ICU, Maitland Private Hospital ICU, Mater Private Hospital (Brisbane) ICU, Mater Private Hospital (Sydney) ICU, Melbourne Private Hospital ICU, Mount Hospital ICU, Mulgrave Private Hospital ICU, National Capital Private Hospital ICU, Nepean Private Hospital ICU, Newcastle Private Hospital ICU, Noosa Hospital ICU, North Shore Private Hospital ICU, Norwest Private Hospital ICU, Peninsula Private Hospital ICU, Pindara Private Hospital ICU, St Andrew's Hospital (Adelaide) CU, St Andrew's Hospital Toowoomba ICU, St Andrew's Private Hospital (Ipswich) ICU, St Andrew's War Memorial Hospital ICU, St John of God (Berwick) ICU, St John Of God Health Care (Subiaco) ICU, St John Of God Hospital (Ballarat) ICU, St John of God Hospital (Bendigo) ICU, t John Of God Hospital (Geelong) ICU, and Public & Private ICU, St Vincent's Private Hospital Northside ICU, St Vincent's Private Hospital (Sydney) ICU, St Vincent's Private Hospital Fitzroy ICU, Strathfield Private Hospital ICU, Sunnybank Hospital ICU, Sunshine Coast University Private Hospital ICU, Sydney Adventist Hospital ICU, Sydney Southwest Private Hospital ICU, The Bays Hospital ICU, The Chris O'Brien Lifehouse ICU, The Memorial Hospital (Adelaide) ICU, Warringal Private Hospital ICU, Westmead Private Hospital ICU, Wollongong Private Hospital ICU, John Hunter Children's Hospital PICU, Queensland Children's Hospital PICU, Royal Children's Hospital (Melbourne) PICU, Sydney Children's Hospital PICU, The Children's Hospital at Westmead PICU

eTable 4 Ventilator capacity by ICU category and Jurisdiction

	Standard ICU Style Ventilators	**Other ICU Ventilators**	**Anaesthetic Machine Ventilators**	**Non-Invasive Ventilators Capable of Providing MV**	**Others**	**Total**
ICU Category						
Tertiary	980	188	477	190	31	1866
Metropolitan	314	81	200	78	22	695
Rural/ Regional	226	91	142	93	25	577
Private	522	128	633	86	49	1418
Paediatric	142	44	24	24	25	259

Jurisdiction ACT	47	9	34	9	0	99
NSW	730	189	545	163	89	1716
NT	27	8	4	0	2	41
QLD	451	89	192	119	0	851
SA	204	20	140	36	35	435
TAS	49	18	35	3	3	108
VIC	525	146	369	108	14	1162
WA	151	53	157	33	9	403
All Australia	2184	532	1476	471	152	4815

Data reported from 175 sites.

eTable 5a Number of renal replacement therapy machines by ICU category

ICU Category	ICU Specific Haemofilters/Dialysis Machines	Other Machines for Haemodialysis	Total
Tertiary	194	206	400
Metropolitan	67	119	186
Rural/Regional	51	187	238
Private	118	154	272
Paediatric	15	9	24
All Australia	445	675	1120

Data based on 175 out of 191 ICUs in Australia

eTable 5b Number of renal replacement therapy machines by ICU jurisdiction

Jurisdiction	ICU Specific Haemofilters/Dialysis Machines	Other Machines for Haemodialysis	Total
ACT	11	8	19
NSW	171	288	459
NT	10	2	12
QLD	23	89	112
SA	20	32	52
TAS	12	14	26
VIC	153	170	323
WA	45	72	117
All Australia	445	675	1120

Data based on 175 out of 191 ICUs in Australia

eTable 6a ECMO by ICU category

ICU Category	Extracorporeal Membrane Oxygenation (ECMO)	Machines Being Used for Cardiopulmonary Bypass
Tertiary	98	38
Metropolitan	4	2
Rural/Regional	14	4
Private	9	42
Paediatric	21	13
All Australia	146	99

Data based on 175 out of 191 ICUs in Australia

eTable 6b ECMO by ICU jurisdiction

Jurisdiction	Extracorporeal Membrane Oxygenation (ECMO)	Machines Being Used for Cardiopulmonary Bypass
ACT	1	1
NSW	58	31
NT	0	0
QLD	24	14
SA	11	6
TAS	6	3

VIC	36	33
WA	10	11
All Australia	146	99

Data based on 175 out of 191 ICUs in Australia

8 eTable 7a Number of Intravenous Infusion Pumps available by ICU category

ICU Category	Number of Intravenous Infusion Pumps
Tertiary	3509
Metropolitan	1589
Rural/Regional	1639
Private	5139
Paediatric	962
All Australia	12838

Data based on 175 out of 191 ICUs in Australia

Table 7b Number of Intravenous Infusion Pumps available by ICU jurisdiction

Jurisdiction	Number of Intravenous Infusion Pumps
ACT	282
NSW	5282
NT	80
QLD	1089
SA	192
TAS	462
VIC	4100
WA	1351
All Australia	12838

Data based on 175 out of 191 ICUs in Australia

eTable 8 - Annual elective surgery patient admissions

	Elective surgery admissions Number (proportion of total admissions)	**Elective surgery bed days Number (proportion of total bed days)**
ICU Category Tertiary	20413 (29.9%)	1041729 (18%)
Metropolitan	3368 (12.3%)	163875 (8.1%)
Rural/Regional	2496 (9.3%)	114070 (6.2%)
Private	40062 (72.5%)	1660403 (60.8%)
Jurisdiction ACT	2391 (48.4%)	98084 (29%)
NSW	21504 (36.8%)	1002206 (23.4%)
NT	209 (12%)	14438 (10%)
QLD	12259 (41.4%)	511567 (25.5%)
SA	5656 (45.1%)	258314 (29.6%)
TAS	256 (14.8%)	15911 (12.2%)
VIC	14753 (36%)	671688 (24.6%)
WA	5312 (39.8%)	229102 (25.8%)
All Australia	62340 (38.1%)	2801310 (24.6%)

eTable 9 – Ventilators identified at Veterinary facilities by region of Australia

Jurisdiction	Total number of ventilators	Metropolitan	Regional
ACT	4	4	0
NSW	75	58	17
NT	2	2	0
QLD	36	21	15
SA	8	8	0
TAS	0	0	0
VIC	47	38	9
WA	16	16	0
TOTAL	188	147	41