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Influenza Pandemic Planning for Intensive Care

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Abbreviations

ACHR	Air Changes Per Hour
AIHW	Australian Institute of Health and Welfare
ANZICS	Australian and New Zealand Intensive Care Society
ARCCCR	ANZICS Research Centre for Critical Care Resources
BiPAP	Biphasic Positive Airway Pressure
CPAP	Continuous Positive Airway Pressure
FICANZCA	Faculty of Intensive Care, Australian and New Zealand College of Anaesthetists
FTE	Full Time Equivalent
H	Haemagglutinin
HEPA	High-Efficiency Particulate Air
ICD-10-AM	International Statistical Classification of Diseases and Related Health Problems, 10^{th} revision, Australian Modification
ICU	Intensive Care Unit
ICU/CCU	Combined Intensive Care / Coronary Care Unit
LOS	Length of Stay
N	Neuraminidase
N/A	Not Applicable / Not Available
SPSS	Statistical Products Services and Solutions
WHO	World Health Organization

Foreword

There has not been an influenza pandemic in Australasia in over thirty years. Though there are sophisticated surveillance mechanisms in place to monitor the spread and types of influenza, there is little room for complacency. Health care bureaucracies, hospitals and health care agencies must be prepared to deal with the realities and consequences of such an event and have strategic action plans in place.

Should an influenza pandemic occur, there can be no doubt that health care services would face a series of short-term crises due to the nature of the illness. Depending on the extent and severity of the crisis, critical care services would need to be provided to large numbers of patients. These services may sometimes need to be provided in less than ideal situations. For example, given attack rate estimates, substantive numbers of critically ill patients may need to be treated in areas other than intensive care units. Emergency responses and standards of care may be less than optimal on occasion. Sustainability of critical care services over the duration of an influenza pandemic can not be known with any certainty, as significant numbers of critical care staff are likely to be affected. Moreover, the efficacy of antiviral medications has not been tested in pandemic situations.

There is no simple way to estimate the requirements for intensive care services in the event of an influenza pandemic. The spread and penetration of the influenza virus may be highly variable within the general community across regions and its impact on health care workers may be difficult to predict. However, conservative estimates suggest that the health care system would be overwhelmed.

This report examines the status of current critical care resources and estimates the likely requirements for services in the event of an influenza pandemic.

Key Findings

- The modern ICU has not yet had to deal with the consequences of an influenza pandemic.
- There was an 87.5% overall response rate to the survey with similar rates of return from Australian and New Zealand ICUs. The response rate was 91.0% from public sector ICUs and 76.1% from private sector ICUs.
- Cancellation of elective surgery would potentially provide an additional 68,252 ICU bed days per annum.
- A potential 1,403 additional ventilated beds could be created in Australasian health care facilities. 1,195 of these were in the public sector and 208 in the private sector.
- If staff were available, public sector ventilated beds could be increased from 4.06 to 9.45 per 100,000 population in Australia and from 4.06 to 9.94 per 100,000 population in New Zealand. In the private sector, ventilated beds could be increased from 1.32 to 2.43 per 100,000 population.
- In Australasian public sector hospitals, additional ventilation capacity could be increased by 132.3% in the public sector, and 83.2% in the private sector, however, there is marked variation in ventilation capacity across regions.
- There were 127 negative pressure and 173 positive pressure rooms in public sector ICUs.
- Complex modelling can only provide an estimate of the likely demand for ICU resources during a pandemic.

Influenza Pandemic Planning for Intensive Care

1.0 Overview of the Study

The occurrence of an influenza pandemic in the near future is a distinct possibility. Such an event has the potential to cause major disruption to social and economic systems and to incur a high mortality and morbidity amongst the general population.[1,2]

An influenza pandemic would impact greatly on health service provision. Hospitals and health care agencies need to develop contingency plans for dealing with such an event in order to mitigate the potentially disastrous effects. In particular, intensive care units (ICUs) as providers of care for critically ill patients, need to develop, and have in place, strategic plans to deal with such an occurrence. Intensivists will be required to be cognisant of available and potential resources and manage these accordingly. Therefore knowledge of current ICU bed status and availability, ventilation capacity and the location of potential additional resources is required. The possibilities for, and limitations of, service provision in such contexts will also need to be considered. The capabilities of the modern ICU to deal with the consequences of an influenza pandemic or other major biologic hazards or emergencies have not yet been tested.

A survey of Australasian intensive care units in 1999 by the ANZICS Research Centre for Critical Care Resources (formerly the ANZICS ICU Registry) and the National Influenza Pandemic Planning Committee investigated the location and availability of critical care resources in the event of an influenza pandemic.[3,4] This report details the findings of the study.

There are five parts to this report. Part 1 begins with an overview of the study and its aims, whilst Part 2 looks at the characteristics of influenza and outlines the historical, social and economic impacts of previous influenza pandemics. Part 3 presents the study findings and discusses these within the contexts of ICU resource provision. Part 4 outlines respondents' knowledge of the infection control characteristics of ICUs. Part 5 contains the conclusion and directions for enhancing understanding.

1.1 Aims of the Study

The primary aims of the study were to:

- enumerate emergency capacity for mechanical ventilation of influenza victims
- map the locations of these ventilation resources
- determine the ventilation characteristics of ICUs as a guide to infection control

This study could not investigate the likely impact of medical and nursing staff illness for service provision in ICUs during an influenza pandemic. Likewise, quality of care issues could not be addressed. Both of these considerations could weigh heavily on the ability to increase service provision in an emergency. The potential consequences for other areas of health service provision such as increased demands for additional general hospital beds, for other health care personnel and for medical and pharmaceutical supplies were not a feature of the study. However, an overview of such information may be found in an influenza pandemic contingency plan for Australian health care institutions.[5]

2.0 Overview of Influenza

Influenza infections are generally associated with self-limiting upper respiratory tract signs and symptoms. An "influenza-like illness" has signs and symptoms that include: rapid onset (within 12 hours), cough, rigors and chills, fever, prostration or weakness, myalgia and redness of the throat and nasal mucous membranes. Influenza may exacerbate pre-existing chronic respiratory, cardiac and renal conditions in susceptible individuals. Potential complications include lower respiratory tract infections such as primary or secondary pneumonia, respiratory failure, atrial fibrillation, cardiac failure and myositis. Less frequent complications include encephalitis, transverse myelitis, Guillain-Barre syndrome, Reye's syndrome, rhabdomyolysis/myoglobinuria, myocarditis and pericarditis. Sudden death may occur.[2,4,5]

The two main types of influenza virus are A and B, both complex viruses that change antigenic characteristics constantly. Minor changes (antigenic drifts) in the surface antigens of these viruses may result in epidemics. Past exposure to similar viruses does not provide sufficient antibody protection for most people and immunity is short-lived. An antigenic shift may occur in type A influenza as a consequence of major changes to one or both surface proteins, haemagglutinin (H) and neuraminidase (N). A pandemic may result from an antigenic shift if the virus is virulent and easily transmissable. Pandemics occur globally at unpredictable intervals, are trans-seasonal and may last for 2 – 3 years. There have been 31 documented influenza pandemics since 1580, three of which have occurred in the 20th century in 1918, 1957 and 1968. The 'Spanish Flu' pandemic of 1918-1919 was particularly virulent and caused the deaths of an estimated 40 million people worldwide.[2,4,6] The 1957 pandemic ("Asian flu") and the 1968 pandemic ("Hong Kong flu") were both due to influenza A (H2N2) and together caused the deaths of more than 1.5 million people and resulted in an estimated $32 billion in economic losses due to loss of productivity and medical expenses.[7]

2.1 Influenza Pandemic Characteristics

Influenza viruses may cause rapid, widespread and severe illness in all age groups. The characteristics of previous pandemics revealed that:

- They strike with little warning
- Simultaneous outbreaks may occur
- States and territories will need to rely on their own resources
- Individual communities may experience a prolonged impact
- 40 – 70% of the workforce may be affected with a varying severity of illness
- Health care workers are at high risk of exposure and illness
- Emergency service personnel such as police and fire service crews, transportation and utility workers are also in a high risk category and there may be labour force shortages
- Vaccines and preventive and therapeutic pharmaceutical products may be in short supply due to increased demand.[1]

2.2 Attack Rates

Attack rates for influenza are reliant on assumptions derived from overseas data.[8] Meltzer, Cox and Fukuda looked at the economic impacts of influenza and designed a model based on gross attack rates, the 'percentage of clinical influenza illness cases per population'.[8] However the need for contemporary modelling in Australian contexts is recognised and work has begun.[9] The attack rate is 'the proportion of the Australian population with symptomatic influenza (severe enough to take at least half a day off work)'.[4]

Attack rates for influenza based on the models by Meltzer et al. have been calculated by the Influenza Pandemic Planning Committee using 1996 population data from the Australian Bureau of Statistics Census. The lowest, mid-range and highest estimates in each category are outlined:[4]

- *Excess number of persons hospitalised secondary to influenza or its complications*:

  Attack Rate 0.10: Range 8,455 to 33,353
  Attack Rate 0.30: Range 25,366 to 100,058
  Attack Rate 0.45: Range 38,049 to 150,087

- *Excess number of person dying secondary to influenza or its complications*:

  Attack Rate 0.10: Range 3,036 to 13,901
  Attack Rate 0.30: Range 9,108 to 41,704
  Attack Rate 0.45: Range 13,662 to 62,555

- *Excess number of persons visiting as outpatients secondary to influenza or its complications*:

  Attack Rate 0.10: Range 838,958 to 991,068
  Attack Rate 0.30: Range 2,516,874 to 2,973,204
  Attack Rate 0.45: Range 3,775,311 to 4,459,806

It is estimated that an increase in mortality and the number of hospitalisations would be likely to occur over a two-month period.[4]

2.3 Influenza Surveillance Systems

Monitoring of influenza in Australia is undertaken through the National Influenza Surveillance Scheme, which includes data from three systems:[10]

1) sentinel general practice consultations, which detect and report influenza-like illnesses
2) laboratory reports of influenza isolates
3) rates of absenteeism from a national employer (Australia Post in 1999).

Independent pharmaceutical and laboratory companies also conducted surveillance programs from March to September 1999. All of these schemes contribute data to give an overview of the types of influenza and its seasonal peaks. However there are variances in case definitions and different methods of data collection across these schemes which limit the value of the information.[4,10] During 1999, influenza A was the dominant viral type in all States and Territories.[10]

In New Zealand data on influenza are collected in three ways:

1) by sentinel general practitioners (1 sentinel general practitioner for every 50,000 population)
2) influenza isolates from hospital inpatients and primary care patients
3) hospital discharge and mortality data (reviewed by New Zealand Health Information Service).[4]

Influenza is not a notifiable disease in Australia and New Zealand.

2.4 Sequence of Events

A pandemic occurs when a novel influenza A virus makes a dramatic change and acquires a new H, or H+N, to which the general population has no immunity.[2,11] Worldwide surveillance mechanisms detect the occurrence of new virus types which are reported to the World Health Organization (WHO). The phases of a pandemic may occur over several years and can be mapped:[2,11]

- *Phase 0 (Interpandemic period)*
  Worldwide monitoring of influenza strains, virus investigation, vaccine development and novel virus alert. The preparedness levels are: 0 – no new virus types reported; 1 - new human influenza strain; 2 –human infection confirmed; and, 3 – human transmission confirmed.

- *Phase 1 (Confirmation of onset of pandemic)*
  A pandemic is declared when a new virus sub-type has caused several outbreaks in one country and has spread to other countries. Disease patterns indicate serious mortality and morbidity in at least one segment of the population.

- *Phase 2 (Regional and multi-regional epidemics)*
  Outbreaks and epidemics occur in multiple countries and regions.

- *Phase 3 (End of first pandemic wave)*
  Influenza activity has stopped in the initially affected countries/regions but new outbreaks and epidemics are occurring elsewhere.

- *Phase 4 (Second or later waves of pandemic)*
  Past experience has shown the occurrence of a second severe wave of outbreaks caused by the new virus, three to nine months following the initial epidemic.

- *Phase 5 (End of the pandemic – Back to phase 0)*
  The pandemic period is likely to end after 2 –3 years. Indices of influenza activity will have returned to normal interpandemic levels and immunity amongst the general population to the new virus sub-type will be widespread.

2.5 Influenza Vaccination

Inactivated vaccines give immunoprophylaxis and are the principal means for reducing influenza-related morbidity and death.[12] The administration of influenza vaccines has been shown to be effective in reducing morbidity for at risk populations, health care and other workers.[12-25]

Influenza vaccination has also been shown to reduce absenteeism in health care workers.[16,18,19] However the economic benefits of influenza vaccination in healthy workers are less certain.[15,20] Approximately 16% of the Australian population, predominantly those in high-risk groups, are vaccinated annually for influenza.[4] The immunisation rate (self-reported), for those ≥ 65 years in 1998 in New South Wales was 64%.[26] The Department of Human Services (Victoria) reported that vaccination rates amongst the total population for influenza and pneumococcal pneumonia had increased from 13.3% in 1992 to 24.6% in 1999 in the State of Victoria.[27] Data for 1999 from aged care facilities in the State of Victoria, showed that 82.8% of residents had been vaccinated against influenza and pneumococcal pneumonia.

An influenza vaccination profile conducted over an eleven-week period during 2000 at the Austin and Repatriation Medical Centre in Melbourne showed that 2,057 workers and volunteers from a population of 4,382, (approximately 3,300 FTE) were vaccinated.[28] The uptake rates for vaccination of health care professionals involved in direct patient care was not established in the dataset. The rate of vaccination of health care workers in Australian contexts is not widely known and is likely to be highly variable in acute care settings. Unpublished data from the Department of Human Services (Victoria) in 1999 showed that 49% of staff in public hospitals were immunised against influenza, though this figure should be interpreted with caution as it may have included all categories of staff, and not just those involved in direct patient care.[29] However there is clear agreement that health care workers have first priority for vaccination and prophylaxis during a pandemic.[4]

Whilst influenza vaccines provide a high level of protection against epidemic influenza, the ability to manufacture and distribute sufficient vaccine in a pandemic situation is untested and priorities for allocation of the vaccine will need to be decided.[4]

2.6 Australian Hospital Utilisation for Influenza and Pneumonia

Influenza specific pneumonia is difficult to separate out from statistical data due to the manner in which it is classified in ICD-10-AM principal diagnostic groupings and the way it is reported by the Australian Institute of Health and Welfare (AIHW).[30] However, in 1998/99 in Australian public sector hospitals, there were 54,512 separations for influenza and pneumonia, which comprised a total of 347,075 patient days with an average length of stay of 6.7 days (excluding same day). There were 10,668 separations in private sector hospitals for influenza and pneumonia, which comprised a total of 91,092 patient days with an average length of stay of 8.7 days (excluding same day). The highest incidence occurred in males ≥ 75 years with 10,469 separations, from a total of 34,880 separations (all hospitals). A similar incidence was apparent for females, with those ≥ 75 years comprising 10,155 separations from a total of 30,300 separations.[30] With increasing longevity and the ageing of the population the risks are likely to increase in coming years.

In New Zealand in 1997/98 there were 11,263 inpatients and day patients with pneumonia and influenza with a mean stay for inpatients of 5.8 days.[31]

2.7 Admission to Intensive Care

Given that it is not possible at the present time to identify episodes of care for influenza and pneumonia in the ICU from ICD10-AM data, and that the provision of intensive care during an influenza pandemic has not been tested to date, predicting the number of patients requiring intensive care services is fraught with difficulty. Though dissimilar, community-acquired pneumonia is possibly the closest approximation to the complications of influenza that can be used to elicit admission rates to ICU. Community-acquired pneumonia is clinically defined as an acute respiratory illness with cough, fever, sputum production, dyspnoea, pleuritic chest pain, radiographic infiltrates, pulmonary consolidation, an increased leucocyte count and/or altered mental status.[32,33]

A limited number of studies detailing the number of patients admitted to the ICU with community-acquired pneumonia, length of stay, and outcomes have been conducted.[32-36] A study by Feagan et al. of 858 patients with a mean age of 69.4 years showed a median length of stay of 7.0 days with 13.6% (range 11.4-16.1%) of patients admitted to the ICU.[33] Another study by McCormick et al. investigated variations in length of stay of 1,118 patients (mean age of 63 years), and showed an unadjusted mean length of stay between hospitals of 7.8 days to 9.2 days.[34] In this latter study, admission to intensive care or coronary care within the first 24 hours, ranged between 6-25%.[34] A study in New Zealand conducted by Gowardman & Trent of 32 patients admitted to the ICU with community-acquired pneumonia reported an ICU length of stay of 5.2 days with 56% of the sample requiring mechanical ventilation.[36] Whilst a study by Leroy et al. reported that 49.7% of patients admitted to the ICU with community-acquired pneumonia required mechanical ventilation.[35]

2.8 Predicted Mortality

Mortality rates from influenza are age specific and are twenty times greater for the elderly than for younger age groups. Deaths amongst those ≥ 65 years of age accounted for 87% of influenza and pneumonia related deaths over the past decade. During inter-pandemic periods the death rate from influenza and pneumonia ranges between 1,500 and 2,000 deaths per annum.[4]

There is a predicted age-adjusted mortality rate of 2.24 per 1,000 based on a 1996 population standard. With a population of around 18.5 million in Australia in 1998, there would be 42,000 excess deaths per year, a 30% increase in the overall mortality rate.[1]

3. 0 About the Study

This study was a collaborative effort between the ANZICS Research Centre for Critical Care Resources (ARCCCR) and the National Influenza Pandemic Planning Committee to determine the availability of intensive care resources in the event of an influenza pandemic.

The study was conducted simultaneously with the 1998 annual review of critical care resources in Australia and New Zealand and the survey tool was distributed in May 1999.[3] The focus of the influenza pandemic survey was on the availability and distribution of critical care resources and the infection control characteristics of these ICUs.

The survey tool (Appendix 2) was enclosed with the ANZICS ICU Registry Core Data Information Form. An information sheet that outlined the reasons for the survey and provided an overview of the potential impact of an influenza pandemic was also enclosed (Appendix 3).

The first phase of the study entailed the distribution of the survey tool, together with the ANZICS Core Data Information Form and this occurred in May 1999. A total of 180 ICUs in the 168 hospitals on the ARCCCR database were targeted (Appendix 4).

Survey follow up was not implemented until November 1999 due to the delays in the provision of project funding and the subsequent appointment of a project officer. Initial follow-up, which consisted of re-sending the survey tool and information sheet to non-responders, was conducted in November 1999. Further follow up of non-responders by mail, telephone, facsimile and e-mail was conducted from December 1999 to March 2000. These follow-up processes comprised the second phase of the study. The third phase consisted of data entry and analysis.

A descriptive statistical analytical approach using software from *Statistical Products Services and Solutions* (SPSS) versions 9.0 and 10.0, has been used for primary data analyses. Additional data analyses using *Microsoft Excel 97* and *EPIinfo6.04b* were also used.

Additional data from the *ANZICS Intensive Care Survey 1998: An Overview of Australian and New Zealand Critical Care Resources* is used to support and elaborate upon the study findings where appropriate.[3]

3.1 Data Quality and Limitations

A number of data limitations were identified during the research processes. The return of incomplete survey tools compromised the integrity of the data set and intensive follow up to retrieve or clarify information was required from some contributing sites. A number of queries were received requesting clarification of the time frame for the study. During this period, four HDUs, previously listed as ICUs, were identified and this data has been omitted.

3.2 Response Rate

The overall response rate to the influenza pandemic planning survey was 87.5%. The response rate to the ARCCCR survey was 99.4%. The differences in the response rates for the two surveys should be noted as no corrections have been made. In Australia the response rate was 87.5% (134 from 153) ICUs, with 86.8.0% in New Zealand (20 of 23 ICUs). The public sector hospital response rate was 91.0% (122 from 134 ICUs) in contrast to the private sector hospital response of 76.1% (32 from 42 hospitals).

3.3 Identifying Critical Care Resources

Strategies for creating additional critical care bed capacity have been identified:[5]

- To utilise reserve critical care bed capacity in public sector hospitals
- To selectively reduce elective admissions to public sector hospitals (which may reduce ICU/HDU bed requirements)
- To utilise emergency ventilation facilities in recovery and operating rooms
- To purchase or lease private sector critical care beds for public patients
- To selectively reduce elective admissions to private sector hospitals (which may reduce ICU/HDU bed requirements).

The first of these points relates to the reserve critical care bed capacity. However this is a limited option as many public sector ICUs do not have the potential for additional bed capacity. Only 43% of ICUs across Australia and New Zealand indicated potential reserve bed capacity in a recent survey.[3] Moreover, the distribution of reserve critical care beds and staff availability may not match the clinical pattern of the pandemic. Limited additional short-term ventilation resources are likely to be found in emergency departments, and there will be provision for non-invasive ventilation such as continuous positive airway pressure (CPAP) and biphasic positive airway pressure (BiPAP) in respiratory wards in some centres.

Many ICU services in private sector ICUs are already operating near capacity as available ICU beds constitute 95.1% of the total ICU beds. Therefore the availability of reserve ICU beds is extremely limited. Furthermore, the willingness of private sector operators of for-profit hospitals to forgo revenue in the event of a pandemic is unknown. Anecdotal evidence suggests that some private sector hospitals are currently unwilling to admit some types of medical patients to ICUs, as the rate of remuneration does not cover service costs. The effects of the increased uptake of private health insurance on the caseload distribution could not be estimated. Since the implementation of the 30% Commonwealth Private Health Insurance Rebate and the incentive to join a health care fund before the age of 30, membership of health care funds has increased from 19% in 1999[37] to 46.4% by the September quarter 2000 (adjusted for Veteran Affairs gold card coverage).[38] In an influenza pandemic many of these patients would present to private hospitals.

The capability of ambulance services to transport critically ill patients to ICUs in other hospitals in the event of an influenza pandemic is an unknown entity. Transfers of critically ill patients are likely to occur inter-regionally, intrastate and interstate but the scale of such transfers cannot be reliably predicted. The ability of other areas to accept patients in the time of a pandemic is also an unknown factor. What is known is that services such as the Metropolitan Ambulance Service in Melbourne have contingency plans in place to deal with ‘overflow’ in times of peak demand and for disaster management. Alternative transport options may have to be sought if ambulance services are overloaded.[39]

Also of importance is the functional level of the ICU facility. ICUs are classified according to specified criteria that focus on service capabilities, staff competencies, available resources and patient type and numbers.[40,41]

3.4 Staffing the ICU

Whilst staffing of the ICU in the event of an influenza pandemic was not a specific focus of the study, the impact on personnel provision needs to be considered. In Australia at the present time, the ability to admit patients to the ICU is frequently constrained by inadequate numbers of qualified nursing staff.[42-44] Estimates for non-attendance at work due to illness during an influenza pandemic are between 40-70%.[5] Additionally many workers may need to stay home to care for family members, as it is likely that schools and day care centres will be closed for public health reasons.[5]

Absenteeism from work during an influenza epidemic in England in 1957 rose by 4.5-6% in several large organisations and three or more working days were estimated to have been lost by

8-10% of the insured population. In Liverpool, at the time of the epidemic, 12.6-19.4% of nurses were absent during the first month.[45]

Potential sources of health care labour have been identified and include medical and nursing students, nurses who are on the register but who rarely work or who are not currently employed in nursing, specialist physicians, interns and hospital medical officers, allied health professionals and support staff and volunteers from a range of community service organisations.[5] Given the estimates for staff numbers likely to be affected by influenza, a pandemic would severely tax existing resources.

Health care workers will have priority for vaccination.[5] They may also be prescribed antiviral medications such as amantadine hydrochloride and zanamivir which are used for the prevention and treatment of influenza (amantadine is effective only against influenza A). Such medications if given early in the course of the disease, limit its duration and offer short-term prophylaxis.[4,12,25,46-49] Zanamivir (Relenza), manufactured by Glaxo Wellcome, is used to treat "at risk" adults and symptomatic individuals who present within 36 hours. A pooled analysis of eight trials demonstrated that influenza symptoms were reduced from 6 to 5 days (a reduction of 1.2 days) and that there was a 6% reduction in complications for which antibiotics were required.[47] However, knowledge of prophylaxis with antiviral agents in institutional settings is limited at present.[12]

3.5 Assumptions about Quality of Care

It is assumed that providing advanced respiratory care in an "emergency location" would be better than not providing it at all. Several studies have shown, however, that ICU mortality rates may be higher in times of increased workload and also when less trained staff are available.[50-53] It is likely that the impact of such care provision could never be quantitated. It is likely that criteria for triage of patients for ICU treatment would be required to maximise community benefit.

3.6 Hospital Type

If private sector ICU resources are to be co-opted for use during an influenza pandemic, some indication of the location of these resources is required. Hospitals are usually classified as public or private according to their primary funding sources. The distinctions between public and private sector hospitals regarding clinical service provision are diminishing. A number of public hospitals are managed by private (for profit) health care providers. There are also private ICU beds co-located in public sector ICUs. Private sector involvement could not necessarily be guaranteed because of reimbursement inadequacies for medical ICU patients.

Table 1 illustrates the number of ICUs and their distribution in the public and private hospital sectors in 1998.

Table 1: Hospital type, number of ICUs, available & ventilated beds/100,000 population (1998)

Hospital Type		NSW	VIC	QLD	SA	WA	TAS	ACT	NT	NZ
Public Sector	*Number of ICUs*	44	26	23	7	5	3	1	2	23
	*Available Beds 100,000 population**	6.27	4.91	5.49	7.53	3.54	6.36	4.22	5.26	4.66
	*Ventilated Beds 100,000 population**	3.83	3.84	4.68	4.97	3.60	3.60	4.22	5.26	4.06
Private Sector	*Number of ICUs*	10	11	9	4	4	3	1	0	0
	*Available Beds 100,000 population**	1.16	2.38	2.17	3.29	2.23	3.18	2.59	-	-
	*Ventilated Beds 100,000 population**	0.91	1.56	1.67	1.88	1.09	1.48	0.64	-	-

* Data from ARCCCR[3], Australian Bureau of Statistics[54] and Statistics New Zealand[55]
Population data is shown in Table 1a in Appendix 1.

There were no private ICUs located in New Zealand or the Northern Territory at the time of the survey.

3.7 Geographic Location of ICUs

The ARCCCR used a modified version of the geographic location definitions used by the AIHW medical and nursing labour force surveys to map the location of ICUs (Appendix 5).[56] Table 2 shows the geographic location of public and private sector ICUs.

Table 2: Geographic location & number of ICUs (1998)

Sector	ICU Location	NSW	VIC	QLD	SA	WA	TAS	ACT	NT	NZ
Public	Capital City	27	15	10	6	4	1	1	1	1
	Metropolitan Centre	4	1	4	0	0	0	0	0	7
	Rural Centre	13	10	8	1	1	2	0	0	15
	Remote Centre	0	0	1	0	0	0	0	1	0
Sub-total		**44**	**26**	**23**	**7**	**5**	**3**	**1**	**2**	**23**
Private	Capital City	8	9	4	4	4	2	1	0	0
	Metropolitan Centre	2	1	4	0	0	0	0	0	0
	Rural Centre	0	1	1	0	0	1	0	0	0
Sub-total		**10**	**11**	**9**	**4**	**0**	**3**	**1**	**0**	**0**
Total		**54**	**37**	**32**	**11**	**9**	**6**	**2**	**2**	**23**

There were no ICUs located in the private sector in New Zealand or the Northern Territory at the time of the survey.

ICUs located within capital cities constituted 55.7% of the sample, 13.1% were located in metropolitan centres, 30.1% in rural centres and 1.1% in remote centres.

The geographic location of ICUs is of consequence for an influenza pandemic. The distribution and number of critically ill patients requiring intensive care support may not match the geographic location of such services.

Transportation of critically ill patients may be necessary and interhospital transfer of critically ill patients may contribute to an increase in morbidity and mortality.[57] However most studies to date have focused on the transport of critically ill patients for procedural purposes or for surgical patients, both intrahospital and interhospital.[57] Physiological changes as a result of movement are experienced by up to 75% [58,59] of transported ICU patients, moreover it has been demonstrated that post-transport, pulmonary deterioration may extend for up to 24 hours beyond the original travel time.[60]

3.8 ICU Levels

There is considerable variation in the level and type of care required for a patient with an influenza-related illness and its complications. Critically ill patients may need varying degrees of respiratory support and a wide range of antibiotic and antiviral therapies. These care differentials mean that patients will be admitted to intensive care units at all levels. ICU level categorisation is dependent on resources, staffing, facilities and the number and type of patient. Standards for the three levels of ICU are defined by FICANZCA and succinctly these are:[41]

Level III – provides the highest level of care that includes complex multi-system life support for an indefinite period.
Level II – provides a high standard of general intensive care that includes complex multi-system life support for at least several days.
Level I – provides immediate resuscitative management, short-term cardio-respiratory support and monitors and prevents complications for at risk patients.

Table 3: Designated ICU levels* - public & private sector (1998)

Designated ICU Level*		NSW	VIC	QLD	SA	WA	TAS	ACT	NT	NZ
Public Sector	III	12	14	10	4	4	2	1	0	8
	II	15	6	8	2	0	1	0	2	11
	I	17	6	5	1	1	0	0	0	4
	Sub-total	**44**	**26**	**23**	**7**	**5**	**3**	**1**	**2**	**23**
Private Sector	III	4	5	4	3	1	1	0	0	0
	II	2	4	5	1	3	1	0	0	0
	I	4	2	0	0	0	1	1	0	0
	Sub-total	**10**	**11**	**9**	**4**	**4**	**3**	**1**	**0**	**0**
Total		**54**	**11**	**32**	**11**	**9**	**6**	**2**	**2**	**23**

* Designation refers to criteria for ICU level classification as specified in FICANZCA policy IC-1[41]

Level III ICUs offer a comprehensive range of interventional and support services for critically ill patients and have the greatest number of available beds. These ICUs also have the greatest number of ventilated beds in contrast to those in Level ICUs. In Level III ICUs, ventilated beds, as a percentage of available beds, ranged from 108.7% in Western Australia to 82.3% in Victoria and Tasmania; Level 2 ICUs, 74.7% in South Australia and the Northern Territory to 32.2% in Western Australia; Level 1 ICUs, 56% in New Zealand to 33.5% in New South Wales and the Australian Capital Territory.[3]

In the event of an influenza pandemic, patients may be admitted to all levels of ICUs, HDUs and step-down units. For example, it is likely that some patients who may require Level II or III care may be admitted to a Level I ICU. The complexities of ICU care mean that provision of appropriate resources and the allocation of clinical staff for particular ICU level classification may be difficult to predict and provide. The impact of these factors on patient outcomes can not be known. Contingency plans to deal with human resource issues in intensive care are required to ensure that care is not compromised. It is likely that there will be some blurring of the boundaries between the various ICU levels when a pandemic occurs.

3.9 ICU Type

ICU type is categorised by the ARCCCR using generally accepted terms that describe the primary function(s) of the unit.[3] A general ICU has adult and/or paediatric medical and surgical patients. ICU/CCU refers to a combined intensive care and coronary care unit. Specialist ICUs though minimal in number are of two broad types, neurological/neurosurgical and trauma.

Table 4: ICU type – public & private sector ICUs

	ICU Type	NSW	VIC	QLD	SA	WA	TAS	ACT	NT	NZ
Public Sector	General	19	12	10	4	3	0	1	1	12
	ICU/CCU	19	10	9	2	1	3	0	1	9
	Paediatric	1	1	2	0	1	0	0	0	1
	Cardiothoracic/ Specialty	5	3	2	1	0	0	0	0	1
	Sub-total	**44**	**26**	**23**	**7**	**5**	**3**	**1**	**2**	**23**
Private Sector	General	5	6	4	2	1	1	0	0	0
	ICU/CCU	4	5	5	2	3	2	1	0	0
	Cardiothoracic	1	0	0	0	0	0	0	0	0
	Sub-total	**10**	**11**	**9**	**4**	**4**	**3**	**1**	**0**	**0**
Total		**54**	**37**	**32**	**11**	**9**	**6**	**2**	**2**	**23**

3.10 Bed Availability

Table 5 shows the distribution of beds in Australasian public and private sector ICUs. A physical bed is a single patient care location fully configured to ICU standards (an actual bed not a bed space). An available bed is a bed in use, or immediately available for use by an admitted patient. Such a bed has advanced life support capability and is fully staffed and funded. A ventilated bed is a physical ICU bed plus ventilator.[3]

Table 5: ICU bed status 1998 (specialist paediatric ICU beds in brackets)#

	Public Sector			Private Sector*		
Location	**Physical Beds#**	**Available Beds#**	**Ventilated Beds#**	**Physical Beds**	**Available Beds**	**Ventilated Beds**
NSW	507 *(21)*	392 *(10)*	241 *(10)*	91	80	60
VIC	274 *(24)*	229 *(18)*	179 *(18)*	115	111	73
QLD	218 *(16)*	190 *(14)*	162 *(16)*	79	75	58
SA	113	112	74	49	49	28
WA	72 *(10)*	65 *(10)*	66 *(10)*	41	41	20
TAS	33	30	17	15	15	7
ACT	24	13	13	8	8	2
NT	13	10	10	0	0	0
NZ	225 *(9)*	177 *(6)*	154 *(9)*	0	0	0
Total	**1,479**	**1,218**	**916**	**398**	**379**	**248**

* There were no private hospitals with intensive care facilities in the Northern Territory or New Zealand at the time of the survey.
#paediatric beds in brackets are included in the total number for each region

In Australian public sector ICUs, 73.1% of available beds have ventilation capacity and in the private sector, 64.5% of available beds are ventilated beds ($p<0.000$ comparing public to private sector ICUs). In New Zealand, 86.2% of available beds have ventilation capacity. It should be noted that available beds included those in combined ICU/CCU.

For the 1998 calendar year there were a total of 249,306 bed days in Australian ICUs (data from 20.0% of ICUs was not available) and 35,076 bed days in New Zealand ICUs (data unavailable from 21.7% of contributing sites). Of the total ICU bed days, 24.0% (median figure), were allocated to elective surgical patients in public and private sector ICUs. An elective surgical admission to intensive care, such as cancer or coronary artery bypass graft surgery, does not infer that such treatment is non-urgent. Theoretically, these elective surgical procedures could be cancelled which would provide a potential 68,252 additional bed days per annum. Only 20.0% of these additional bed days would be available in public sector ICUs.

3.11 Estimating Admission Rates and Bed Requirements

Tables 6 to 12 use the modelling for attack rates and hospitalisation for influenza and its complications cited in part 1 and the admission rate of patients to ICU with community-acquired pneumonia.[4,33,34]

Table 6: Estimated hospitalisations & admission rates to ICU

Attack Rate	Excess Number Of Persons Hospitalised: Range	Estimated Rate of Admission to ICU: Number of Persons*				
		5%	10%	15%	20%	25%
0.10	8,455	423	846	1,268	1,691	2,114
	33,353	1,668	3,335	5,003	6,671	8,338
0.30	25,366	1,268	2,537	3,805	5,073	6,342
	100,058	5,003	10,006	15,009	20,012	25,015
0.45	38,049	1,902	3,805	5,707	7,610	9,512
	150,087	7,504	15,009	22,513	30,017	37,522

* All figures have been rounded

It should be remembered that Meltzer's model was based on the economic impacts of an influenza pandemic and the 'soundness' of applying this model to calculate rates of admission to ICU using a similar range to that for patients with community-acquired pneumonia is contentious. Nevertheless, it does provide a framework for estimating the likely number of persons who may require intensive care services in the event of an influenza pandemic.

Using data from Table 6, if patients admitted to ICU had an average length of stay of 5.2 days,[36] then this would entail the provision of an additional 2,200 (lowest estimate) to 195,114 (highest estimate) ICU bed days in the event of an influenza pandemic. Tables 7 to 9 are simple estimates of the likely ICU length of stay measured at two-day intervals for the required ICU bed days.

Table 7: Estimate of hospitalisations & required number of ICU bed days – attack rate 0.10

Attack Rate	Excess Number of persons hospitalised (range)	Number of Admissions To ICU (5%,10%,15%, 20%, 25%)	Required number of ICU bed days				
			LOS 2 days	LOS 4 days	LOS 6 days	LOS 8 days	LOS 10 days
0.10	8,455	**423**	846	1,692	2,538	3,384	4,230
		846	1,692	3,384	5,076	6,768	8,460
		1,268	2,536	5,072	7,608	10,144	12,680
		1,691	3,382	6,764	10,146	13,528	16,910
		2,114	4,228	8,456	12,684	16,912	21,140
	33,353	**1,668**	3,336	6,672	10,008	13,344	16,680
		3,335	6,670	13,340	20,010	26,680	33,350
		5,003	10,006	20,012	30,018	40,024	50,030
		6,671	13,342	26,684	40,026	53,368	66,710
		8,338	16,676	33,352	50,028	66,704	83,380

LOS = length of stay

Table 8: Estimate of hospitalisations & required number of ICU bed days – attack rate 0.30

Attack Rate	Excess Number of persons hospitalised (range)	Number of Admissions To ICU (5%,10%,15%, 20%, 25%)	Required number of ICU bed days				
			LOS 2 days	**LOS 4 days**	**LOS 6 days**	**LOS 8 days**	**LOS 10 days**
0.30	**25,366**	**1,268**	2,536	5,072	7,608	10,144	12,680
		2,537	5,074	10,148	15,222	20,296	25,370
		3,805	7,610	15,220	22,830	30,440	38,050
		5,073	10,146	20,292	30,438	40,584	50,730
		6,342	12,684	25,368	38,052	50,736	63,420
	100,058	**5,003**	10,006	20,012	30,018	40,024	50,030
		10,006	20,012	40,024	60,036	80,048	100,060
		15,009	30,018	60,036	90,054	120,072	150,090
		20,012	40,024	80,048	120,072	160,096	200,120
		25,015	50,030	100,060	150,090	200,120	250,150

LOS = length of stay

Table 9: Estimate of hospitalisations & required number of ICU bed days – attack rate 0.45

Attack Rate	Excess Number of persons hospitalised (range)	Number of Admissions to ICU (5%,10%,15%, 20%, 25%)	Required number of ICU bed days				
			LOS 2 days	**LOS 4 days**	**LOS 6 days**	**LOS 8 days**	**LOS 10 days**
0.45	**38,049**	**1,902**	3,804	7,608	11,412	15,216	19,020
		3,805	7,610	15,220	22,830	30,440	38,050
		5,707	11,414	22,828	34,242	45,656	57,070
		7,610	15,220	30,440	45,660	60,880	76,100
		9,512	19,024	38,048	57,072	76,096	95,120
	150,087	**7,504**	15,008	30,016	45,024	60,032	75,040
		15,009	30,018	60,036	90,054	120,072	150,090
		22,513	45,026	90,052	135,078	180,104	225,130
		30,017	60,034	120,068	180,102	240,136	300,170
		37,522	75,044	150,088	225,132	300,176	375,220

LOS = length of stay

The cancellation of elective surgery showed a potentially 68,252 ICU bed days (per annum) may become available in public and private sector ICUs, however, this would still leave a substantive shortfall in bed days at the middle to upper attack rate range. However, the increase in hospitalisations and mortality are likely to occur over a two month period[4] and this would place enormous strain on existing and potential resources.

Again, using data from Table 6, if 50% of patients admitted to ICU required mechanical ventilation,[35,36] the number of patients would range from 212 (lowest estimate) to 18,761 (highest estimate). It is possible to map, albeit simply, the likely number of ICU patients who require mechanical ventilation (Tables 10 to 12). It should be noted that other forms of respiratory support were not included in these estimates.

Table 10: Estimate of hospitalisations & ICU admissions requiring mechanical ventilation – attack rate 0.10

Attack Rate	**Excess Number of persons hospitalised (range)**	**Number of Admissions To ICU** (5%,10%,15%, 20%, 25%)	**Number of ICU admissions requiring mechanical ventilation***		
			25%	**50%**	**75%**
0.10	**8,455**	**423**	106	212	317
		846	212	423	635
		1,268	317	634	951
		1,691	423	846	1,268
		2,114	529	1,057	1,586
	33,353	**1,668**	417	834	1,251
		3,335	834	1,668	2,501
		5,003	1,251	2,502	3,752
		6,671	1,668	3,336	5,003
		8,338	2,085	4,169	6,254

* all figures have been rounded

Table 11: Estimate of hospitalisations & ICU admissions requiring mechanical ventilation – attack rate 0.30

Attack Rate	Excess Number of persons hospitalised (range)	Number of Admissions To ICU (5%,10%,15%, 20%, 25%)	Number of ICU admissions requiring mechanical ventilation*		
			25%	**50%**	**75%**
0.30	**25,366**	**1,268**	317	634	951
		2,537	634	1,269	1,903
		3,805	951	1,903	2,854
		5,073	1,268	2,537	3,805
		6,342	1,586	3,171	4,757
	100,058	**5,003**	1,251	2,502	3,752
		10,006	2,502	5,003	7,505
		15,009	3,752	7,505	11,257
		20,012	5,003	10,006	15,009
		25,015	6,254	12,508	18,761

* all figures have been rounded

Table 12: Estimate of hospitalisations & ICU admissions requiring mechanical ventilation – attack rate 0.45

Attack Rate	Excess Number of persons hospitalised (range)	Number of Admissions To ICU (5%,10%,15%, 20%, 25%)	Number of ICU admissions requiring mechanical ventilation*		
			25%	**50%**	**75%**
0.45	**38,049**	**1,902**	476	951	1,427
		3,805	951	1,903	2,854
		5,707	1,427	2,854	4,280
		7,610	1,903	3,805	5,708
		9,512	2,378	4,756	7,134
	150,087	**7,504**	1,876	3,752	5,628
		15,009	3,752	7,505	11,257
		22,513	5,628	11,257	16,885
		30,017	7,504	15,009	22,513
		37,522	9,381	18,761	28,142

* all figures have been rounded

3.12 Identifying Additional Emergency Ventilated Beds

Respondents were asked to identify the number of additional emergency ventilated beds that could be activated and brought into service in the event of an influenza pandemic, though the physical location of the additional ventilated beds was not described. Potential care locations included operating or recovery rooms, high dependency units, anaesthesia or emergency departments, or other specialty areas. Examples of additional ventilator resources for consideration included the use of anaesthetic machines, CPAP and BiPAP. The availability of oxygen and suction and air supply also needed to be considered alongside ventilator support systems. The response assumed that a potential physical bed location had available oxygen, air and suction resources.

Only physical infrastructure was considered as the recruitment and retention rates for ICU staff would be impossible to predict during times of a national health emergency. Staffing therefore was not a specific element of the enquiry.

Table 13: Available/additional ventilated beds

	Public Sector		Private Sector	
Location	**Available Ventilated Beds**	**Additional Ventilated Beds**	**Available Ventilated Beds**	**Additional Ventilated Beds**
NSW	241	425	60	22
VIC	179	148	73	40
QLD	162	237	58	91
SA	74	43	28	25
WA	66	97	20	22
TAS	17	26	7	8
ACT	13	15	2	0
NT	10	19	0	0
NZ	154	185	0	0
Total	**916**	**1,195**	**248**	**208**

There were 1,403 potential additional ventilated beds reported by respondents. This resource could not be estimated by 12.0% of respondents. The figures for public sector ICUs were likely to be more generally representative because of the higher response rate (91.0%), in contrast to the private sector with 76.1%.

If staff were available, public sector ventilated beds could be increased from 4.06 to 9.45 per 100,000 population in Australia and 4.06 to 8.94 per 100,000 population in New Zealand. In Australian private sector healthcare facilities, ventilated beds could potentially increase from 1.32 to 2.43 per 100,000 population. In Australian public sector hospitals, additional ventilation capacity could be increased by 132.3% and in private sector hospitals by 83.2%. However, there is marked variation in additional ventilation capacity across regions for public hospitals, for example 58.0% in South Australia, 81.4% in Victoria and 174.2% in New South Wales. In New Zealand, ventilation capacity could potentially be increased by 118.4%. Figure 1 is a graphic representation of available and potential bed resources.[61]

Figure 1:
ICU Ventilated Beds/100,000 by Region & Sector (Public/Private): Available & Potential Additional Beds

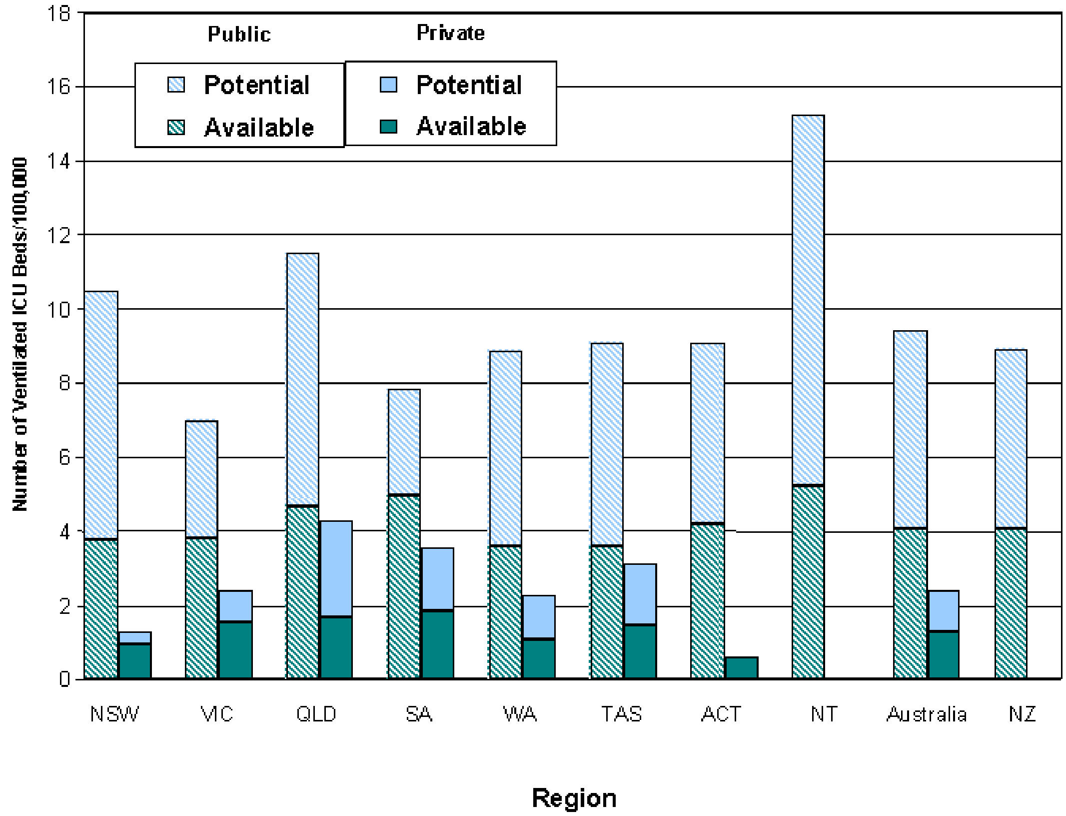


Figure 2:
Relationship Between Estimated Demand & Supply for Ventilated ICU Beds

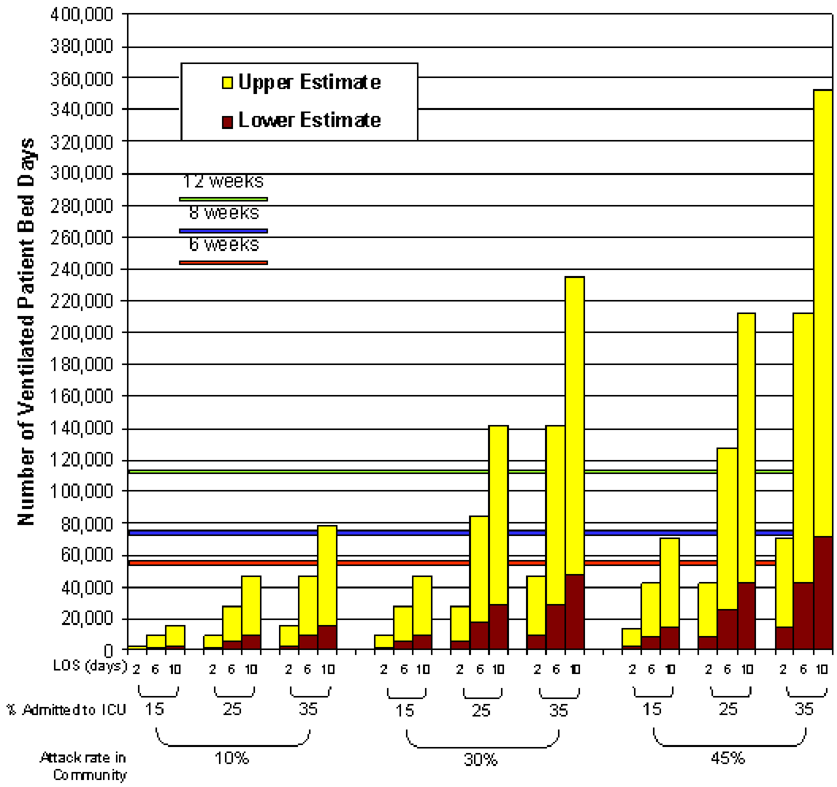


Figure 2 shows the likely time frames of an influenza pandemic (represented by the horizontal bars – 6, 8 and 12 weeks), the number of ICU bed days that could be generated through cancellation of elective surgery and the demand for ventilated beds.[61]

Resource distribution by ICU type is outlined in Table 14. The location of additional ventilated beds in particular types of ICUs may limit their utilisation.

Table 14: Resource distribution by ICU type

	ICU Type	Additional Ventilated Beds	Single Rooms	Ensuite/ Pan Sanitiser
Public Sector	General	730	167	44
	ICU/CCU	246	91	29
	Paediatric	39	13	5
	Cardiothoracic/ Specialty	180	18	6
	Sub-total	**1,195**	**289**	**84**
Private Sector	General	136	42	20
	ICU/CCU	72	22	8
	Sub-total	**208**	**64**	**28**
	Total	**1,403**	**353**	**112**

Anecdotal evidence suggests that access to ICU resources in many jurisdictions is already quite limited. Substantiation of the high rates of refusal to ICU on a national level is required. In particular, pressure on ICU resources is exacerbated during the Winter months when the peak incidence of respiratory infections occurs.

Short-term ventilation resources could be doubled but the effect on the rest of the hospital system has not been assessed. Additional bed days could be created by the cancellation of elective surgery and resources could be co-opted. The rates and effects of staff vaccination programs and antiviral prophylaxis on staff availability are unknown. Locating and employing staff who are trained but not currently engaged in the health care work force is unable to be determined with any degree of accuracy.

The potential requirement for ICU beds can only be estimated from previously published attack rates across at risk sections of the population and the age/risk demographics at specific locations. Even the most conservative estimates suggest that the current system would be overwhelmed.

4.0 Infection Control Characteristics

Because influenza is mainly disseminated by airborne particles, information was sought on the ventilation characteristics of ICUs for infection control purposes. Although bacterial and viral filtration is available for patients on closed endotracheal mechanical ventilation, many infectious patients would not be intubated. Respiratory isolation may therefore be required when patients first present to hospital. The impact of new antiviral agents on the duration of infectivity has not been elucidated at present.

Factors that reduce aerosol spread included the number of rooms that could be placed on positive and negative pressure and their maintenance schedules, the number of available single rooms and the number of rooms with ensuite facilities and/or a pan sanitiser. (An ensuite facility refers to a patient bathroom with a toilet, shower and hand basin). The nature of ICU air pressure with respect to the corridor, the origin(s) of the ICU air, ICU air circulation/exhaust and whether the exhaust air was filtered or treated was established.

The Department of Human Services (Victoria) recommends the following elements for ICU ventilation, filtration and air quality:[62]

- The ICU should be at a positive pressure in relation to the outside corridor.
- There should be a minimum of 15 air changes per hour (achr).
- There should be 100% outside air.
- Supply air should be high-efficiency particulate air (HEPA) filtered.

And for isolation rooms:[63]

- The isolation room should be at a negative pressure in relation to the ICU, preferable with an airlock.
- There should be a minimum of 12 achr with low level exhaust.
- There should be 100% outside air and 100% exhaust air discharge to the outside.

These requirements are similar to operating room requirements and are designed to provide maximum air dilution and low particle concentrations.

Adherence to ventilation standard AS1668.2 or State/Territory guidelines is essential for work areas and patient accommodation.[64] Ventilation equipment that maintains fresh air inflow and regulates temperature, humidity and purity (dust, infectious agents and gases) is mandated.[65]

Table 15: Public & private sector ICU infection control facilities

	Public Sector				Private Sector			
Location	**Single Rooms**	**Ensuite/ Pan Sanitiser**	**Neg. Press. Rooms**	**Pos. Press. Rooms**	**Single Rooms**	**Ensuite/ Pan Sanitiser**	**Neg. Press. Rooms**	**Pos. Press. Rooms**
NSW	117	38	44	53	7	5	1	11
VIC	42	21	26	36	18	4	6	6
QLD	34	15	19	24	19	10	6	8
SA	28	2	5	24	7	4	3	5
WA	18	1	12	10	8	3	1	1
TAS	10	4	5	5	5	2	0	1
ACT	4	0	4	4	0	0	0	0
NT	3	0	0	1	0	0	0	0
NZ	33	3	12	16	0	0	0	0
Total	**289**	**84**	**127**	**173**	**64**	**28**	**17**	**32**

Table 15 illustrates the distribution and number of single rooms, positive and negative pressure rooms and rooms with an ensuite facility or a pan sanitiser. There were a total of 353 single rooms in public and private sector ICUs, 112 rooms with ensuite facilities or pan sanitisers, 144 negative pressure rooms and 205 positive pressure rooms. Table 15 indicates a lack of knowledge of the operation of negative and positive pressure isolation rooms.

Caution is required when interpreting the data for negative and positive pressure rooms in this table as it is possible that some of these rooms may be interchangeable, that is, the same room may be represented in both categories. However, it was not known how many of these rooms could alternate between negative and positive pressure.

The provision of adequate numbers of single rooms in acute care settings is emphasised and there should be at least one single room per five ward beds and one respiratory isolation room with an individual air supply and exhaust system per 100 ward beds.[65]

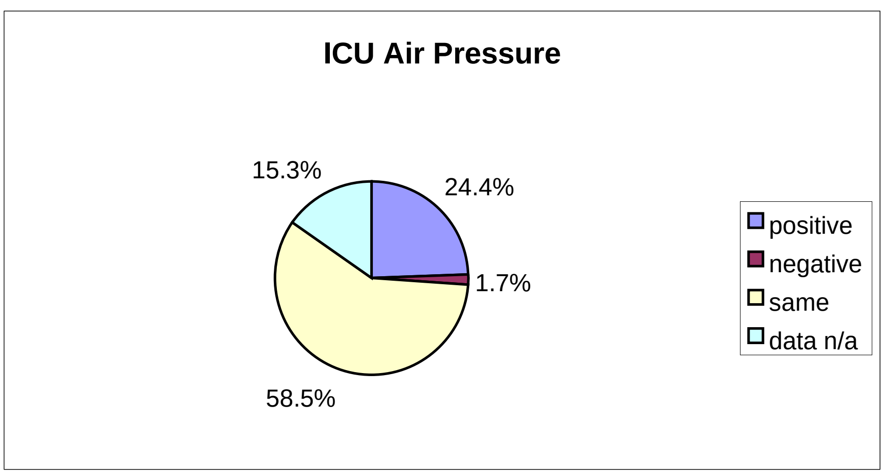
Table 16: Resource distribution by ICU level

Designated ICU Level		Additional Ventilated Beds	Single Rooms	Ensuite/ Pan Sanitiser
Public Sector	3	762	175	53
	2	287	74	19
	1	146	40	12
	Sub-total	**1,195**	**289**	**84**
Private Sector	3	144	33	15
	2	48	24	10
	1	16	7	3
	Sub-total	**208**	**64**	**28**
Total		**1,403**	**353**	**112**

Table 16 is an overview of public and private sector designated ICU levels, the number of additional ventilated beds identified, the numbers of single rooms and those with an ensuite or pan sanitiser.

Figures 1 to 7 show selected elements of ICU and operating room infection control characteristics. Data in these figures are reproduced as tables in the appendices. Substantive numbers of respondents were unable to provide details of infection control characteristics for the ICU.

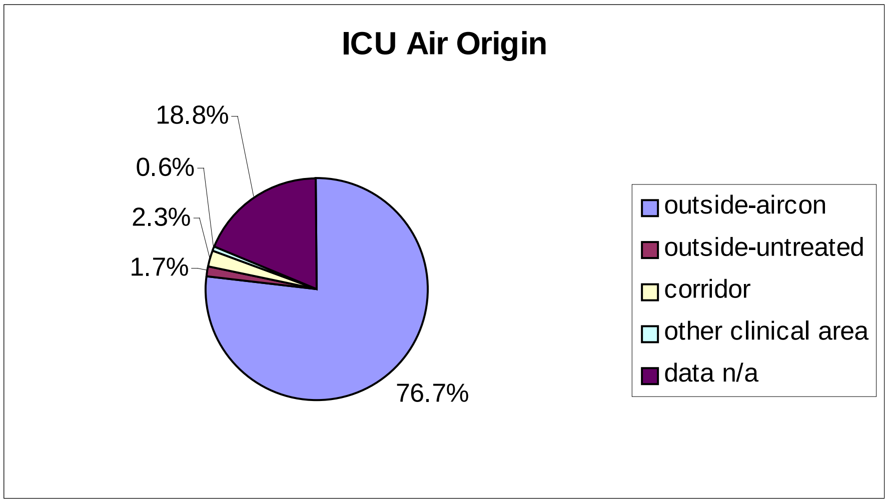
Figure 3: ICU Air Pressure



ICU air pressure responses (Figure 3) show neutral balance or ICU air pressure the same as that of the corridor as the majority response (58.5%). Normal operation would dictate a positive pressure airflow to assist in maintaining a clean environment.[62] Neutral or negative pressure within the entire ICU would be beneficial during an influenza pandemic as this would assist in controlling the spread of airborne viral particles.

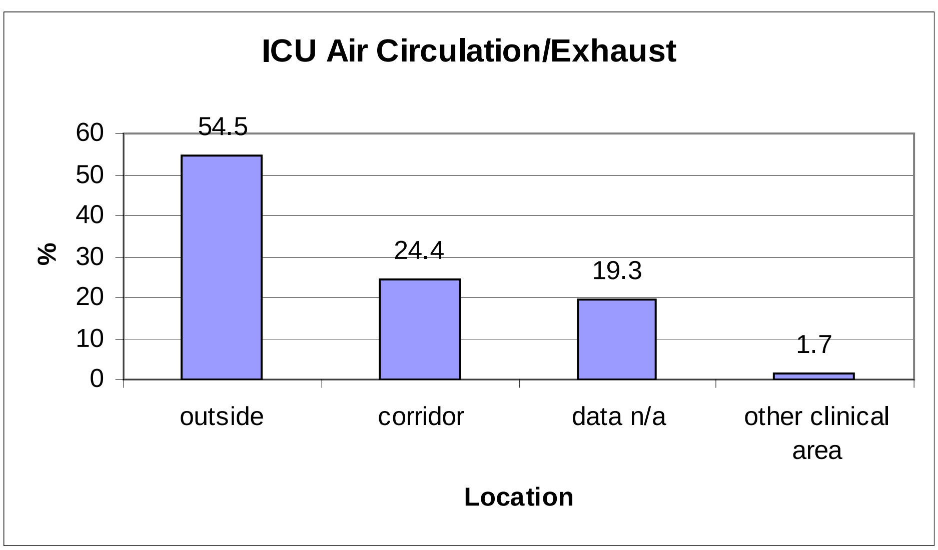
Airflows within major buildings (including hospitals) can affect the transmission of viral infections to staff and patients.

Figure 4: ICU Air Origin



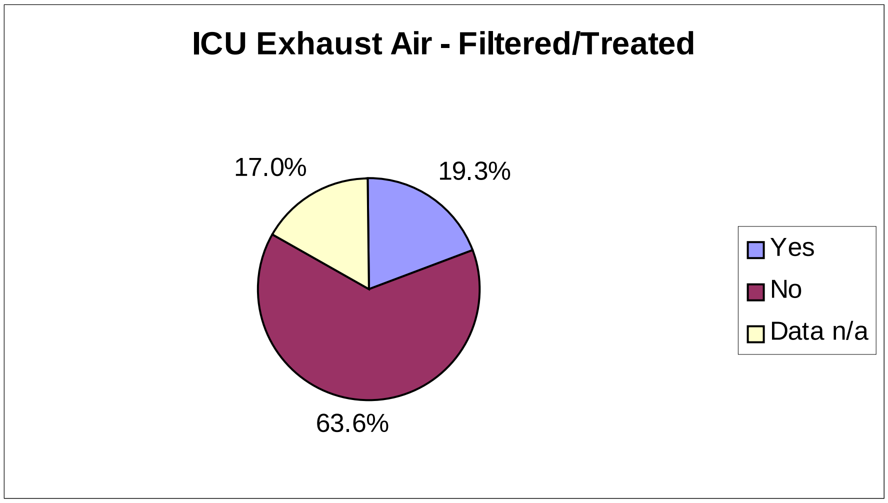
ICU air supply responses (Figure 4) indicate an understanding of the nature of the air supply system and that a majority of ICUs have appropriately designed air supply systems.[62,66] This is essential in controlling the concentration of airborne contaminants.

Figure 5: ICU Air Circulation/Exhaust



The item on the survey tool pertaining to ICU exhaust was possibly ambiguous (Figure 5). This was indicated by the high number of responses stating that ICU exhaust air was discharged to the corridor and indicates a lack of understanding of the exhaust air systems installed, a lack of understanding of the question by the respondent, or an engineering design problem. Further studies are required to determine understanding of the characteristics of ICU circulation and exhaust systems.

Figure 6: ICU Exhaust Air Filtered/Treated



The data on ICU exhaust filtration demonstrated some ambiguity in that 19.3% of respondents indicated that such air is filtered (Figure 6). Further studies are required to gain a better understanding of knowledge of ICU air filtration and treatment systems and to determine if systems such as ultraviolet light in the 254 nanometre range are being used.

Figure 7: Operating Room/Recovery Room Air Circulation/Exhaust

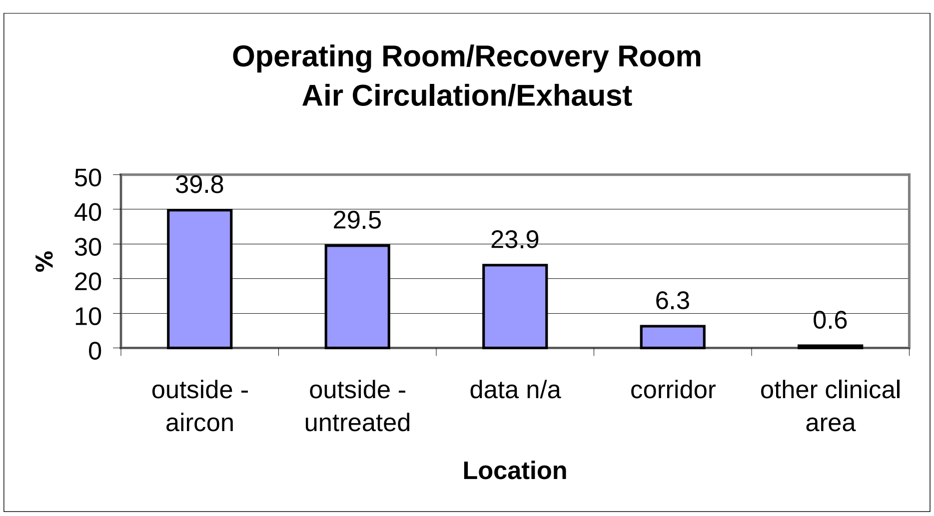
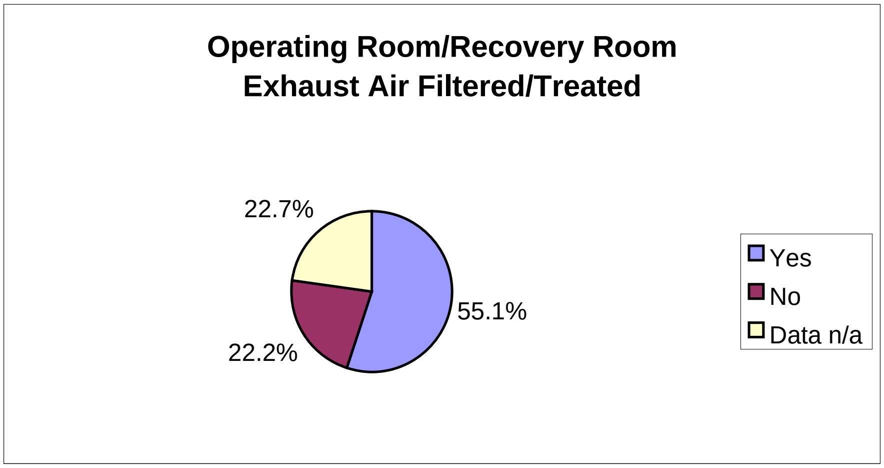
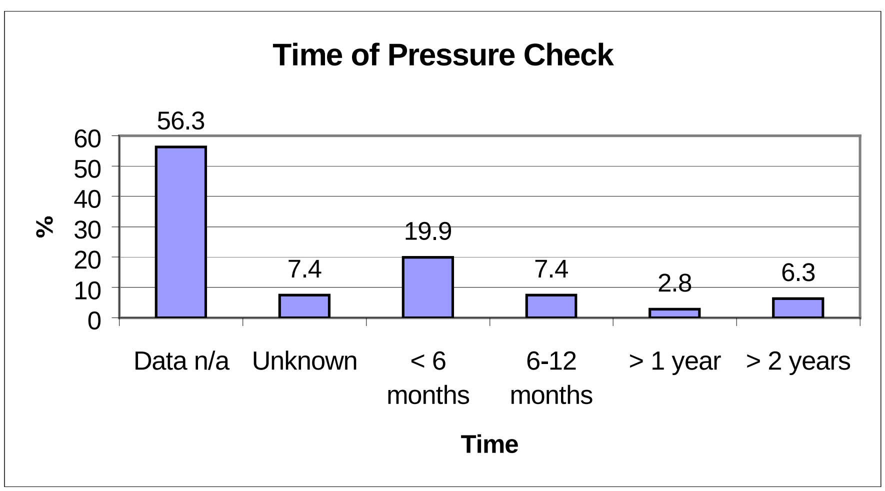


Figure 8: Operating Room/Recovery Room Exhaust Air Filtered/Treated



Where possible, respondents were asked to also include information on operating room and recovery room air origin, circulation and filtration (Figures 7 and 8). However, the items pertaining to operating and recovery rooms on the survey instrument were possibly ambiguous in nature. The question of operating room exhaust systems indicated that the first two options in the response to the question could have been amalgamated to represent one option. This would provide a large response to outside air discharge, the most appropriate response to the control question. The same question on ICU exhaust should have correlated with similar numbers, but deviated by a considerable margin.

Figure 9: Pressure Status Confirmation



More than half of all respondents, (56.3%), did not provide information on the time of pressure status confirmation (Figure 9). A further 7.4% of sites could not specify the time of the most recent pressure check. It was known that a small number of ICU specialists had consulted hospital engineering services to try to determine this information without success.

5.0 Conclusion

It was evident from the study processes and findings that we need to know more about influenza, its complications and its consequences in critical care contexts. This study has highlighted a lack of knowledge about intensive care resources, systems and personnel in the event of an influenza pandemic.

5.1 Directions to Enhance Understanding

Implementing appropriate measures to enhance understanding is a key goal. Immediate, intermediate and long-term directions include:

- Disseminate the report to all contributing ICUs, to health departments and relevant government agencies.
- Release key resource data to relevant authorities should a pandemic occur.
- Contribute to the development of a contingency plan for an influenza pandemic.
- Monitor the development and spread of novel influenza viruses.
- Promote influenza vaccination for direct patient care staff.
- Improve understanding of, and determine, impact of antiviral medications.
- Separate viral and bacterial pneumonia from influenza in ICD10-AM.
- Source economic and healthcare models to quantify impact of an influenza pandemic.
- Gain an understanding of attack rates within Australasian contexts.
- Develop a predictive tool to estimate likely admissions to ICU and the number requiring ventilation support.
- Develop triage criteria for assessment and admission.
- Quantify likely demand for critical care personnel.
- Identify potential sources of critical care labour.
- Elaborate on assumptions regarding quality of care.
- Identify and document ICU isolation rooms and ventilation systems.
- Document ICU isolation room operating procedures.
- Conduct in-service education on the operation of isolation rooms.
- Convert any alternative positive/negative pressure isolation rooms to negative pressure only.

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Appendix 1: Additional Tables

Table 1a: Australia & New Zealand Population Data

Location	Population
NSW	6,341,600
VIC	4,660,900
QLD	3,456,300
SA	1,487,300
WA	1,831,400
TAS	471,900
ACT	308,400
NT	190,000
Australia*	**18,751,000**
North Island	2,866,500
South Island	925,400
New Zealand**	**3,791,900**

Source:

* Australian Bureau of Statistics – actual population as at 30th June 1998[54]
** Statistics New Zealand – estimated population as at 30th June 1998 [55]

Table 2a: ICU Air Pressure

		NSW/ACT		VIC/TAS		QLD		SA/NT		WA		NZ	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Public Sector	Positive	7	15.6	6	20.6	8	34.8	3	33.3	1	20.0	7	30.4
	Negative	2	4.4	1	3.4	0	0	0	0	0	0	0	0
	Same	31	68.9	21	72.2	15	65.2	3	33.3	3	60.0	12	52.2
	Data Unavailable	5	11.1	1	3.4	0	0	3	33.3	1	20.0	4	17.4
	Total	**45**	**100**	**29**	**100**	**23**	**100**	**9**	**100**	**5**	**100**	**23**	**100**
Private Sector	Positive	1	9.1	6	42.8	3	33.3	1	25.0	0	0	0	0
	Negative	0	0	0	0	0	0	0	0	0	0	0	0
	Same	4	36.4	5	35.7	4	44.4	2	50.0	4	100	0	0
	Data Unavailable	6	54.5	3	21.4	2	22.2	1	25.0	0	0	0	0
	Total	**11**	**100**	**14**	**100**	**9**	**100**	**4**	**100**	**4**	**100**	**0**	**0**

Data has been amalgamated for NSW/ACT, VIC/TAS and SA/NT to avoid identifying particular ICUs.

Table 3a: ICU Air Origin

		NSW/ACT		VIC/TAS		QLD		SA/NT		WA		NZ	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Public Sector	Outside Air Cond.	36	80.0	25	86.0	21	91.3	6	66.7	4	80.0	17	73.9
	Outside Untreated	1	2.2	0	0	1	4.3	0	0	0	0	1	4.3
	Corridor	0	0	1	3.4	1	4.3	0	0	0	0	1	4.3
	Other Clin. Area	0	0	1	3.4	0	0	0	0	0	0	0	0
	Data Unavailable	8	17.8	2	6.9	0	0	3	33.3	1	20.0	4	17.4
	Total	**45**	**100**	**29**	**100**	**23**	**100**	**9**	**100**	**5**	**100**	**23**	**100**
Private Sector	Outside Air Cond.	5	45.5	10	71.4	6	66.7	3	75.0	3	75.0	0	0
	Outside Untreated	0	0	0	0	0	0	0	0	0	0	0	0
	Corridor	0	0	1	7.1	0	0	0	0	0	0	0	0
	Other Clin. Area	0	0	0	0	0	0	0	0	0	0	0	0
	Data Unavailable	6	54.5	3	21.4	3	33.3	1	25.0	1	25.0	0	0
	Total	**11**	**100**	**14**	**100**	**9**	**100**	**4**	**100**	**4**	**100**	**0**	**0**

Table 4a: ICU Air Circulation/Exhaust

		NSW/ACT		VIC/TAS		QLD		SA/NT		WA		NZ	
		No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Public Sector	Outside	26	57.8	16	55.0	15	65.2	3	33.3	2	40.0	12	52.2
	Corridor	13	28.9	10	34.4	5	21.7	2	22.2	2	40.0	6	26.1
	Other Clin. Area	0	0	2	6.9	0	0	1	11.1	0	0	0	0
	Data Unavailable	6	13.3	1	3.4	3	13.0	3	33.3	1	20.0	5	21.7
	Total	**45**	**100**	**29**	**100**	**23**	**100**	**9**	**100**	**5**	**100**	**23**	**100**
Private Sector	Outside	4	36.4	9	64.2	5	55.6	2	50.0	3	75.0	0	0
	Corridor	1	9.1	1	7.1	1	11.1	1	25.0	0	0	0	0
	Other Clin. Area	0	0	1	7.1	0	0	0	0	0	0	0	0
	Data Unavailable	6	54.5	3	21.4	3	33.3	1	25.0	1	25.0	0	0
	Total	**11**	**100**	**14**	**100**	**9**	**100**	**4**	**100**	**4**	**100**	**0**	**0**

Table 5a: ICU Air Filtration/Treatment

		NSW/ACT		VIC/TAS		QLD		SA/NT		WA		NZ	
		No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Public Sector	Yes	29	64.4	6	20.6	8	34.8	1	11.1	1	20.0	2	8.7
	No	10	22.2	21	72.2	14	60.9	5	55.6	3	60.0	17	73.9
	Data Unavailable	6	13.3	2	6.9	1	4.3	3	33.3	1	20.0	4	17.4
	Total	**45**	**100**	**29**	**100**	**23**	**100**	**9**	**100**	**5**	**100**	**23**	**100**
Private Sector	Yes	4	36.4	3	21.4	2	22.2	1	25.0	0	0	0	0
	No	1	9.1	7	50.0	5	55.6	3	75.0	4	100	0	0
	Data Unavailable	6	54.5	4	28.5	2	22.2	0	0	0	0	0	0
	Total	**11**	**100**	**14**	**100**	**9**	**100**	**4**	**100**	**4**	**100**	**0**	**0**

Table 6a: Operating/Recovery Room Circulate/Exhaust

		NSW/ACT		VIC/TAS		QLD		SA/NT		WA		NZ	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Public Sector	Outside Air Cond.	15	33.3	12	41.2	14	60.9	3	33.3	0	0	13	56.5
	Outside Untreated	16	35.6	11	38.0	7	30.4	0	0	2	40.0	4	17.4
	Corridor	2	4.4	2	6.8	1	4.3	1	11.1	1	20.0	1	4.3
	Other Clin. Area	0	0	0	0	0	0	1	11.1	0	0	0	0
	Data Unavailable	12	26.7	4	13.7	1	4.3	4	44.4	2	40.0	5	21.7
	Total	**45**	**100**	**29**	**100**	**23**	**100**	**9**	**100**	**5**	**100**	**23**	**100**
Private Sector	Outside Air Cond.	4	36.4	3	21.4	3	33.3	1	25.0	2	50.0	0	0
	Outside Untreated	1	9.1	5	35.7	4	44.4	2	50.0	1	25.0	0	0
	Corridor	0	0	2	14.2	0	0	0	0	0	0	0	0
	Other Clin. Area	0	0	0	0	0	0	0	0	0	0	0	0
	Data Unavailable	6	54.5	4	28.5	2	22.2	1	25.0	1	25.0	0	0
	Total	**11**	**100**	**14**	**100**	**9**	**100**	**4**	**100**	**4**	**100**	**0**	**0**

Table 7a: Operating Room Air Filtration/Treatment

		NSW/ACT		VIC/TAS		QLD		SA/NT		WA		NZ	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Public Sector	Yes	25	55.6	7	24.1	9	39.1	0	0	1	20.0	5	21.7
	No	9	20.0	19	65.4	14	60.9	5	55.6	2	40.0	12	52.2
	Data Unavailable	11	24.4	3	10.3	0	0	4	44.4	2	40.0	6	26.1
	Total	**45**	**100**	**29**	**100**	**23**	**100**	**9**	**100**	**5**	**100**	**23**	**100**
Private Sector	Yes	3	27.3	3	21.4	1	11.1	0	0	1	25.0	0	0
	No	2	18.2	7	50.0	6	66.7	3	75.0	2	50.0	0	0
	Data Unavailable	6	54.5	4	28.6	2	22.2	1	25.0	1	25.0	0	0
	Total	**11**	**100**	**14**	**100**	**9**	**100**	**4**	**100**	**4**	**100**	**0**	**0**

Table 8a: Pressure Status Confirmation

		NSW/ACT		VIC/TAS		QLD		SA/NT		WA		NZ	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Public Sector	Yes	17	37.8	18	62.0	12	52.2	5	55.6	3	60.0	7	30.4
	No	14	31.1	6	20.6	6	26.1	1	11.1	0	0	4	17.4
	Data Unavailable	14	31.1	5	17.2	5	21.7	3	33.3	2	40.0	12	52.2
	Total	**45**	**100**	**29**	**100**	**23**	**100**	**9**	**100**	**5**	**100**	**23**	**100**
Private Sector	Yes	1	9.1	5	35.7	4	44.4	1	25.0	1	25.0	0	0
	No	4	27.3	2	14.3	2	22.2	3	75.0	3	75.0	0	0
	Data Unavailable	7	63.6	7	50.0	3	3.3	0	0	0	0	0	0
	Total	**11**	**100**	**14**	**100**	**9**	**100**	**4**	**100**	**4**	**100**	**0**	**0**

Table 9a: Time of Pressure Status Confirmation

		NSW/ACT		VIC/TAS		QLD		SA/NT		WA		NZ	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Public Sector	< 6 months ago	10	22.2	7	24.1	8	34.8	1	11.1	1	20.0	2	8.7
	6 – 12 months ago	4	8.9	3	10.3	3	13.0	1	11.1	1	20.0	1	4.3
	>1 year ago	0	0	1	3.4	0	0	0	0	0	0	2	8.7
	> 2 years ago	1	2.2	3	10.3	0	0	3	33.3	1	20.0	0	0
	Unknown	3	6.7	5	17.2	0	0	1	11.1	0	0	3	13.0
	Data Unavailable	27	60.0	10	34.4	12	52.2	3	33.3	2	40.0	15	65.2
	Total	**45**	**100**	**29**	**100**	**23**	**100**	**9**	**100**	**5**	**100**	**23**	**100**
Private Sector	< 6 months ago	0	0	1	7.1	2	22.2	1	25.0	1	25.0	0	0
	6 – 12 months ago	0	0	3	21.4	0	0	0	0	0	0	0	0
	>1 year ago	0	0	0	0	0	0	0	0	0	0	0	0
	> 2 years ago	0	0	1	7.1	1	11.1	0	0	0	0	0	0
	Unknown	1	9.1	0	0	0	0	0	0	0	0	0	0
	Data Unavailable	10	90.9	9	64.2	6	66.7	3	75.0	3	75.0	0	0
	Total	**11**	**100**	**14**	**100**	**9**	**100**	**4**	**100**	**4**	**100**	**0**	**0**

Appendix 2:

ANZICS / National Influenza Pandemic Planning Committee

Intensive Care Unit Data Information Form

Please photocopy and complete one form for each intensive care unit in your hospital

Hospital ____

Type of ICU: (Circle one only)

ICU - CCU / Medical - Surgical ICU / Paediatric / Speciality (eg Cardiac) (________________)

What is the Maximum Number of VENTILATOR BEDS in your ICU? ____

On average, How many beds are occupied by ELECTIVE PATIENTS ? ____
(include Ventilated and Non-ventilated and include Cardiac surgery).

What PERCENTAGE of total ICU bed days is occupied by elective Surgical Patients ? (include cardiac surgery) ____%

In a major Public Health Emergency (eg Flu pandemic),
HOW MANY EXTRA EMERGENCY VENTILATOR BEDS COULD YOUR HOSPITAL ACTIVATE ? ____
(Consider the use of all ventilator capacity- time-cycled, anaesthetic machines, Bipap and the availability of oxygen/ suction and air-supply and areas such as recovery and operating rooms, Specialty HDU/ ICU beds)

Infection Control Characteristics of your ICU **(Circle applicable alternatives.)**

What is the AIR PRESSURE of the ICU with respect to the corridor
Positive **Negative** **The same**

Where does the ICU air ORIGINATE ?
Outside via air conditioning Unit **Outside (untreated)** **Corridor** **Other Clinical Area**

Where does the air from the ICU circulate / exhaust?
Outside **Corridor** **Other Clinical Area**

Is the ICU exhaust air FILTERED or TREATED in other microbicidal way **Yes / No**

.../2

Where does the air from the OPERATING AND RECOVERY ROOMS CIRCULATE / EXHAUST TO?

Outside via air conditioning Unit (untreated)	**Outside**
Corridor	**Other Clinical Area**

Is the OR/RR exhaust air filtered or treated in other microbicidal way **Yes / No**

How many ICU beds are in single rooms with a door? ____

Please give the characteristics of these single rooms

How many can be placed on negative pressure? ____

How many rooms can be placed on positive pressure? ____

Has the pressure status been confirmed? **Yes / No**

How long ago?

Unknown / < 6 months ago / 6 - 12 months ago / > 1 year ago > 2 years ago

How many rooms have a pan sanitiser or en-suite? (suitable for VRE) ____

Enquiries:

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Tel/fax: (61 3) 9639 8819

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RETURN TO: ANZICS ICU REGISTRY by 30th November 1999

Appendix 3:

The National Influenza Pandemic Planning Committee

Information Sheet for ANZICS members.

The potential impact of an influenza pandemic

Influenza viruses are unique in their ability to cause sudden and severe illness in all age groups on a global scale. An influenza pandemic is unlike any other public health emergency or community disaster:

- There may be very little warning.
- Outbreaks are expected to occur simultaneously throughout Victoria and the rest of Australia. To a large extent, each region will have to rely on its own resources.
- The effect of influenza on individual communities will be relatively prolonged (6 to 8 weeks), compared to minutes-to-hours observed in most other natural disasters.
- The impact on the health of Victorians could be devastating:
    - up to 20,000 persons may require hospitalisation within a 6 to 8 week period.
    - up to 7,200 excess deaths within a 6 to 8 week period.
- Forty to seventy per cent of the workforce may be unable to attend work for some period of time due to illness.
- Health care workers are likely to be at an even higher risk of exposure and illness, further impeding the care of patients.
- Critical community personnel such as police, firemen, transportation and utility workers may suddenly be in short supply.
- Effective preventive and therapeutic measures, including vaccines (against the pandemic strain) and antiviral agents are likely to be in short supply.

The greatly increased demand for services and staff shortages are expected to stretch the resources of health care institutions. To more effectively meet this challenge, health care institutions should develop contingency plans. Planning for the next influenza pandemic now will not only facilitate an effective response when the time comes, but also provide tangible benefits in the interim such as improvements in infrastructure, health care worker vaccination, and Y2K (millenium bug) planning. A National Influenza Pandemic Contingency Plan is currently being developed under the auspices of the Communicable Diseases Network of Australia and New Zealand. The latest draft should be released for public comment in mid April 1999. The Victorian Influenza Pandemic Draft Contingency Plan for Health Care Institutions will form an appendix to the National Plan.

As part of this planning, it is important to document the emergency ventilation capacity within the Australia and New Zealand. To minimise nosocomial transmission of influenza, it is also important to be aware of airflow direction.

Additional questions regarding the characteristics of single rooms or potential isolation facilities are included. The Victorian Department of Human Services conducted a survey of Victorian public hospitals in 1996/97. The responses suggested that there may have been considerable misinterpretation of the survey questions. Nevertheless, it appeared that the number of monitored negative pressure rooms and rooms suitable for patients with VRE (vamcomycin resistant enterococci) within ICU and critical care units was low. The attached survey questions have been reviewed by several ICU physicians, infection control practitioners and an engineer.

Ownership of the data

The attached survey is being conducted under the auspices of the National Influenza Pandemic Planning Committee. Dr Graham Rouch, Chief Health Officer of Victoria, is chairman of that Committee.

Only summary, non-hospital identifying data will be made available for planning purposes to the respective State and Commonwealth Health departments within Australia and New Zealand.

The ANZICS ICU registry will hold the hospital identifying data and will make this available to the Office of the Coordinator of Critical Care and Emergency Services (or equivalent in other States) in the event of a major public health emergency such as an influenza pandemic.

Your assistance in completing this survey is greatly appreciated.

Appendix 4: Hospitals Surveyed

New South Wales

Albury Base Hospital
Armidale & New England Regional Hospital
Auburn Hospital
Blacktown Hospital
Broken Hill Base Hospital
Campbelltown Hospital
Canterbury Hospital
Coffs Harbour & District Hospital
Concord Repatriation Hospital
Dubbo Base Hospital
Fairfield Hospital
Gosford Hospital
Griffith Base Hospital
Hornsby Ku-ring-gai Hospital
Illawarra Regional Hospital
John Hunter Hospital
Lismore Base Hospital
Liverpool Hospital
Manly Hospital
Manning River Base Hospital
Mater Misericordiae Private Hospital
Mona Vale Hospital
Mount Druitt Hospital
North Gosford Private Hospital
North Shore Private Hospital
NSW Private Hospital Ashfield
Orange Base Hospital
Port Macquarie Base Hospital
Prince of Wales Hospital
Royal North Shore Hospital
Royal Prince Alfred Hospital
Ryde Hospital
Shoalhaven District Memorial Hospital
St George Hospital
St Luke's Private Hospital
Strathfield Private Hospital
St Vincent's Hospital
St Vincent's Private Hospital
Sydney Adventist Private Hospital
Sydney Children's Hospital
Tamworth Base Hospital
The Bankstown Lidcombe Hospital
The Hills Private Hospital
The Illawarra Hospital
The Nepean Hospital
Wagga Wagga Base Hospital
Westmead Hospital

Victoria

Austin & Repatriation Medical Centre
Ballarat Health Services
Barwon Health
Bendigo Health Care Group
Box Hill Hospital
Cabrini Hospital
Central Gippsland Health Service
Dandenong Hospital
Epworth Hospital
Frankston Hospital
Goulburn Valley Health
John Fawkner Hospital
Knox Private Hospital
Maroondah Hospital
Melbourne Private Hospital
Mildura Base Hospital
Monash Medical Centre
New Latrobe Regional Hospital
Royal Children's Hospital
Royal Melbourne Hospital
South Eastern Private Hospital
South West Healthcare - Warrnambool
St John of God Healthcare Ballarat
St John of God Healthcare Geelong
St Vincent's Hospital
St Vincent's Private Hospital
The Alfred Hospital
The Northern Hospital
The Valley Private Hospital
Wangaratta District Base Hospital
Warringal Private Hospital
Western District Health Service
Western Hospital
Wimmera Health Care Group
Wodonga Regional Health Service

Australian Capital Territory

Calvary Hospital
The Canberra Hospital

Tasmania

Calvary Hospital
Launceston General Hospital
Mersey Community Hospital
North West Regional Hospital
Royal Hobart Hospital
St Helen's Private Hospital

Queensland

Allamanda Private Hospital
Bundaberg Base Hospital
Cairns Base Hospital
Calvary Private Hospital
Gold Coast Hospital
Greenslopes Private Hospital
Hervey Bay Hospital
Holy Spirit Hospital
Ipswich Hospital
John Flynn Private Hospital
Logan Hospital
Mackay Base Hospital
Maryborough Hospital
Mater Adults Hospital
Mater Misericordiae Children's Hospital
Mater Misericordiae Private Hospital
Mater Misericordiae Private Hospital Townsville
Mount Isa Base Hospital
Nambour General Hospital
Pindara Private Hospital
Princess Alexandra Hospital
Queen Elizabeth II Jubilee Hospital
Redcliffe Hospital
Rockhampton Hospital
Royal Brisbane Hospital
Royal Children's Hospital
The Prince Charles Hospital
The Wesley Hospital
Toowoomba Base Hospital
Townsville General Hospital

South Australia

Ashford Community Hospital
Flinders Medical Centre
Modbury Public Hospital
Port Augusta Hospital
Repatriation General Hospital
Royal Adelaide Hospital
St Andrew's Hospital
The Memorial Hospital
The Queen Elizabeth Hospital
Wakefield Hospital
Whyalla Hospital

Western Australia

Albany Regional Hospital
Bunbury Regional Hospital
Fremantle Hospital
Hollywood Private Hospital
Mount Hospital
Princess Margaret Hospital for Children
Royal Perth Hospital
St John of God Health Care Subiaco
St John of God Health Care Murdoch
Sir Charles Gairdner Hospital

Northern Territory

Alice Springs Hospital
Royal Darwin Hospital

New Zealand

Ashburton & Community Health Services
Auckland Hospital
Christchurch Hospital
Dunedin Hospital
Gisborne Hospital
Green Lane Hospital
Grey Hospital
Hawkes Bay Hospital
Health Waikato
Hutt Hospital
Midcentral Health
Middlemore Hospital
Nelson Hospital
North Shore Hospital
Northland Health
Rotorua Hospital
Southland Hospital
Starship Children's Hospital
Taranaki Hospital
Tauranga Hospital
Timaru Hospital
Wairau Hospital
Wanganui Hospital
Wellington Hospital

Appendix 5: Modified Geographic Region Classification

1. Capital Cities

Australia: Sydney, Melbourne, Brisbane, Perth, Adelaide, Hobart, Darwin, Canberra

New Zealand: Wellington

2. Metropolitan Centres

- **Urban centres with a population ≥ 100,000**

Australia: Gosford-Central Coast, Newcastle, Wollongong, Queanbeyan, Geelong, Gold Coast-Tweed Heads, Townsville-Thuringowa

New Zealand: Auckland, Christchurch, Dunedin, Hamilton, Napier-Hastings

3. Rural Centres

- **Rural centres with a population between 10,000 and 99,999.**

NSW: Albury-Wodonga, Armidale, Ballina, Bathurst, Broken Hill, Casino, Coffs Harbour, Dubbo, Lismore, Echuca-Moama, Forster-Tuncurry, Goulburn, Grafton, Griffith, Lithgow, Moree Plains, Muswellbrook, Nowra-Bombaderrry, Orange, Port Macquarie, Singleton, Tamworth, Taree, Wagga Wagga

VIC: Bairnsdale, Ballarat, Bendigo, Colac, Echuca-Moama, Horsham, Mildura, Moe-Yallourn, Morwell, Ocean Grove-Barwon Heads, Portland, Sale, Shepparton-Mooroopna, Traralgon, Wangaratta, Warrnambool

QLD: Bundaberg, Cairns, Caloundra, Gladstone, Gympie, Hervey Bay, Mackay, Maroochydore-Mooloolaba, Maryborough, Nambour, Rockhampton, Tewantin-Noosa, Toowoomba, Warwick

SA: Mount Gambier, Murray Bridge, Port Augusta, Port Lincoln, Port Pirie, Whyalla

WA: Albany, Bunbury, Geraldton, Mandurah

TAS: Burnie-Somerset, Devonport, Launceston

NZ: Hamilton, Invercargill, Kapiti, Blenheim, Gisborne, Greymouth, Nelson, New Plymouth, Palmerston North, Rotorua, Tauranga, Timaru, Wanganui, Whangarei,

4. Remote Centres

Alice Springs, Mount Isa

Adapted from:

Department of Primary Industries and Energy and Department of Health and Family Services (1994) *Rural, Remote and Metropolitan Areas Classification* in Australian Institute of Health & Welfare (1999) Medical Labour Force 1997. AIHW catalogue No. HWL 13, AIHW, Canberra (p75).