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ORIGINAL ARTICLE

Early experience with influenza A H1N109 in an Australian intensive care unit

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Summary Influenza is a common seasonal viral infection that affects large numbers of people. In early 2009, many people were admitted to hospitals in Mexico with severe respiratory failure following an influenza-like illness, subtyped as H1N1. An increased mortality rate was observed. By June 2009, H1N1 was upgraded to pandemic status. In June—July, Australian ICUs were experiencing increased activity due to the influenza pandemic. While hospitals implemented plans for the pandemic, the particularly heavy demand to provide critical care facilities to accommodate an influx of people with severe respiratory failure became evident and placed a great burden on provision of these services. This paper describes the initial experience (June to mid September) of the pandemic from the nursing perspective in a single Australian ICU. Patients were noted to be younger with a higher proportion of women, two of whom were pregnant. Two patients had APACHE III comorbidity. Of the 31 patients admitted during this period, three patients died in ICU and one patient died in hospital. Aerosol precautions were initiated for all patients. The requirement for single room accommodation placed enormous demands for bed management in ICU. Specific infection control procedures were developed to deal with this new pandemic influenza.

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Introduction

Influenza is a common seasonal viral infection that affects large numbers of people annually, with the highest mortality seen in the elderly. In April 2009 health authorities in Mexico reported increased numbers of people admitted to their hospitals with severe respiratory failure following an influenza-like illness. Many of these people were young. Furthermore, an increased mortality rate was observed. A novel strain of influenza A was identified and subtyped as H1N1 2009 (H1N1). The virus spread rapidly around the world from Mexico, made possible by the large volume of air travel. In March—April approximately 2.35 million passengers departed from Mexico to travel to more than 1000 cities in 164 countries around the world (Khan et al., 2009). By June 2009, the World Heath Organisation (World Health Organisation, 2009) upgraded the epidemic to pandemic status due to the rapid spread and lack of immunity in the global population. The 2009 H1N1 influenza A virus was genetically mapped as an avian strain that crossed from the host carrier pigs into humans (Gatherer, 2009). The viral antigenicity and the high level of person-to-person transmission combined to create the optimal setting for the pandemic. Because influenza is triggered during winter months by cooler temperatures, increased cloud cover and rainfall, countries in the Southern Hemisphere entering their winter season had to rapidly prepare for an increased number of people with severe respiratory failure related to H1N1.

By June—July, Australian hospitals had implemented plans to manage the pandemic, in particular a heavy demand to provide intensive care (ICU) facilities to accommodate the influx of people with severe respiratory failure. A binational registry of all patients admitted to ICU in Australia and New Zealand with respiratory failure associated with Influenza A and in particular H1N1, was implemented (ANZIC Influenza Investigators, 2009). This paper aims to describe the insights into the issues faced and lessons learned from managing and nursing patients with H1N1 in an Australian general ICU across winter 2009 to inform future pandemic situations with a focus on intensive care.

Method of review

This review reports the issues arising and lessons learned from the H1N1 pandemic and uses some specific cases to detail management and care. The study was conducted from the time the first patient was admitted to the ICU with H1N1 (index case), 23 June 2009 to mid September 2009.

The study was conducted in a 22-bed ICU located in a tertiary-referral teaching hospital offering a wide range of services including Extra-Corporeal Membrane Oxygenation therapy (ECMO). The ICU operates as a closed unit located in two separate, but adjacent areas. One area has 12 beds, eight of which are in single rooms (six with anterooms) and the other area has 10 beds, three of which are in single rooms. Under normal circumstances an additional equipped, but non-staffed bed is kept for emergency in-hospital admissions. Nurse to patient ratios are one-to-one, except for patients who are waiting for ward placement. In addition, for each area there is a nurse shift coordinator and a resource nurse. The ICU is supported by three respiratory technicians who maintain respiratory equipment. However, ventilation requirements are managed by medical and nursing staff. A separate high dependency unit (HDU) of eight beds operates under the direction of the intensive care senior medical and nursing staff.

Case details and care processes were documented in accordance with national guidelines (National Health and Medical Research Council, 2007). The project was approved with the relevant institutional committee. Patient confidentiality and anonymity was maintained throughout the study.

Patients admitted to the ICU were eligible for recruitment. They were included if they were confirmed to have H1N1 influenza. Those with influenza A or when the cause of respiratory failure was unknown were excluded.

Patient details abstracted from the hospital's 'INFINITE' Registry (ANZIC Influenza Investigators, 2009) was maintained by the ICU research coordinators. Additional patient details were added to the registry as more laboratory data became available. It is unlikely that any patient was missed because the laboratory data was reviewed several times for all patients admitted with respiratory failure. The Clinical Nurse Specialists and ICU Research Coordinators, listed as authors on this paper, collectively contributed a consensus recollection of events and issues encountered during the study period.

Descriptive statistics were used to characterise the patients with H1N1. Data obtained from the ICU clinical database included age, gender, severity of illness estimated from the worst in first 24 hour Acute Physiology and Chronic Health Evaluation (APACHE) II score (Knaus et al., 1985), comorbidity using APACHE III comorbidity codes (Knaus et al., 1991) and length of stay (LOS) in ICU and hospital. Organ failure was assessed by the maximum sequential organ failure assessment score (SOFA) (Vincent et al., 1996). The duration of mechanical ventilation (MV) was calculated from the time of intubation and commencement of MV (or time of admission to ICU when the patient was intubated before admission) to the time of extubation (or change to spontaneous breathing via a T-piece if patients received a tracheostomy). The SPSS version 17.0 for Windows (SPSS; Chicago, IL) was used to analyse the data.

Findings and experience

There were 343 patients admitted to the ICU during the 84-day study period, compared to 311 during the same period in 2008. Grouping the time of patient admission to ICU into 7-day periods from the admission day of the index case, the majority of admissions occurred between mid July and mid August (Fig. 1). The H1N1 virus was confirmed by means of a polymerase-chain reaction (PCR) assay. Initially testing was challenging as the standard test, PCR, used for throat and nose swabs, had a reduced sensitivity to detect the virus in patients with severe respiratory disease. Detection improved by testing sputum and bronchial lavage specimens using nucleic acid detection tests. Recent influenza A infection was also confirmed by the presence of high antibody titres in respiratory serology tests. Of the 39 patients entered into the ICU 'INFINITE' registry, 31 were confirmed

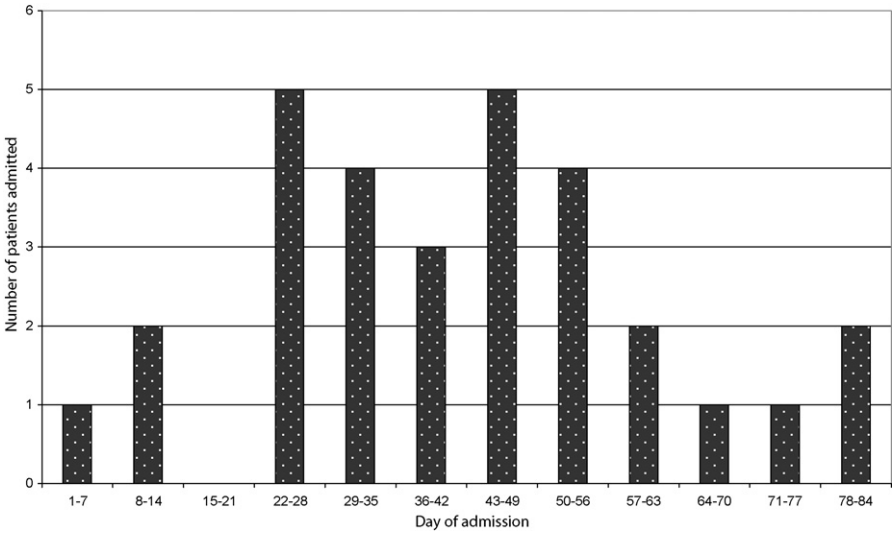

Figure 1 Time of admission grouped into seven-day periods from the admission to ICU of the index case until day 84.

H1N1 influenza cases, six had influenza A and two did not have a confirmed diagnosis. No patients were missed.

The patients were generally young (mean age 42 years, SD 15) compared to other patients admitted to the ICU during the same period (mean age 51 years, SD 20, $p = 0.018$) and the majority were women (61%), of whom two were pregnant. Viral pneumonia was the admitting diagnosis for 12 patients compared to one case in the corresponding period in 2008. Ten patients were admitted with bacterial pneumonia. Other admitting diagnoses included asthma (three patients), cardiac arrest, respiratory arrest and 'other' respiratory illness (one patient each). The median LOS in ICU was significantly longer for the patients with H1N1 (9 days, IQR 4—15, $p < 0.001$) compared to other patients admitted to the ICU during the same period in 2009 (2 days, IQR 1—4) and 2008 (2 days, IQR 1—5). The cohort characteristics are shown in Table 1.

The first patient identified as having HINI was a young woman initially admitted to the HDU where she received non-invasive ventilation. Subsequently she developed severe respiratory failure and required intubation on day three following which she was transferred to an open ICU-bed. Within 12 hours the patient was diagnosed with H1N1 influenza and moved into a negative pressure isolation room with aerosol precautions (including standard precautions, gloves, gown and a PFR-N95 mask). Personal protective equipment (PPE) was donned before entry into the isolation room and removed before leaving the room. Staff who had possible unprotected contact with the patient (at least 30) were advised not to attend work. For those who came to work ($n = 4$), a course of Oseltamivir (Tamiflu) was given and they were sent home. Hence for the early part of this patient's admission, inadequate infection control measures had been implemented.

As the severity of the level of respiratory failure became apparent, several modes of therapy were considered including ECMO (Box 1) and airway pressure release ventilation—APRV (Box 2) (Downs and Stock, 1987; Stock et al., 1987). Seven patients were externally referred for ECMO. One pregnant woman had refractory hypoxia and

Box 1 Extra Corporeal Membrane Oxygenation (ECMO)
Extra Corporeal Membrane Oxygenation (*ECMO*) is an historical name for extracorporeal life support (ECLS) that uses cardiopulmonary bypass technology to provide gas exchange in patients with severe, potentially reversible acute respiratory failure. An external artificial circulation carries deoxygenated blood from the patient to a gas exchange device (oxygenator) and blood becomes enriched with oxygen and carbon dioxide is removed. The blood then re-enters the patient's circulation. Circuit flow may be achieved using a pump (centrifugal or roller) or by the patient's arterio-venous pressure gradient (pumpless). There are two forms of ECMO—veno-venous ECMO and veno-arterial ECMO. ECMO enables ventilator settings to be reduced to provide time for treatment and recovery to occur.

Box 2 Airway pressure release ventilation (APRV)
Airway pressure release ventilation or APRV is a protective lung strategy that uses pressure-controlled mode of ventilation to maintain plateau pressures to no greater than 30 cm H_2O. It has the advantage that the patient is able to spontaneously breathe during the time-high interval, which limits the adverse effects of ventilation (e.g. haemodynamic instability) and potentially redirects ventilation to the more perfused area of the lungs (primarily from diaphragmatic plate movement). This mode of ventilation also has the advantage of slow lung recruitment over 12 hours enabling the FiO_2 to be titrated down to a safer level. Time-low is kept at a relatively short period of time (0.6 seconds) to prevent de-recruitment of the lung at end exhalation and is manipulated to provide the required PEEP (positive end expiratory pressure) for the patient.

Table 1 Cohort characteristics ($n = 31$).

Characteristic	Value
Mean age in years (SD)	42 (15)
Females	65%
Mean worst in 24 hour APACHE II score (SD)	18.8 (8.5)
Mean admission SOFA score (SD)	7 (4.2)
APACHE III comorbidity	6%
Intubated	87%
Median Body Mass Index (IQR)	27 (23—34)
Median days of mechanical ventilation	9 (3—21)
Median LOS in ICU (IQR)	9 (4—15)
Median LOS in hospital after ICU discharge (IQR)	16 (7—30)
Median LOS in hospital (IQR)	15 (7—26)
ICU mortality	$n = 3$ (10%)
In-hospital mortality after ICU discharge	$n = 1$ (3%)

APACHE, Acute Physiology and Chronic Health Evaluation; SD, standard deviation; IQR, interquartile range; LOS, length of stay; *n*, number of patients.

Box 3 Example of the ventilatory approach using airway pressure release ventilation (APRV)

A teenager presented with a flu-like illness and was ventilated on APRV with an upper pressure limit of 26 cm H_2O, PEEP of 7.5 cm H_2O and FiO_2 of 0.8. Her PaO_2 was 70 mm Hg (9.3 kPa) with an oxygen saturation of 94%. She was positioned right side up and commenced on Tamiflu on arrival. Her haemodynamic instability required vasopressor support to maintain her mean arterial pressure greater than 65 mm Hg. Her urine output was 50 mL per hour. Oxygen saturation was maintained at 95% but her PaO_2 was only 68 mm Hg (9.1 kPa). When attempting to lower her FiO_2 and upper pressure limit, her PaO_2 decreased to 48 mm Hg (6.4 kPa) and her FiO_2 was increased to 0.8. She was ventilated on APRV for 3 days and weaned to pressure support ventilation (PSV) on day 4. However, after 8 hours on PSV she deteriorated, with $PaCO_2$ retention. She was put back onto APRV and her $PaCO_2$ was maintained at around 50 mm Hg (6.7 kPa). The next day she was put onto PSV, but failed to wean and her APRV was recommenced for a further two days. She was weaned to PSV on day 8 but again failed after 16 hours and went back to APRV at similar levels to prior to PSV. She received a tracheostomy at this time. On day 10 she was trialled on PSV and over the next 3 days she was weaned to be successfully decannulated on day 13.

a PaO_2 of 49 mm Hg (6.5 kPa). Initially she was managed on APRV with inspired oxygen concentration of 100%, Pressure High (Continuous Positive Airway pressure [CPAP] high) 28 cm H_2O and Pressure Low (CPAP low) of zero. The patient was placed on a Pressure low of zero as this allowed the patient to expire without any impedance to expiratory flow (the patient's breathing) from the ventilator and therefore facilitated CO_2 excretion. Her inspiratory time was set at 4 seconds and her expiratory time 0.6 seconds which gave her a frequency of 12 breaths per minute, preventing complete alveolar collapse. The intrinsic positive end expiratory pressure (Auto PEEP) of 10 cm H_2O was set at an alveolar level and therefore it did not impede expiration. When PEEP is set on the ventilator, it impedes the expiratory gas flow from the patient and consequently the CO_2 clearance. By removing the ventilator-set PEEP, there is no impedance to the gas flow from the patient and enables CO_2 clearance. In APRV, the setting for time low is short. This deliberately causes air trapping that results in intrinsic PEEP equivalent to the amount generated by the ventilator but this is at alveolar level (in the lungs) and not at ventilator level. The intrinsic PEEP does not cause impedance to gas flow from the patient. Provided acceptable pH, $PaCO_2$ and lactate levels were maintained by the patient, a PaO_2 of 50—60 mm Hg (6.7—8.0 kPa) was accepted. Utilising this mode of ventilation the patient avoided ECMO and made a full recovery with a viable pregnancy.

Airway pressure release ventilation was used as opposed to other ventilatory modes or early ECMO because this lung protective ventilation strategy utilised a pressure controlled mode of ventilation. It enabled the patient to breathe spontaneously during the 'time-high' interval, which limits the adverse effects of ventilation (e.g. haemodynamic instability) and potentially redirects ventilation to better perfused areas of the lung base. This mode of ventilation also has the advantage of slow lung recruitment over several hours enabling the FiO_2 to be titrated down to safer values as arterial blood gases improved. 'Time-low' was kept short (0.6 seconds) to prevent de-recruitment of the lung at end-exhalation and manipulated to provide the required PEEP. Seven patients received APRV and three of these also received nitric oxide as rescue therapy, two of who died in ICU. A further example of this ventilatory approach is contained in Box 3 .

The infection control approach in the ICU was expanded after the initial experience. Any patient admitted with an influenza-like illness was isolated to minimise the risks from aerosolisation and intubated patients had inline closed suction. In-line ultrasonic nebulisation was also used for intubated patients, but for non-intubated patients metered dose inhalers were used. This was a critical infection control action during the pandemic. A flow chart of admitting a patient with suspected H1N1 is shown in Fig. 2.

Fit testing of PFR-N95 masks was undertaken as each staff member presented for work. Staff with beards were excluded from caring for these patients as they could not obtain a proper seal with the mask. The PFR-N95 masks caused pressure areas on the bridge of the nose of most staff and in some cases along the cheeks with extended wear. This meant that some staff were unable to care for these patients for longer than two hours at a time. Two different types of mask were sourced. While one apparently was less likely to create pressure areas on the bridge of the nose, this problem was never completely eradicated. The ICU had sufficient supplies of gowns and gloves, but the supply of the PFR-N95 masks ran low requiring additional supplies to be sourced. Pregnant staff ($n = 2$), as a precaution, were allo-

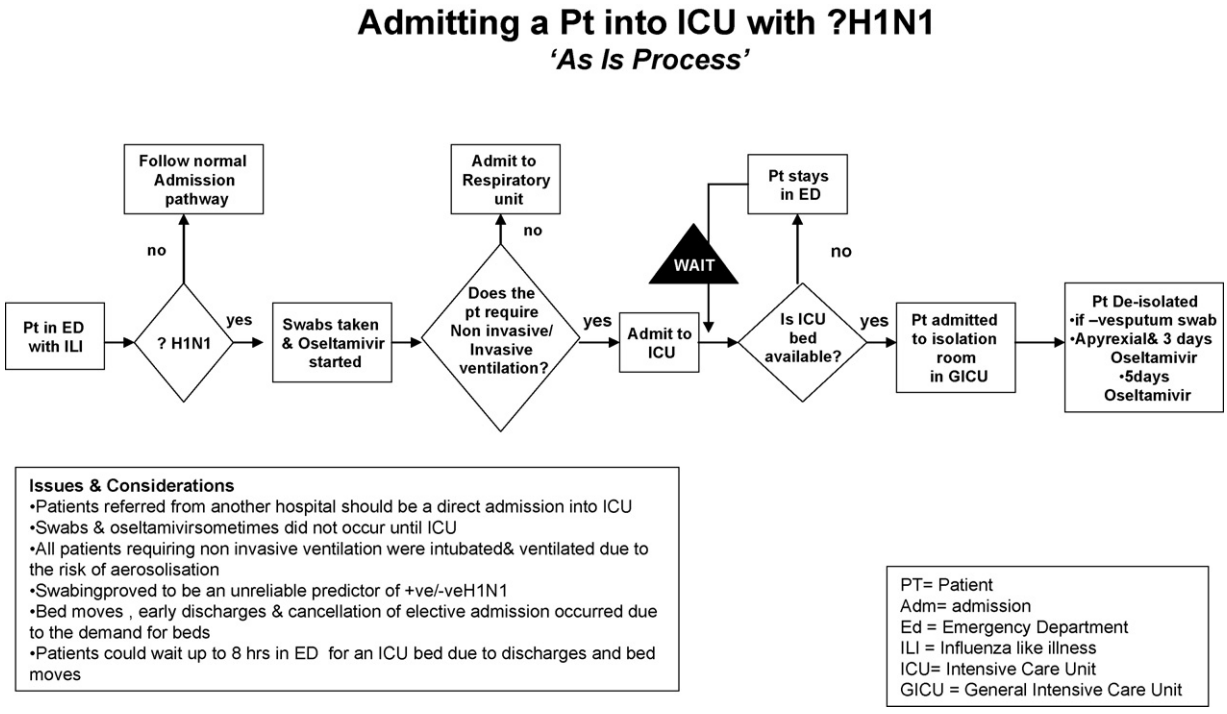

Figure 2 Admitting a patient into ICU with suspected Influenza H1N1.

cated to work in the surgical area of ICU where there were no H1N1 patients.

Visitors were not restricted during the pandemic but they were advised not to bring young children into the unit. Visitors were instructed in the infection control precautions that included mask fit testing before entering the patient's room.

Availability of isolation rooms was a problem because all suspected cases of H1N1 were nursed in an isolation room. The ICU occupancy during this time ranged from 82 to 109% (mean 98.3%). The occupancy was considerably higher in 2009 when compared to the previous year (Fig. 3). The increased demand for isolation rooms required frequent moving of patients from one bed area to another; up to six patients within a 24-hour period.

Clearance from isolation precautions was facilitated by treating every ICU admission with 'flu-like' symptoms as if they were positive for H1N1 and giving Tamiflu even if results initially were negative. Early on in the pandemic the medical Head of Department liaised with other Australian ICU specialists and decided that patients may be cleared from isolation after 72 hours of Tamiflu regardless of pyrexia. This was later changed to clearance from aerosol isolation after 72 hours if the patient was apyrexial or after five days regardless of the temperature, facilitating the transition of patients out of isolation rooms. If the results came back negative, Tamiflu was stopped. Patients admitted from the ward who had flu-like symptoms for a day or more and not treated with Tamiflu delayed freeing of isolation rooms.

For patients whose PCR results indicated a lower respiratory tract virus, a negative sputum or bronchoscopy specimen was required for clearance. Initially these samples were processed off-site with long reporting times (2—5 days) but after the first week in-house analysis resulted in same-day or next-day reports.

The ICU bed capacity was increased to cope with the demand, from 22 to 24 beds. An alternative staffing model was developed in case the ICU reached the maximum capacity of 24 patients, but this model was not adopted during the pandemic as the ICU only briefly went to 24 beds and were able to manage within existing resources. There were no refusals of admission to ICU or transfers to other hospital ICUs but elective surgical admissions were managed on a 'day-before' triage system, that is, elective cases were reviewed the day before the planned surgery to see if they should proceed. If the elective surgery demand was high, then cases were cancelled.

Planning for surge capacity (Cutter and Cutter, 2008; Department of Health, 2007; Scalera and Mossad, 2009; The Scottish Government, 2008) was undertaken to prepare for bed capacity being exceeded in the ICU. While the plan was to initially isolate all the patients with H1N1, if the capacity exceeded the number of isolation rooms an escalation plan was to seal off one of the ICU areas with plastic sheeting (floor to ceiling), preventing its use as thoroughfare and making the area available for H1N1 cases. If further capacity was required, the plan was to surge into the HDU (eight ventilator capable beds) and the HDU would move to another area within the hospital.

Planning for surge capacity also included recalling staff who were on secondment out of the ICU, activating the disaster list (global mobile phone text message) and utilising available casual and agency staff. A further pool of nurses that was considered included ex-graduate nurses who had completed a six-month rotation in ICU within the last 18 months. Other staffing initiatives included: up-skilling non-ICU staff using an 'on the job' teaching model; utilising non-trained ICU nurses to work next to a trained ICU nurse and have responsibility for the basic nursing care of the patient, while the experienced ICU nurse would

Figure 3 Comparison of ICU occupancy 2009 to 2008.

make decisions on sedation, vasopressors, ventilation and other specific advanced ICU care of the patient. The ICU also explored increasing the nurse to patient ratio as a last resort. A plan was discussed to initiate formal training but it was decided to progress with the 'on the job' model as the formal training required greater resources. The surge capacity plan was never enacted although at the peak of the pandemic activity just one more admission would have initiated the plan. A summary of the issues arising and strategies implemented are shown in Table 2.

Staff were required to spend up to 12 hours in an isolation room with aerosol precautions. To minimise fatigue, staff were given the opportunity to nurse a different patient mid-shift when the H1N1 case numbers were low, but this opportunity became unavailable as the number of admissions to the ICU increased. To help maintain staff morale and prevent fatigue and stress, extra relief was provided to

Table 2 Issues arising and strategies implemented.

Issue	Strategies implemented
Fear of contracting H1N1	Aerosol precautions for all suspected cases
Staff developing flu-like symptoms	The hospital conducted a General Practitioner clinic that allocated a protected timeslot for staff with flu-like symptoms
Staff allocated to isolation room for 12-hour shift	Staff were offered to change patient allocation mid-shift and breaks were given every 2—3 hours
Uncomfortable masks (PFR-N95)	PFR-N95 masks were uncomfortable and some staff developed pressure ulcers. More comfortable PFR-N95 masks were sourced for the staff caring for the patients for long periods
Minimising risk of transmission of H1N1 to pregnant staff	Pregnant staff expressed concerns about safety at work. Pregnant staff were allocated to work in the surgical area of ICU (no H1N1 cases) during the pandemic
Inconsistency of information	A central point of communication was identified to improve communication between the ICU, infection control department and Health Department
Increased workload	Demand for beds and infection control precautions led to frequent bed moves. ICU Clinical Nurse Specialists and Staff Development Nurses worked clinically to assist and support the clinical nursing staff
Maintenance of morale	Developed consistent plan, support for staff and staff kept informed. Staff worked as a team to meet the challenge. Regular cakes and lollies also helped

staff working in isolation rooms. This included two-hourly breaks and provision of food and refreshments. Senior ICU nurses worked on the floor as a first priority to help and support bedside staff during this period.

Inconsistency of information in the early stage of the pandemic placed further stress on the staff and reduced staff morale. Staff were unsure as to the severity of illness and the information that was provided changed rapidly. Maximum infection control methods were initiated early in the pandemic to minimise the risk for infection and allay anxiety among patients, staff and visitors. In addition senior staff, medical and nursing, liaised openly and quickly with hospital administrators via a specific hospital-wide committee.

Discussion — lessons learnt

This report describes the issues arising and lessons learned in an Australian ICU with the H1N1 pandemic that occurred during the Southern Hemisphere winter 2009. A considerably higher proportion of patients with viral pneumonia were admitted in 2009 compared to the previous year. The majority of cases were admitted to ICU between mid July and mid August and stretched critical care resources to the limit. The extra workload lasted for several weeks, consistent with reports from other centres in Australia and New Zealand (ANZIC Influenza Investigators, 2009). At the peak of the pandemic, when it was believed that the surge plan would have to be implemented, the number of admissions to ICU with H1N1 decreased abruptly. This sudden decrease was similar to the pattern of admissions seen with seasonal influenza at the end of the winter season.

Staff perceived the media and health authorities played down the seriousness of the pandemic in Australia. Although there was cancellation of some elective surgery because of unavailability of ICU beds, some medical staff were uninformed to the extent of the pandemic and the constraints upon ICU. Consequently there may have been unnecessary referrals to the ICU. Better communication and adherence to ICU admission criteria are essential to ensure that only the sickest patients who require intensive care are admitted to maximise intensive care resources.

Planning for future epidemics will benefit from the lessons learned from recent outbreaks of new infectious disease that include the severe acute respiratory syndrome (SARS) in 2002 (Lew et al., 2003) and the H1N1 pandemic in 2009. When an outbreak of new infectious disease occurs, the population has no innate immunity and there is no vaccine to protect staff, patients and the community. Preparedness for a pandemic by the Australian Government (Horvath et al., 2006) included the manufacture of sufficient vaccine for the entire Australian population on confirmation of a pandemic, but several months were required before it was available. During this lag time, adherence to infection control practices, particularly aerosol precautions was vital. The ICU was proactive in implementing strict infection control measures early to protect patients and staff. Nevertheless there was significant confusion, inconsistency and concern about risks to staff and appropriate precautions in the early stages of the index admission. Patients were placed into isolation with full aerosol precautions although the criteria to remove these precautions were inconsistent. Antiviral therapy was also commenced as soon as possible which is crucial in reducing illness among patients with seasonal influenza (Harper et al., 2009).

The isolation of any patient with flu-like symptoms necessitated a demanding workload for staff to move beds and patients within the ICU to accommodate aerosol precautions. While infection control practices for isolating patients were well established in the ICU before the pandemic, the ICU did not have a mask fit-testing program in place prior to the pandemic. In future all ICU staff should be fit-tested

on induction to the hospital so that maximum infection control methods can be implemented rapidly. Large numbers of consumables such as PFR-N95 masks should be stockpiled to ensure adequate supply. It is important that staff are able to demonstrate appropriate infection control practices to maximise patient safety and facilitate effective care in times of crisis. Suboptimal levels of adherence levels in the correct use of PPE have been reported (Daugherty et al., 2009).

Visitors were also required to practice infection control precautions including a fit test for the PFR-N95 masks. Upon reflection, it may have been beneficial to limit the visitors to two close relatives in order to prevent contamination from visitors to patients who were situated in the open area of the ICU although this did not appear to create a source of infection spread.

Care of the staff is important. For example staff initially presenting with flu-like symptoms were told to go to their general practitioner (GP) but subsequently a 'flu' GP clinic was set up for staff at the hospital. This clinic dedicated a time period in the early evening for staff only. This was instigated by the Director of Clinical Services after discussion about concerns of staff safety and morale as it was a major problem hospital wide. Strategies to maintain staff morale, allay anxiety and minimise fatigue must be an integral part to successfully manage an outbreak.

The ICU developed a surge plan to cope with the volume of admissions to ICU. If ICU capacity was exceeded critically ill patients would be cared for away from the ICU. This can be quite challenging although some of the staff had experienced re-locating to HDU during a Vancomycin Resistant Enterococci (VRE) outbreak some years previously. Staffing issues were also addressed in the surge plan. Critical care nurses have a highly developed clinical skill set and ongoing clinical experience is necessary to maintain the competencies to provide safe and effective care (Hynes, 2006). Finding enough adequately trained critical care staff can be challenging, particularly if staff also become ill. Alternative models in providing care must be evaluated in the planning process.

Conclusion and recommendations

This study found that the large proportion of patients who are critically ill with H1N1 can place extraordinary demands on ICU resources. Optimal management requires rapid mobilisation of infection control resources and practices, early administration of antivirals on a degree of suspicion basis, adequate support strategies for staff and contingency plans to extend ICU beyond traditional boundaries. These should be established and practised prior to an outbreak. Effective communication with all the key stakeholders is essential.

Conflict of interest

There are no conflicts of interest.

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