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Clinical Update

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SPECIAL EDITION

Air Leaks in H1N1 Influenza

When a novel influenza strain appeared in the U.S. in the spring of 2009, healthcare professionals worried that hospital and critical care units would be overwhelmed with patients. In the months since, a picture of this new strain, H1N1, has developed.

Two characteristics of a virus are monitored by epidemiologists: how easily the virus spreads and the severity of the illness that results from infection. H1N1 looks like an easily spread virus, but it does not appear to be more serious than seasonal flu. The greatest difference is that H1N1 hits younger people than does seasonal influenza. Persons over age 65, who account for 90% of seasonal influenza deaths, have experienced only 11% of H1N1 deaths[1].

The Centers for Disease Control and Prevention (CDC) provides weekly updates of influenza activity at http://www.cdc.gov/h1n1flu/update.htm. As of October 17, 2009, CDC estimates approximately 22 million Americans have had H1N1 influenza since April, about 98,000 were hospitalized and about 3,900 people died from influenza-related complications (compared with an estimated 36,000 annual deaths from seasonal influenza)[1]. Early on, public health officials encouraged viral testing of suspected cases, but once the disease became so widespread, diagnosis has been made by symptoms alone. Millions of people have been ill but didn't seek care, so CDC considers these estimates low[1].

Critical Illness

This fall, a number of reports were published describing the clinical course of people who became critically ill with H1N1 infection. That alone is remarkable — that researchers began robust data collection from the beginning of the pandemic and journals sped up the review process to disseminate information as soon as possible. It seems as if there is little moderate illness — people are either able to stay home and recover, or they are critically ill.

Critically ill patients with H1N1 have had rapidly progressive lower respiratory infection resulting in respiratory failure, acute lung injury (ALI) and fulminant ARDS. The most severely ill patients had BMI>30 and severe obesity with BMI>40[2]; in fact, obesity was the most common comorbid condition and often the only comorbidity (see Table 1). Mean or median age ranged from 32-46 years[2,3,4,6]; and patients experienced shock and multiorgan dysfunction syndrome (MODS)[3,4,5]. Patients in the cohort from Australia and New Zealand who required ECMO were young adults, pregnant or postpartum, and obese[6].

Patients with H1N1 ARDS required advanced mechanical ventilation with high mean airway pressures; despite high levels of PEEP (>10cmH_2O)[4] and high FIO_2 many had refractory hypoxemia[2,3]. Rescue therapies including prone positioning, high-frequency ventilation and extracorporeal membrane oxygenation were also used in this young, otherwise healthy population[2,4,6]. Sixty-eight Southern hemisphere patients were treated with ECMO in 2009 compared with four in 2008[6]. Autopsy on patients who died showed bilateral severe hemorrhagic viral pneumonitis with interstitial inflammation and diffuse alveolar damage[2,5].

Barotrauma Significant Problem

The multicenter Mexico series reported a 10% incidence of barotrauma[3]; it was 8.3% in Canada[4] compared with an overall 6% in all patients with ARDS[7]. Given that ARDS from H1N1 strikes younger people, and ALI and ARDS are more common in older people, consider barotrauma a significant comorbidity in H1N1 patients.

Air Leaks are Dangerous

Barotrauma is the clinical term for air outside the alveoli, including subcutaneous air, pneumopericardium, pneumomediastinum, pneumoperitoneum, and tension pneumothorax[7,8]. Lung disease in ARDS, particularly when associated with a viral pneumonia, is patchy; it is not evenly disseminated throughout both lungs. Thus,

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mechanical ventilator pressure and volume are not uniformly distributed and patients will have regional differences in pulmonary compliance throughout the lung[7]. The overdistention of only some alveoli can create a pressure gradient that allows air to leak out of the air sacs and to dissect along the vascular system and into the mediastinum[7]. If there is resistance to air flow along this pathway, air can extend into subcutaneous tissues, causing subcutaneous emphysema. The worst case scenario is a leak of air into the pleural space. Patients on maximal ventilatory support can progress to tension pneumothorax and cardiovascular collapse very quickly[7].

Nursing Assessment is Key

Nurses play a key role in identifying extrapulmonary air early, which can be life-saving. Most of these patients will be sedated while receiving mechanical ventilation, so they will be less able to communicate symptoms. The nurse needs to frequently palpate for crepitus indicating subcutaneous emphysema over the chest wall, the supraclavicular space, and up into the neck and face. Note any signs of new respiratory distress, such as tachycardia, diaphoresis and accessory muscle use. Auscultation may or may not be helpful. Hamman's sign, described as crunchy, bubbling, popping, crackling, clicking, or popping sound in the chest can be associated with pneumomediastinum or pneumothorax[8]. If present, it should be investigated but its absence does not mean the patient is free of barotrauma. Clinicians are typically taught that breath sounds are absent with pneumothorax, but sounds are often transmitted from other areas of the chest. Similarly, the traditional tracheal shift may not be felt when the endotracheal tube anchors the trachea in the midline. Look at the chest to see if the affected side is fixed in the inspiratory position[7,8]. Asymmetrical chest movement can signal pneumothorax. In critically ill patients with maximum ventilatory support, these signs can be very subtle.

When monitoring the ventilator, a pneumothorax can cause a sudden decrease in pulmonary compliance[7]. Additionally, the pressure manometer may not return to the PEEP baseline as air accumulates in the pleural space under pressure.

An acute, profound drop in blood pressure or cardiac arrest may be the first sign; pulseless electrical activity should be attributed to tension pneumothorax in the H1N1 patient with ARDS until proven otherwise[7,8].

Pressure Relief STAT!

If a patient has hemodynamic compromise and physical assessment indicates tension pneumothorax, an emergency needle thoracostomy can be live saving. An 18 gauge or larger needle is placed in the second intercostal space in the midclavicular line to vent the pressure building up from the pneumothorax and buy time while equipment is set up for an urgent tube thoracostomy[7].

A disposable, latex-free, prepackaged chest tube insertion kit that contains everything needed for the procedure except the chest tube will save time when minutes count in the most critically ill patients. All the nurse needs to do is grab the kit, the tube and the drain, open the kit on a Mayo stand or bedside table, and the clinician can put on sterile gloves and continue from there. While the clinician is inserting the chest tube, the nurse can set up the chest drain to which the tube will be attached.

As we approach the peak time for seasonal flu in the Northern hemisphere, public health officials are concerned that seasonal flu combined with H1N1 will significantly increase the number of critically ill patients requiring ventilator support this winter. Knowing that there is a higher incidence of barotrauma being reported in young adults with H1N1 and severe ARDS will help nurses target assessments to identify the presence of extrapleural air and to intervene to prevent deaths from treatable pneumothorax.

Table 1

Study	Age (Mean* / Median^)	BMI (Mean* / Median^)
Australia & New Zealand ECMO[6]	36^	29^
Australia & New Zealand No ECMO[6]	44^	29^
Mexico[5] one hospital	38*	29*
Canada[4]	32*	30^
Mexico[3] 6 hospitals	44^	30^
Michigan[2] referral center	43*	47*

Sources

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