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ATRIUM Clinical Update

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Air Transport for Patients with Chest Tubes and Pneumothorax

Flying in helicopters, fixed wing propeller planes, and commercial jets has the potential to cause serious complications for patients with pneumothorax. In follow up to our Clinical Update (Sept. 2006) on managing chest drains in hyperbaric chambers, this issue will focus on the effects of altitude on patients with air leaks.

Civilian medical evacuation helicopters typically fly 500 to 1000 feet above the ground; altitude above sea level will depend on the starting elevation (e.g., Denver is at 5000 feet above sea level; New York City is at sea level.) Smaller fixed-wing aircraft range in altitudes between 2,400 and 15,000 feet. While commercial aircraft fly at altitudes between 24,000 and 40,000 feet, the pressurized cabin is equal to approximately 8,000 feet above sea level – still higher than routine helicopter flight[1]. Thus, the effects of the decreased atmospheric pressure at altitude will be more significant in commercial aircraft compared with helicopters.

Physics of Pressure and Altitude

Boyle's law states that when temperature is constant, the volume of gas in an enclosed space is inversely proportional to the pressure. That is, under less pressure, the volume increases. At sea level, barometric pressure is approximately 760 mmHg. At 8,000 feet, that pressure drops to 565 mmHg, a drop of 26%[1]. Barometric pressure is lowest closer to the North and South poles and with lower ambient temperature[2]. An untreated pneumothorax would increase in size by at least 26% in a patient in a pressurized commercial jet compared with baseline on the ground. Air trapped in the abdomen will also expand, causing distention and limiting diaphragm movement, potentially causing respiratory distress[3,4]. In fact, air in any part of the body will increase in volume; that's why many passengers experience ear pain during flight due to pressure on the eardrum if the eustachian tube is blocked, preventing pressure equalization. See box below for effects of gas expansion in flight.

Gas Expansion With Altitude Effects[1,2,5]

- Pneumatic splints
- Airway tube cuffs inflated with air
- Air in IV bottles
- Intra-aortic balloons
- Bronchogenic cysts and bullae
- Abdominal wounds; potential dehiscence
- Cranial fracture
- Intraocular air

Changes in barometric pressure will also affect oxygenation. At sea level, under optimal conditions, inspired PO_2 is 149 mmHg, resulting in a PaO_2 of 100mmHg. In a pressurized jet cabin, inspired PO_2 drops to 109mmHg with a maximum PaO_2 of 73 mmHg (the equivalent of breathing 15% oxygen at sea level[5]). This drops oxygen saturation from 89% to 90% – the point on the oxyhemoglobin dissociation curve at which small drops in PaO_2 result in large drops in saturation[1,4]. Healthy individuals will tolerate these changes well, but persons with cardiopulmonary disease or other conditions sensitive to hypoxia, such as sickle cell anemia, may become symptomatic.

Flying After Spontaneous Pneumothorax

The American College of Chest Physicians and the British Thoracic Society have each published guidelines for management of pneumothorax, as discussed in a review article by Baumann[6]. While there is some disagreement about how to reduce the risk of spontaneous pneumothorax recurrence, the guidelines agree that patients without an active intervention, in whom pneumothorax is allowed to resorb, should not fly until 7 days after follow-up imaging shows compete resolution of the air leak[5]. After traumatic pneumothorax, patients should wait two weeks after resolution[5]. Commercial airlines advise air travelers to wait 6 weeks between diagnosis of a pneumothorax and flying. Patients with recurrent spontaneous pneumothorax should avoid flying for a year unless definitive surgical treatment to resolve the underlying cause of the pneumothorax occurs[6].

Preparing Patients for Air Transport

Patients with untreated pneumothorax are at risk for significant expansion of the trapped air at altitudes which can change a small, clinically insignificant pneumothorax into a life-threatening tension pneumothorax. Increasing intrapleural pressure can cause desaturation and hemodynamic compromise[5,7]. In-flight chest decompression is fraught with hazard and should be avoided if at all possible.

With the recent introduction of mobile chest drains, it is even easier for clinicians to manage chest tubes during transport. The Pneumostat provides a one-way valve and a contained fluid reservoir for patients with simple pneumothorax and minimal fluid drainage. Patients with more significant fluid drainage can be managed with the Express Mini 500 drain, which provides a collection chamber capacity of 500cc, a one-way valve, an option to use with suction, and safety features present in larger, more traditional drains. Chest tubes in place should never be clamped for flight.

In preparing patients for air transport, it is essential to carefully review a chest radiograph for the presence of extrapulmonary air. Unfortunately, there is no research that predicts the amount of extrapulmonary air that may be acceptable for flight[5]. Other diagnostic imaging such as ultrasound and CT scan may be used to confirm the diagnosis. It is also important to consider the mechanism of injury and the risk for pneumothorax during the transport period. For example, a patient with flail chest (multiple ribs fractured in multiple places) is at high risk for lung injury, even if a pneumothorax is not evident on initial evaluation. Consider the altitude of the planned air transport, the length of the anticipated trip, and whether the patient will require positive pressure ventilation, which increases risk for tension pneumothorax[2].

If there is any question about the presence or size of a pneumothorax, it should be treated before flight.

Sources on page 2.

Clinical Update is an educational newsletter provided by Atrium Medical Corporation and is edited by Patricia Carroll, RN,BC, CEN, RRT, MS.

In The Literature

Tradition or Science?

It's only June, but this is one of the best articles of the year – a real must read for all nurses – *Critical Care Nurse* examines seven common nursing practices and determines which are supported by research and which are not. The practices and the evidence-based recommendations include: instilling saline before suctioning, verifying gastric tube placement, measuring blood pressure, choosing ECG leads, patient positioning and mobility, using the Glasgow Coma Scale for neurological assessment, and managing intracranial hypertension. This comprehensive article, with more than 200 references, provides a head start on updating your policies and procedures.

Source: Rauen CA, Chulay M, Bridges E, Vollman KM, Arbour R: Seven evidence-based practice habits: putting some sacred cows out to pasture. *Critical Care Nurse* 2008;28(2):98-102,104-110,112-118,120-124.

Quality of Life After Traumatic Injury?

The current issue of the *Journal of Nursing Scholarship* includes a research article from Australia that examines health-related quality of life (HRQoL) 3 months after hospital discharge for moderate to severe traumatic injury. The authors use a construct of illness representation that includes: identifying symptoms, perceived progress toward recovery, consequences of the trauma, control over the symptoms and illness, and beliefs about what caused the illness. Learning about HRQoL after hospital discharge can help acute care nurses educate patients about what to expect in the future during their recovery.

Source: Lee B, Chaboyer W, Wallis M: Predictors of health-related quality of life 3 months after traumatic injury. *Journal of Nursing Scholarship* 2008;40(1):83-90.

Are Your Blood Pressures Accurate?

That's the questions researchers tackled in a study described in the current issue of *MEDSURG Nursing*. The nurses compared blood pressure measurements taken in an ambulatory cardiology clinic with patients seated on the exam table with legs dangling and no back support with patients seated in a chair with both feet on the floor, back supported, and arm supported at the level of the heart. Systolic pressures were significantly lower when patients were seated in the chair, and when measurements were repeated with a minimum of 5 minute rest periods during the visit. Diastolic pressures were not affected.

Source: Turner M, Burns SM, Chaney C, et. al.: Measuring blood pressure accurately in an ambulatory cardiology clinic setting: do patient position and timing really matter? *MEDSURG Nursing* 2008;17(2):93-98. An accompanying article discusses the research in the context of the concepts of accuracy, precision and practicality. Connelly LM: Accuracy and precision. *MEDSURG Nursing* 2008;17(2):99-100.

Does Your Unit's Culture Improve Effectiveness?

Jesus Casida, of Wayne State University in Detroit, describes the use of the Denison Organizational Culture Survey (DOCS) in the healthcare setting to assess effectiveness of nursing unit and organizational culture. The four key trait scales are involvement, consistency, adaptability and mission, with indices for each trait. The author recommends using this tool to identify the cultural traits or the units that require attention with the goal of improving measurable organizational outcomes. Casida recommends this tool because other instruments primarily assess only behavior, while the DOCS links traits to effectiveness.

Source: Casida J: Linking nursing unit's culture to organizational effectiveness: a measurement tool. *Nursing Economic$* 2008;26(2):106-110.

Sources from page 1:

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2. Kaczala GW, Skippen PW: Air medical evacuation in patients with airleak syndromes. *Air Medical Journal* 2008 27(2):91-98.
3. James E: Above board: flying with Air Force's critical care air transport team. *Advance for Respiratory Care Practitioners* December 10, 2007. Available online at http://tinyurl.com/3qevvr
4. Parsons CJ, Bobechko WP: Aeromedical transport: its hidden problems. *Canadian Medical Association Journal* 1982;126(3):237-243.
5. Currie GP, Kennedy A, Paterson E, Watt SJ: A chronic pneumothorax and fitness to fly. *Thorax* 2007;62:187-189.
6. Baumann MH: Management of spontaneous pneumothorax. *Clinics in Chest Medicine* 2006;27:369-381.
7. Essebag V, Halabi AR, Churchill-Smith M, Lutchmedial S: Air medical transport of cardiac patients. *Chest* 2003;124(5):1937-1945.

On the World Wide Web

Valuable free publications online this month!

AACN NTI Proceedings

For the first time, AACN has published the NTI Proceedings online. At this link, you can search through an index of all sessions from the 2008 NTI in Chicago, and see the outlines and references for each session taught at this year's NTI. Three cheers for AACN for putting this valuable resource online and available to nurses everywhere! Available online at http://tinyurl.com/5xywm8

Free Evidence-Based Handbook on Patient Safety and Quality

The Agency for Healthcare Research and Quality has published an amazing handbook online with free access for nurses. This joint project by AHRQ and the Robert Wood Johnson Foundation went online at the end of April at http://www.ahrq.gov/qual/nurseshdbk The sections of the book are: Patient Safety and Quality, Evidence-based Practice, Patient-centered care, Working Conditions and the Work Environment for Nurses, Critical Opportunities for Patient Safety and Quality Improvement, and Tools for Quality Improvement and Patient Safety. Chapters, authored by national nursing experts such as Patricia Benner, can be individually downloaded so you can customize the content to your practice area. You will not be disappointed by the wealth of information available online from this comprehensive, practical resource.