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Clinical Update

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Loculated Pneumothorax: A Special Challenge In Critical Care

What Is a Loculated Pneumothorax?

A loculated pneumothorax is a pocket of pleural air trapped in a small area. In one study, the diagnosis of a loculated pneumothorax was made when a pneumothorax persisted despite treatment with a chest tube in the pleural space on the same side, or a collection of air in the pleural space was in an area requiring image-guided drainage (1).

In otherwise healthy patients, air escaping into the pleural space can move around on the affected side and typically will move to the most anterior, superior position on that side of the chest. However, the situation is very different for critically ill patients with ARDS who require mechanical ventilation. Patients with significant parenchymal lung disease often develop adhesions in the pleural space. These adhesions essentially segment the pleural space into "sections," and a chest tube in one section will not evacuate air in another section-even when the chest tube is functioning properly.

In patients with ARDS who require mechanical ventilation, most loculated pneumothoraces are in the anteromedial and subpulmonic areas (1,2).

Diagnosis Can Be Tricky

While reports vary, approximately 50% of patients with ARDS who require mechanical ventilation will develop a pneumothorax during their treatment. The ARDS damages the lung parenchyma, and the high intrathoracic pressures resulting from mechanical ventilation of stiff lungs contributes to rupture of the diseased lung tissue. Up to 96% of patients who develop pneumothorax while receiving ventilation will progress to tension pneumothorax because the machine blows air out of the hole in the lung into the pleural space with positive pressure. A loculated pneumothorax is considered to be a tension pneumothorax when the pressure within the intrapleural air collection is higher than atmospheric pressure (2).

We are all familiar with the cardinal signs of tension pneumothorax - sudden increase in ventilation pressures, severely reduced breath sounds on the affected side, jugular venous distention, and the dreaded mediastinal shift that results in cardiovascular collapse. However, in patients with severe ARDS and pleural adhesions, most if not all of those signs will be absent. The lung may be so diseased, stiff and noncompliant that it does not fully collapse when air trapped in the pleural space presses on it. If only a small portion of the lung is externally compressed, the mediastinum will not be affected, and breath sounds will remain essentially at the patient's baseline.

Check Your Knowledge...

Q. What impact will a dependent loop in the patient tubing have on fluid drainage out of the chest?

Answer on other side

Therefore, radiographic evidence of extrapulmonary air collections becomes even more important in this group of critically ill patients. However, even daily chest radiographs can miss small loculated pneumothoraces. Two studies reported by Chon and colleagues (2) reported that in critically ill, mechanically ventilated adults, 33% to 50% of "missed" pneumothoraces (that is, pneumothoraces too small or subtle to be seen on the radiograph until retrospective review) progressed to tension. Even small areas of compression on the lung can have a significant impact on pulmonary function when the lungs are so dysfunctional to begin with.

Boland and associates (1) performed chest CT scans on six patients with severe ARDS to assess the underlying parenchymal disease or to evaluate the extent of pneumothoraces identified on portable chest radiographs. Six additional loculated air collections not seen with traditional radiography were identified with CT scan. Patients with pneumothorax did not have the traditional signs - the most repeatable finding was a subtle drop in oxygenation measurements. All patients showed an improvement in PaO_2 within 24 hours of chest tube insertion and pneumothorax resolution.

Treating Loculated Pleural Air Collections

In otherwise healthy patients, treating a pneumothorax is relatively easy; the chest tube is inserted in the mid-axillary line and directed anterior and superior to the location of the air. Since there is communication throughout the pleural space, the exact location of the chest tube is not critical. This is not the case with loculated pneumothorax. By definition, a loculated collection of pleural air is in a small, well-defined area, typically walled off by adhesions around the lung. Therefore, it can be nearly impossible to use routine chest tube placement techniques and expect to place the catheter in precisely the correct location.

Fluoroscopy has been used in the past to direct drainage of pneumothoraces. In this subset of critically ill patients, however, CT imaging guidance may become the more favored approach because its three-dimensional view allows the location of the air collection to be pinpointed more precisely. Chon and colleagues (2) describe their procedure this way: after an initial diagnostic CT scan, an 18-gauge needle is inserted into the air collection, and proper positioning is confirmed by aspirating air and by repeat CT scan with the needle in place. Once proper positioning is assured, a guidewire is inserted into the loculated area, and dilators are passed over the guidewire in progressively larger sizes in order to form a soft tissue tract through which a 28 French chest tube is ultimately placed. After insertion, the chest tube is connected to a traditional chest drainage system.

Keep a Sharp Lookout

Loculated pneumothorax provides only subtle clinical clues. The only clinical evidence may be deteriorating oxygenation without another obvious cause. Be prepared for chest CT scans for these critically ill patients to better evaluate their lung disease and to identify and treat this hard-to-catch complication of mechanical ventilation in patients with ARDS.

In The Literature

Helping Nurses Use Research at the Bedside

As we strive to move from basing our nursing practice on "the way it's always been done" to research or evidence-based practice, it's important for bedside nurses to know how to interpret research findings and apply them to practice. Some nurse managers have instituted journal clubs. These meetings, facilitated by nurses who can evaluate and interpret nursing research, encourage clinical nurses to read research studies and discuss them with colleagues so everyone learns more about nursing research: what constitutes a good study, and how to determine if there are problems with a research paper.

Since registered nurses can have either a diploma, or an Associate or higher degree, their level of formal education about research can vary from not studying research at all in nursing school to designing studies of their own. Lynn Rasmussen and her colleagues in Kansas City, Missouri, published an article describing what they call the "Basic Research Review (BRR) Checklist." They designed this tool to help nurses quickly critique research studies. There are two versions: one for qualitative research and one for quantitative research. Aspects evaluated include the purpose of the study, literature review, methods and procedures, results and conclusions.

The BRR Checklist provides an ideal starting point for helping staff nurses interpret published research and evaluate whether selected studies should be used as a basis for changing practice policies or procedures. The tool would also be a helpful road map for any nurse in graduate school or one completing a BSN who is taking a research course.

Source: Rasmussen L, O'Conner M, Shinkle S, Thomas MK: The basic research review checklist. *Journal of Continuing Education in Nursing* 2000;31(1):13-17.

Excuse Me? Was That Groovy, Cool or Phat?

The average age of today's nurse is the early 40s. But nurses of all ages need to work together effectively. All nurses also experience stress in the workplace. What is interesting, though, is that nurses of different generations experience stress in different ways. Susan Santos and Karen Cox explored the factors influencing occupational adjustment related to workplace stress in a pediatric hospital. The nurses were surveyed and stratified into groups by age: those born between 1909 and 1945 were considered the Mature generation (4 %), those born between 1946 and 1964 were the Boomers (43%), and the Xers were born between 1965 and 1981 (41%). (Twelve percent of nurses surveyed did not provide their year of birth.)

The authors were able to rank common stressors in order of severity for all nurses. When the data were examined by generational group, however, the Boomers had significantly higher mean scores on stress scales of *role overload*, when resources exceeded demand, and *role boundary*, where there were conflicting demands and loyalties. Matures had significantly higher mean scores in the area of *role insufficiency*, where job demands exceeded training and skills, and Xers had significantly higher mean scores in *physical environment* stress, where the workplace itself provided the highest stress. The authors further describe the generational differences on measurements of strain and coping as well.

Santos and Cox followed up their survey data with focus group interviews to further clarify sources of discomfort and effective coping strategies so that interventions could be more specific and constructive. What emerged from the focus groups was a negative, severe conflict between Boomers and Xers from the Boomers' perspective. The authors write that the intensity of the perceptions was compelling.

This article is a must read for nurse managers at any level who wish to enhance intergenerational understanding as a means of reducing workforce stress on a nursing unit.

Source: Santos SR, Cox K: Workplace adjustment and intergenerational differences between matures, boomers and Xers. Nursing Economics 2000;18(1):7-13.

On the World Wide Web...

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This web site is the "parent" site of 57 communities that range from energy to food and packaging to manufacturing to healthcare. Healthcare sites include news in the industry, regular columns and features written by experts in various fields, discussion boards and e-commerce. You can link to any site from this home page. Health care sites include dentistry, home health, hospitals, long-term care provider, and the following site, nurses.com.

www.nurses.com
This site, part of the VerticalNet communities, is a home for all nurses, regardless of practice area. Editor Lou Pilla keeps nurses up-to-date with regular reports of top headlines for the nursing community and oversees a group of expert columnists on topics including: legal briefings, IV Q&A, medication errors, sharps safety, advanced practice and women's health. There are also audio interviews, and the editor attends and reports live from major conventions. The editor of Clinical Update, Pat Carroll, writes the *Career Corner* and *Manager's Roundtable* columns for this site. Look for the series of columns on *The Nurse Manager's Role in Product Selection* beginning in October.

Check Your Knowledge...

A. A dependent loop, in which fluid has to flow "uphill" to get into the chest drain's collection chamber can severely hamper drainage. Dependent loops should be avoided; the tubing should be coiled on the bed with straight gravity drainage to the chest drain.

References: Loculated Pneumothorax

(1) Boland GW, Lee MJ, Sutcliffe NP, Mueller PR: Loculated pneumothoraces in patients with acute respiratory disease treated with mechanical ventilation: preliminary observations after image-guided drainage. *Journal of Vascular and Interventional Radiology* 1996;7(2):247-252.

(2) Chon KS, vanSonnenberg E, D'Agostino HB, O'Laoide RM, Colt HG, Hart E: CT- guided catheter drainage of loculated thoracic air collections in mechanically ventilated patients with acute respiratory distress syndrome. American *Journal of Roentgenology* 1999;173(5):1345-1350.

(3) Klein JS: Interventional techniques in the thorax. *Clinics in Chest Medicine* 1999;20(4):805-826.

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