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ATRIUM Clinical Update

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Chest Drainage Tube Positioning: Avoid Dependent Loops

When caring for patients requiring chest drainage, nurses must not only understand concepts of physiology, but also the physics of air and fluid flow through the tubes that make up the chest drainage system.

Fluid Can't Flow Uphill

Nurses manage patients with fluid flowing through tubes on a daily basis. The physics are the same for intravenous (IV) tubing, a Foley catheter drainage tube or a chest drainage system. A dependent loop of tubing occurs when the tubing forms a U-shape that requires fluid in the tube to flow against gravity to reach the distal end of the tube, either at the patient (for intravenous tubing) or in a drainage device (for chest and urinary drainage).

Infusion pumps use various forms of technology to maintain a driving pressure in the tubing that can and keep fluid flowing into the patient at a constant rate even against gravity. With chest drainage and Foley catheter systems, gravity is an important factor affecting fluid flow into the drainage reservoir. As the vertical distance between the patient and the collection device increases, fluid flow increases as well. Fluid collected in a dependent loop in the drainage tubing can stop flow completely[1, 2].

Practice Doesn't Always Match Knowledge

Eliminating dependent loops in urinary drainage is one element in preventing catheter-associated urinary tract infections. A study from the Bay Area Patient Safety Collaborative earlier this year analyzed nurses' knowledge and practice of urinary catheter care[3]. Approximately 91% of nurses knew that dependent loops should be avoided, but in practice, less than 30% of patients' drainage systems were free from dependent loops when observed. Six months after an education program, more than 70% of patients were free from dependent loops. Nine months later, that number was down to about 45% of patients. For a variety of reasons, knowing best practice does not always translate to the bedside.

While it is almost a reflex for a nurse to lift up urinary drainage tubing to allow urine to flow into the collection bag and then coil the tubing on the bed – sometimes without even thinking about it – that reflex is not as well honed for nurses caring for patients with chest tube drainage. But, the ramifications can be just as important to safe and effective nursing care.

Physics is Phun!

A classic article in *Anaesthesia*[4] discusses physics and physiological principles of chest drainage in great detail. Kam points out that flow is directly related to the difference between the pleural pressure and the pressure in the collection system (aided by gravity) and inversely related to resistance in the system. Fluid collecting in a dependent loop of tubing will increase resistance to flow, requiring additional driving pressure to overcome that resistance and allow air and fluid to flow through the tubing and completely out of the chest. He states, "Pressure in excess of the vertical height of the fluid within the dependent loop is required for the flow of air.[4]"

Nursing Research Shows Best Practice

The first study on chest tube drainage tube positioning was done by Gordon and colleagues and published in 1997[1]. These researchers set up a laboratory study in which they compared drainage in three tubing configurations: straight from the patient level to the drainage device, coiled on the patient level and then straight to the drainage device, and with a dependent loop between the patient level and the drainage device. Suction was applied to each set-up. When a dependent loop was present, drainage stopped when the weight of the fluid in the loop was enough to overcome the vacuum pressure applied to the tube. The volume of fluid that stopped drainage was between 35mL and 45mL. Under these conditions, fluid continued to collect in the simulated lung, and a positive pressure of +8cmH_2O was not enough to overcome the resistance of the dependent loop. The mean flow of fluid was equivalent and linear over the hour of measurement in both straight and coiled tubing set-ups[1].

A second study by Schmelz and colleagues replicated the first, but looked at additional data.[2] In the Gordon study, the dependent loop was relieved every 15 minutes over an hour of measurements and drainage; thus, the total volume drained in one hour was similar for each tubing configuration. The Schmelz study examined an undisturbed dependent loop as well as a dependent loop that was relieved every 15 minutes. The total volume drained did not differ significantly between the initial three configurations (mean 296mL), confirming Gordon's findings[1]. However, the undisturbed dependent loop resulted in only 65mL drainage. Pressures at the connection of the chest tube and drainage tube were also measured, and pressures in both types of dependent loop set-ups were significantly higher than straight drainage tubing or tubing coiled at the patient level, reflecting the increased resistance to flow described by Kam[2, 4].

A best-practice review of chest drainage management advises clinicians to avoid "long ascending loops" because a column of fluid accumulating in the tubing may effectively seal the drain, prevent air evacuation and result in a tension pneumothorax[5]. Even though chest drain devices have positive pressure relief valves, they vent only when there is positive pressure in the drain. If the drainage tubing is blocked, positive pressure can build up in the chest and never reach the protection the drain provides.

It is unrealistic for a nurse to lift tubing to allow fluid to drain into the chest drain every 15 minutes. Thus, research-based best practice is to eliminate dependent loops in drainage tubing to optimize fluid flow out of the chest and reduce the risk of any pressure build-up in the system.

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In The Literature

Differences in Nursing and Medical Practice

An interesting article in the current issue of *AACN Advanced Critical Care* describes the use of ACNPs in the hospitalist role in a non-teaching inpatient setting. Most interesting is the table comparing the hospitalist curriculum in medical and nursing models. The physician curriculum lists "patient safety," while nursing has the broader "risk reduction." In ethics, physicians have "advanced directives" and "informed consent" while nurses have "patient advocacy" and "cultural competence." If you ever wanted a snapshot of the differences in the philosophy of medical and nursing practice, it's here.

Source: Rosenthal LD, Guerrasio J: Acute care nurse practitioner as hospitalist: role description. *AACN Advanced Critical Care* 2009;20(2):133-136. PubMed Citation

Infections Cost What?

The current issue of the *American Journal of Infection Control* contains a report on a methodology to review the literature to assess the cost of health-associated infections in Massachusetts. These data are ideal if you need to support the cost-savings of a program to implement best practices to reduce these infections. The most common infection, UTI had a mean additional cost of $1257. Surgical site infections were next most common, and most costly at $25,546. Next were VAP at $23,818 and blood stream infections at $19,192. Multiply these costs by the number of infections on your unit or in your hospital, and you'll begin to see how much health-associated infections truly cost.

Source: Stone PW, Kunches L: Cost of hospital-associated infections in Massachusetts. *American Journal of Infection Control* 2009;37(3):210-214. PubMed Citation

How Do Nurse Managers Think?

Nurse managers often assume their positions because they have clinical expertise, not necessarily because they have background or specific education in management theory or technique. A practical article in the current issue of *Nursing Economic$* examines the concept of critical thinking in nurse managers – what it is, how it works, and how it can be enhanced in nurse managers to enhance leadership development and patient outcomes.

Source: Zori S, Morrison B: Critical thinking in nursing managers. *Nursing Economic$* 2009;27(2):75-79, 98 PubMed Citation

On the World Wide Web

Public Access to Literature Supported

In 2008, Congress passed a bill that requires NIH research grant recipients to submit an electronic version of the final, peer-reviewed manuscript resulting from that research to the National Library of Medicine's PubMed Central for free distribution no later than 12 months from the original publication date. On March 19, 2009, the NIH issued a statement confirming that the NIH Public Access Policy remains a legislative mandate for 2009 and beyond.

The Public Access Policy is at http://publicaccess.nih.gov/policy.htm

The National Institutes of Public Health Access is at http://publicaccess.nih.gov/

To search the open access database and receive results that link to free full text: http://www.ncbi.nlm.nih.gov/sites/entrez?db=pmc

The Directory of Open Access Journals was designed to increase the visibility and ease of use of scholarly and scientific journals that are available online for reading, download and printing for free. User registration at the journal site is permitted as long as there is no charge. Visit http://www.doaj.org

Go directly to health science journals at: http://tinyurl.com/m7l6xs

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2. Schmelz JO, Johnson D, Norton JM, Andrews M, Gordon PA. Effects of position of chest drainage tube on volume drained and pressure. *American Journal Of Critical Care*. 1999;8(5):319-323. PubMed Citation

3. Parodi s, Lawrence C, Patey D. Catheter associated urinary tract infection (CAUTI) prevention. 2009; http://www.beaconcollaborative.org/assets/files/0109_CAUTI_KaiserPermanente.pdf. Accessed June 1, 2009.

4. Kam AC, O'Brien M, Kam PCA. Pleural drainage systems. *Anaesthesia*. 1993;48:154-161. PubMed Citation

5. Tang ATM, Velissaris TJ, Weeden DF. An evidence-based approach to drainage of the pleural cavity: evaluation of best practice. *Journal of Evaluation in Clinical Practice*. 2002;8:333-340. http://tinyurl.com/o6p9vd