Evidence-Based Care of Patients with Chest Tubes

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Objectives

After attending this session, learners should be able to…
…compare traditional practices with evidence-based practices
…develop evidence-based standards of practice for patients with chest tubes

Disclosure

Pat Carroll designs educational materials for Atrium Medical Corporation.

About the Speaker

Pat Carroll, a registered nurse and registered respiratory therapist, published her first article on caring for patients with chest drainage in 1986 and has been educating nurses on proper care of these patients ever since. Pat has clinical experience in adult and pediatric emergency and critical care, general medical-surgical and home care. She designed and taught a registered nurse re-entry program, has served on advisory boards of respiratory therapy and radiologic technology schools, and has taught in nursing and respiratory therapy programs in Connecticut and New York.

A multi-award winning author, Pat has written more than 100 peer-reviewed articles in the nursing literature, and 4 books, including an AJN Book of the Year. She is a contributor to the evidence-based guides at NursingConsult.com.

Until she decided to stop traveling in 2005, Pat spoke at 20 consecutive NTIs. She is currently an adjunct professor in the School of Health Sciences at Excelsior College, where she teaches online courses with students all over the world, including those deployed in the U.S. Armed Forces. She continues to write and design educational programs for medical manufacturers.
Developing Policies and Procedures

Evidence-based policies and procedures reflect translating research into practice and are associated with improved outcomes of care. The Magnet® model emphasizes the importance of integrating new knowledge, innovation and improvements in nursing practice.

Despite the clear benefits of evidence-based practice, there are also barriers to developing and implementing these policies and procedures.
Literature Review

For the topics in this presentation, topics are rated in one of four ways:

- **Strong guidance**: multiple studies generally agree
- **Equivocal**: multiple studies, disagreement without clear advice
- **Avoid**: multiple studies agree with avoiding an action or approach
- **No information**: no research in this area
Chest Drain Suction

No research supports -20 cmH₂O as an optimal level of suction. Has been used for at least 50 years and is recommended by experts as safe initial setting.

Many studies have examined whether suction is the best approach after lung resection or other thoracic procedures. Outcomes include

- Air leak duration
- Time with chest tube
- Hospital length of stay (LOS)
Recommendation

In routine cases, limited or no suction resulted in reduced time with tube, and reduced length of stay. 4-9

Okamoto noted increased fluid drainage in patients using suction and questioned if this was due to pleural irritation, and not "better drainage".

Concerns about using suction with air leaks center around the concept that suction pulls air through air leak, preventing tissues from coming together to heal.

Recent questions raised by researchers:

Is apparent pneumothorax on CXR a true pneumothorax resulting from air leak, or is it:
- Pleural dead space or apical deficit
- Atelectasis from small airway obstruction

Is a “residual” pneumothorax less risky than keeping a tube in and one attached to suction?
When evaluating this research:

- Did the “gravity group” ever use suction? (Many are placed on suction in OR / PACU; gravity doesn’t start till return to unit)
- What determines when suction is stopped?
- What is the suction level?
- What outcomes were considered?
  - Air leak
  - Residual pneumothorax on CXR
  - Number of chest tube days
  - Hospital LOS

**Management options**

- Stop suction when no bubbling in water seal
- No suction during the day, at night apply suction to drain (-10 cmH₂O)

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**Bertholet (2011)²**

Initially suction at -10 cmH₂O for one hour postop, then if CXR shows < 25% pneumothorax, suction turned off
Chest Tube Manipulation

Classic research discovered pressures as low as -400 cmH₂O with chest tube stripping.¹¹,¹²

**Recommendation**

*Do not strip or milk chest tubes.*

Other manipulation: milking, fan-folding, tapping are not standardized in any way, so difficult to compare research. Overall, tubing manipulation does not improve drainage of fluid from the chest.¹²-¹⁷

A survey showed 71% of nurses state stripping not allowed, but 74% of surgeons were in favor of it.¹⁸

Question from research:

Is increased amount of fluid produced in response to milking chest tubes actually from tissue irritation and trauma and not from improved physics of normal fluid drainage?¹⁹

Chest Tube Clearance

Key is positioning drainage tubing to use physics principles and facilitate fluid drainage.

Dependent loops containing fluid can completely block fluid drainage within **30 minutes** and change pleural pressures from -18 cmH₂O to +8 cmH₂O, a change of 26 cmH₂O in pressure.²⁰-²²
Recommendation

Avoid fluid-filled dependent loops in chest drainage tubing.\textsuperscript{16,18,23}

If impossible to avoid, lift and drain at least every 15 minutes to maintain drainage.

Question on research:

When evaluating “tube clearing” devices, consider if they reduce nursing time that must be devoted to tube maintenance or if they make care more complicated.

Imaging

What is the best way to see a pneumothorax?

- CT is considered gold standard
- Pneumothorax not seen on radiograph, but seen on CT is called “occult” pneumothorax\textsuperscript{24,25}
- Ultrasound is emerging as a reliable tool in experienced hands with detection rates generally as good as CXR\textsuperscript{24-26}
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27 and in one study, approaching CT accuracy.28

Thinking about “occult” pneumothorax
- How many critically ill patients are not able to have CT scans?
- How many patients have we been treating over the years that had these pneumothoraces, but without CT, they were not detected?29

Ultrasound much quicker and at no additional cost to the patient, but dressings and subcutaneous air block imaging26

To detect malpositioning, 3D imaging of CT is much more effective than portable CXR25

Question on research:
Keep in mind that portable CXR may miss as much as 17% of pneumothorax25

Chest Tube Dressings
No research has been done on chest tube dressings, particularly the use of petroleum gauze around the chest tube.*

In one study, knots were tied in 4 different types of suture material, then wrapped in gauze with saline.
or petroleum. More knots exposed to petroleum untied and failed at a lower tensile strength than saline-exposed knots.

Otherwise, some principles can be taken from research done on dressings for CABG incisions.

*At NTI, a poster presentation described a study of 4361 thoracotomy patients. Neither air leaks nor wound infections were attributable to dressing materials. The researchers use and recommend a simple dry occlusive gauze dressing.


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**Negative Pressure**

We typically worry about positive pleural pressure and risks from pneumothorax, but there is increasing appreciation of risks from negative pressure.

Damage in ARDS / Acute lung injury (ALI) is caused by the transpulmonary pressure gradient: the difference between the pressure in the alveoli and outside the alveoli. With positive
pressure ventilation and PEEP, the pulmonary pressures are significantly higher than normal.\textsuperscript{34,35}

Normal transpulmonary pressure difference with quiet breathing
- Alveoli: -1 to +1 cmH\(_2\)O
- Pleural space: -2 to -8 cmH\(_2\)O
- Differential: 1 to 9

Mechanical ventilation +10 PEEP with chest drain -20 cmH\(_2\)O
- Alveoli: 10 to 40 cmH\(_2\)O
- Pleural space: -20 cmH\(_2\)O
- Differential: 30 to 60 cmH\(_2\)O

**Chest Tube Removal Criteria**

How reliable is assessment of bubbling?

- Variable and very subjective
- Small amount of bubbling is not an absolute contraindication to tube removal

Oldfield (2009)\textsuperscript{1} determined that the risk of any hospital-acquired infection was directly related to number of chest tube days.

Remove the tube sooner, risk goes down.

Electronic drains very promising because air leak assessment becomes objective and consistent from clinician to clinician\textsuperscript{36,37}
Studies on electronic drains showed that with reliable assessment for air leak, chest tubes for lung resection are removed sooner and that decreases hospital LOS.\textsuperscript{38-40}

Trending is particularly helpful when surgeons are typically making the tube removal decisions based on a single assessment of bubbling on morning rounds; if bubbling seen, or not sure, will usually delay decision for 24 hours.

Pleural fluid thresholds vary from ≤ 200 mL/d to < 400 mL/d (or 5 mL/kg/day)\textsuperscript{41-45}

Pleural tubes do not have to remain just because the patient is receiving mechanical ventilation; in fact, chest tubes do not have to be inserted in all trauma patients with pneumothorax, even if being ventilated.\textsuperscript{46}
Cardiac surgery thresholds vary in volume and timeframe. $^{47-49}$

One study evaluated removing tubes when fluid drainage changed from bloody to serosanguineous because it indicated cessation of bleeding. $^{50}$

### Post Removal Imaging

Key consideration: treating the patient or the image?

Even when reaccumulation of air or fluid is seen on the CXR, interventions are held until and unless patients are symptomatic. $^{47,51-53}$

Eliminate one CXR with 750 cases/yr, save $15,500$ $^{51}$

So why not do imaging only if clinical change?
**Recommendation**

Avoid routine portable CXR after chest tube removal regardless of whether tubes are pleural or mediastinal and regardless of patient age.\(^54,55\)

Order CXR if symptoms appear or clinical assessment changes consistent with complication of tube removal.

Excellent application for screening ultrasound

Significant financial savings and reduction of risks associated with radiation and moving patients for portable films

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**Rules to Live By**

- Treat the patient, not an image
- Trust the body’s healing power
- Use technology wisely to complete physical assessment, not to replace it
- Guide sacred cows out to pasture where they can age gracefully and not harm anyone
References


Resources

Annotated Nursing Literature on Chest Drainage

Comprehensive, referenced review of care of patients with chest tubes from indications, to tube insertion, types of drains, tube and drain management, patient assessment and tube removal.

Systematic review of the literature relating to chest drain care, specifically: dressings, tube manipulation and positioning, and tube removal.

Crawford D: Care and nursing management of a child with a chest drain. *Nursing Children and Young People* 2011;23(10):27-34.
Comprehensive review of care of children with chest tubes including indications (with a focus on pneumothorax), patient assessment, chest tube insertion, tube and drain management and removal with special attention to particular needs of children; includes questions with activities to apply content to practice.

Descriptive trial of digital drain use in thoracic surgery.

The classic reference that first identified very high negative pressures with chest tube stripping demonstrated pressures between -145 cmH2O and -370 cmH2O depending on length of tube compressed and -145 cmH2O -408 cmH2O when roller was compared to manual technique; pleural pressures were higher than mediastinal pressures. Study measurements were done on 20 men who had postoperative pleural or mediastinal chest tubes; measurements were taken at the juncture of the chest tube and the drainage tubing; suction to the drain was -20 cmH2O.

This study compared standard care with venting and sump drainage; all chest tubing was stripped with a roller. Chest drains today automatically vent excess negative pressure in the system. This study did not compare tube manipulation techniques.

Review of nursing care for patients with chest tubes: tube insertion, managing the chest drain, complications and tube removal.

Study of 15 thoracic surgery patients; patients were not well prepared preop and had significant pain directly related to chest tube.

Bench test of pressure and drainage through chest drain tubing in various configurations; demonstrates hazards of dependent loops.

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Compares traditional practices with evidence-based practices relating to suction levels, manipulating chest drain tubing, positioning tubing


This comprehensive, extensively referenced review examines the state of the art of nursing care in 1993, including indications; tube placement; drainage systems; principles relating to chest drainage; controversies including mediastinal bleeding, tube clearance, clamping, tube site care, antibiotics; chest tube removal; complications; and autotransfusion


This clinical evidence review examines the literature relating to drainage tube manipulation and finds no research supporting the practice


Milking compared with stripping showed no difference in drainage in cardiac surgery patients; statistical analysis also showed no difference in drainage between suction pressures of -5 cmH2O and -20 cm H2O


“Ask the Expert” recommends against routine tube manipulation


This randomized study compared an intervention of local application of ice to chest tube insertion site to usual care and found reduced pain with ice when coughing and during mobility exercises and less analgesic use in study patients.


Survey of practicing nurses identified significant gaps in knowledge relating to care of patients with chest tubes and makes recommendations for educational interventions.


This study, in followup to the previous, checked knowledge deficit and then examined how nurses gained knowledge as practicing professionals.


This classic study is one of the first to compare milking, stripping and no manipulation to CABG patients and determined there was no benefit to tube manipulation and recommended avoiding any dependent loops in the drainage tubing.


A study comparing two methods of ambulation: the standard practice in which IV pole, oxygen tank, Foley catheter, chest tube and drain were handled by assistive personnel OR use of a device designed to hold the equipment and incorporate a walker if needed. The integrated system was preferred by the patients and the nurses noted it was safer for ambulation compared to traditional methods. A comprehensive review of literature relating to postoperative ambulation is included.


This retrospective correlational study determined that the risk of any hospital acquired infection increased in patients with chest tubes as chest tube days rose.
This pilot study (upon which Fox relied) found patients were ill prepared for their experience with chest tubes; pain was intense but short-lasting with tube removal.

Randomized trial compared milking (any compression with twisting or squeezing) with stripping (continuous compression with a roller) when a clot was visible in the drainage tubing. 78/200 patients had no clots; tube manipulation did not improve outcomes and is not recommended

Prospective observational study compared bedside thoracic ultrasound by APRN with portable chest radiography to detect pneumothorax in cardiothoracic surgery patients immediately after pleural chest tube removal: each method found 3 pneumothoraces with ultrasound results in 4.24 minutes and radiography results in 79.2 minutes at a cost of $200.

This animal study was designed to expand on Gordon's research and compared tubing positions: straight, coiled, dependent loop, and loop that was lifted and drained in the setting of pleural pressure changes with breathing. Dependent loop had significantly less fluid drainage; dependent loop and lift and drain had significantly higher pressure measured in the lumen at the chest tube / drainage tube connector (-6 cmH2O) than other positions (-20 cmH2O)

Review of nursing care for patients with chest tubes: types of drains, nursing role, drain position, insertion complications, infection control, monitoring, tube manipulation, suction, pain management, and drain removal

This literature review found no research in support of stripping or milking chest tube draining tubing to maintain patency.


This randomized trial compared use of Micropore and Transpore tape for dressings on median sternotomy beginning with the first postop dressing change by assessing irritation and stripping of skin. Irritation with Micropore was significantly lower than Transpore and skin stripping scores were also significantly worse with Transpore with Transpore worsening each POD and Micropore improving.

Randomized study comparing semiocclusive, occlusive hydrocolloid and standard absorbent dressings on median sternotomy; wounds were evaluated during 4 weeks postop. Conventional dressing more effective in wound healing, less painful to remove and more cost effective despite the need for more frequent dressing changes.

Randomized study comparing dry absorbent dressing, hydrocolloid dressing, and hydroactive dressing applied in the OR at skin closure. No differences in wound healing or rate of infection; dry absorbent was most comfortable and most cost-effective; hydrocolloid
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increased wound exudate and required more frequent changes due to poor integrity; more discomfort with removal and increased cost.

Retrospective descriptive study to determine drainage volume after CABG; mean duration of tube was 45.2 hours with total drainage 1300 mL with plateau of 31 mL/hr at hour 8, suggesting tubes could safely be removed earlier after surgery.

Literature Reviews by Speaker
Carroll P. Salvaging blood from the chest. RN 1996;59(9):32-38.

Note: Not all of the nursing references are cited in the presentation; this comprehensive list is designed as a resource tool to develop evidence-based policies and procedures.

Additional Annotated References
Randomized trial that compared tube removal at 24 hours with tube removal at 48 hours as long as drainage was not >100mL in prior 8 hours; early removal improved outcomes and reduced resource use without increase in effusions.

Retrospective review of trauma patients; CT measurements used to determine chest wall thickness at nipple line. Post-removal pneumothorax was diagnosed with CXR, occurring in 30% of patients. Significant risk factors were younger age, penetrating mechanism of injury, and thin chest wall; logistic regression showed only chest wall thickness as independent risk factor.

Retrospective review of lung resection patients comparing those whose chest tubes were at -20 cmH2O with those who were at gravity drainage; all patients had CXR in PACU, 72% had no air leak after surgery; tube removal criteria <200 mL/24h, no air leak. Patients with suction were converted to gravity at mean of POD 2.65. Without air leak: chest tube duration suction 4.5d, gravity 3.19d; LOS suction 6.74d, gravity 5.13d. Air leak: chest tube duration suction 6.35d, gravity 5d; LOS suction 8.96d, gravity 6.57d; all differences p<0.05; there were no complications attributable to difference in chest drain management.
Comprehensive literature review that discusses imaging with CT, radiograph and ultrasound to detect pneumothorax; “occult” is considered not seen on CXR, approx 2-17% in trauma; provides algorithm, and examines the question “do all patients with pneumothorax of any size require a chest tube if they receive mechanical ventilation?” If fewer chest tubes, reduce 22% risk for associated complications

Increased complication rate when residents inserted tubes, but less than half of malpositioning were detected by CXR, requiring CT to detect these

Compared a new protocol of single postop chest tube; suction -10 cmH2O until pneumothorax <25% or absent, then to gravity drainage; removed when air leak resolved and drainage <400mL/day. When compared with usual care of multiple tubes and suction, there was statistically significant shorter duration of air leak and chest tube and decreased LOS without increase in morbidity or mortality

Randomized trial that compared tube removal based on digital measurements of air leak: if zero for at least past 6 hours, CXR -> tube removed OR instantaneous observation for bubbling: if no bubbling, CXR -> tube removed. Digital measurement resulted in fewer chest tube days, LOS and reduced costs overall.

Randomized trial that compared gravity drainage OR gravity drainage during the day with suction applied at night in patients with visible air leak the morning after surgery; -10 cmH2O applied until morning after surgery, same level at night in suction group. Night suction group had less prolonged air leak, less chest tube time and shorter LOS.

Retrospective study over 10 years with 8608 procedures discovered chest tubes could be removed with drainage < 450mL/day without risk of recurrent effusion

Systematic review and meta-analysis comparing suction with water seal found no difference in duration of air leak, duration of chest tubes, or LOS; suction associated with reduced incidence of pneumothorax, but clinical significance is not known

“Best evidence review” examined the literature and only considered Issacson, Lim-Levy and Pierce to meet inclusion criteria; insufficient evidence to support tube manipulation; given risks illustrated by Duncan, tube manipulation is not recommended

Randomized trial compared milking (1 min Q 2 hr x 48 hr) with observation and all patients had -20 cmH2O.Milking significantly increased drainage, but thought to be resulting from
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stimulation of pleura, not because tube was more patent; no clots were observed in tubes of any patients; advise against routine tube manipulation

This systematic review and meta-analysis examined RCT comparing suction with gravity drainage. Suction reduces postoperative pneumothorax (but not clinically significant), no difference on length of air leak, data favored reduced chest tube time and length of stay in gravity group, but studies not standardized enough for meta-analysis on this point.

Prospective study that examined 400 cardiac surgery patients’ CXR after pleural tube removal found residual asymptomatic inconsequential pneumothorax in 9.3% of patients; 2 patients whose pneumothorax required reinsertion of chest tube were symptomatic. No indication for routine films without specific clinical changes.

Patients hospitalized with pneumothorax and chest drainage and not on mechanical ventilation had CXR and ultrasound 24 hours after bubbling in the drain ceased, 6 hr after clamping, and 6 hr after tube removal. All residual pneumothorax seen on CXR were also seen on ultrasound; 13 (39%) pneumothorax seen on ultrasound were missed and confirmed with either CT scan or aspirating air through the pleural catheter. Time to obtain ultrasound results was 35 min (mean) for CXR, 71 min.

 Compared tube removal when appearance of drainage turned to serosanguineous with removal when < 50 mL x 5 hr; no difference in post removal pericardial effusion; safe to remove tubes when appearance changes because it indicates cessation of active bleeding

Single chest tube after VATS to gravity drainage, removed when drainage < 400 mL/24 hr; 59% removed within 24 hr and 83% within 48 hr without increase in complications

Whenever a postoperative CXR was ordered, ultrasound was performed to compare results. Mean CXR to results was 166 min, ultrasound 11 min; compared with CXR, ultrasound had sensitivity of 83% and specificity of 59%; for pneumothorax, sensitivity of 21% and specificity of 95%. May be able to reduce number of CXR, but not replace.


Chest trauma patients randomized for tube removal when drainage 150 mL/day (standard) or 200 mL/day (trial); trial patients had shorter LOS despite no significant difference in tube duration


Nurses removed chest tubes when drainage < 20 mL/2hr and no air leak. 98% of CXR showed no pneumothorax; in 2 patients, clinical changes would have required CXR. Routine CXR not indicated after chest tube removal.

Comprehensive review of the literature and current state of practice regarding thoracic catheters in pleural conditions. Covers tube type; insertion techniques; size and configuration; comparing size for various clinical indications including pneumothorax, pleural effusion, hemothorax, and postoperative treatment.

Patients who had routine CXR after chest tube removal (usual) were compared with those who only had CXR if symptomatic after tube removal. 8/703 routine patients had chest tubes replaced for symptomatic pleural effusion or pneumothorax; 14/297 in the study group had CXR for symptoms; three were completely normal, and 2 required chest tubes. 283 had no symptoms and no CXR.

Observational multicenter study identified 588 occult pneumothorax in blunt trauma patients. 79% were observed; of these, 6% required chest tube for clinical deterioration; most patients in group who died died from TBI. Most blunt trauma patients with occult pneumothorax can be carefully monitored without chest tube.

285 knots of 4 types of suture material were split into two groups; half were exposed to petroleum for 12 hr, the others exposed to saline. Tensile strength was then tested to assess knot failure: knots exposed to petroleum failed at a lower tensile strength, many by untying.

Compared patients with -10 cmH2O suction with those on gravity drainage. Tube removal when no air leak and < 200mL/24 h. No hazards with gravity drainage, but not able to statistically power duration of air leak or chest tube; did note statistically significant increase in fluid drainage in suction patients.

Animal study that compared ultrasound with CT scan in detecting pneumothorax during positive pressure ventilation; 10 different volumes were assessed. Accuracy in detecting pneumothorax was comparable with ultrasound and CT.

Randomized trial compared suction -15 to – 20 cmH2O to gravity drainage; there was no statistically significant difference in any measure between the groups, including time of chest tube, persistent air leak, complications, or hospital LOS. Raises the question whether “pneumothorax” on CXR is actually dead space or the result of atelectasis from sputum retention, in which case suction will not resolve the condition. Suction is not necessary after lobectomy, may contribute to maintenance of air leak.

“Best evidence review” examined the literature finding 6 studies that met review criteria; no studies in favor of suction, 2 found no difference, and 4 favored gravity; 5 of the 6 initially used suction for a “short period”


“Best evidence review” examined the literature finding 6 studies that met review criteria; conclusion is that routine CXR after tube removal offers no diagnostic or therapeutic advantage over those performed when there is a clinical indication with a change in patient assessment; this is the determining factor for replacing tubes in patients with positive findings on routine CXR


Survey of North American cardiothoracic surgeons and nurses to identify problems with chest tube management; tube clogging was the leading concern; surgeons tend to choose larger tubes to reduce this risk; 74% of surgeons allow stripping, 23% discourage it and 4% forbid it; 28% of nurses’ facilities allow stripping, while 72% do not allow; 75% of nurses agreed that managing chest tube clogging took them away from other important tasks.


This evidence review was done after earlier research by the author that discovered wide variations in care that were not based on research. This addresses indications; tube insertion; complications; management: avoid dependent loops, clamp only to change drain or assess tolerance of tube removal, most patients do well with gravity, but suction may be used if lung is not re-expanded; assessment should include volume and nature of fluid drainage, bubbling in water seal relative to respiratory cycle or coughing, radiograph for tube position and lung expansion, seek specialist if air leak >2 d, check for alternative source of air leak, subcutaneous air; remove when air leak zero x24 hr, fluid < 200mL and lung expanded


Retrospective review of routine CXR findings in infants after chest tube removal; no chest tubes were reinserted in asymptomatic infants regardless of CXR findings, tubes were reinserted in 5 of 12 infants (one with reaccumulation of pleural effusion, 4 for air) with respiratory distress; 7 of 12 had no abnormalities on CXR. Routine CXR is not recommended.


Cochrane Review found 3 studies that met criteria but could not be combined in meta-analysis; no data to support tube manipulation (milking or stripping) to prevent cardiac tamponade; no evidence to support or reject tube manipulation


Prospective study compared patient management in patients who had routine CXR with those who did not, both postoperatively and post tube removal. Management changed in 3 patients based on postop CXR; intervention in 1 patient post tube removal was based on clinical presentation, not CXR; there were no adverse events in those who did not have routine CXR.


Review of the literature and state of the art in assessing for and managing pneumothorax in critically ill patients. CT is the gold standard, but may be impractical; pneumothorax can be missed on portable CXR; ultrasound is emerging as standard of care and can detect >90% of
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pneumothorax missed by CXR; wide range of “occult” pneumothorax: those missed on CXR and detected on CT.


Randomized study assigned patients with pleural tubes to removal when no air leak and fluid ≤ 100 mL/d, ≤ 150 mL/d ≤ 200 mL/d; drainage time and LOS not significantly different among groups; no significant differences in thoracentesis for reaccumulation of fluid. All patients -20 cmH2O suction.

**Resources on Policies and Procedures / Evidence Searching**

Evidence-Based Searching in PubMed
Center for Healthcare Informatics Education
Health Sciences Library
Stony Brook University
[http://tinyurl.com/cb6adsf](http://tinyurl.com/cb6adsf)   link to PDF

PubMed Basics Quick Reference Guide
[http://tinyurl.com/6q52sd2](http://tinyurl.com/6q52sd2)   link to PDF

Searching PubMed with MESH Quick Reference Guide
[http://nnlm.gov/training/resources/meshtri.pdf](http://nnlm.gov/training/resources/meshtri.pdf)   link to PDF

Full Text and PubMed Quick Reference Guide
[http://nnlm.gov/training/resources/fulltexttri.pdf](http://nnlm.gov/training/resources/fulltexttri.pdf)   link to PDF

Evidence-Based Care Summaries: NursingConsult.com


Windle PE: Moving beyond the barriers for evidence-based practice implementation. *Journal of Perianesthesia Nursing* 2006;21(3):208-211.