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## Evidence-based Care of Patients with Chest Tubes

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# Evidence

Evidence is more than research; it incorporates scientific nursing and medical research in combination with clinical guidelines, clinical judgment, expertise, patient preferences and the clinical context for care.

We are focusing on the literature because the other aspects are individualized to the healthcare organization, the individual nurse and the patients for whom you care.

What the Literature Says

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## What is evidence?

*"a problem solving approach to clinical decision making...that integrates the best available scientific evidence with the best available experiential evidence."*

*Evidence ≠ research*

- **Research** answers a specific question about a specific population under certain conditions
- **Evidence** includes clinical guidelines, literature reviews, position papers, regulations, QI data, expert opinions, patient experience, clinician judgment & expertise

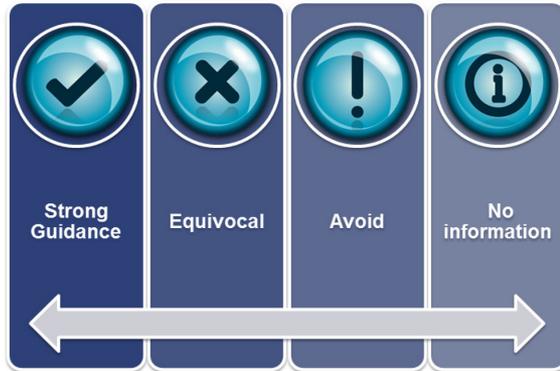


Johns Hopkins Nursing  
Evidence-Based Practice  
Model and Guidelines 2007

What the Literature Says

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# Literature Model

## Carroll Literature Assessment Model

**Strong guidance:** multiple studies generally agree

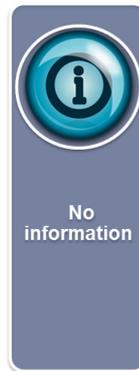
**Equivocal:** multiple studies, without clear advice on clinical action

**Avoid:** multiple studies agree on not taking a course of action

**No information:** insufficient data to make a recommendation

No evidence that has established -20 cmH<sub>2</sub>O as the “magic number;” likely it was just the height of the bottles<sup>1</sup>

- No evidence, no best practices for suction levels
- Probably originated from height of glass bottles<sup>1</sup>
- All other things being equal, flow rate and suction are directly related



1. Carroll 2003

# Applying Suction

Many studies have compared using suction with leaving chest drains to simple gravity drainage after lung resection surgery.

Study outcomes vary and include:

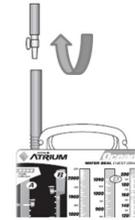
- Duration of air leak (visible bubbles in the water seal)
- Duration of chest tube (in place in the chest)
- Hospital length of stay (LOS)

**Strong guidance says that when all patients having lung resection are randomized at the time of surgery, time with chest tube and LOS were significantly lower when limited or no suction was used, without an increase in complications<sup>2-7</sup>**

## Applying Suction

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- Compare gravity with suction in various combinations in lung surgery
- Duration of air leak, time with chest tube, hospital length of stay
- In routine cases, time with chest tube and hospital length of stay decreased with **limited suction or no suction** without increase in complications<sup>1-6</sup>
- All other things being equal, the longer the chest tube, the longer the stay



Strong  
Guidance

1. Coughlin SM, et al 2012 2. Deng B, et al 2010 3. Prokakis C, et al 2008 4. Antanavicius G, et al 2005 5. Okamoto, et al, 2006  
6. Sanni et al 2006

## Applying Suction

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### Pathophysiology

- Suction pulls greater volume of air through opening in lung tissue
- If air is moving through opening, tissue cannot approximate and heal
- Is lack of full re-expansion air leak, pleural deficit or ?<sup>1</sup>
- New question: *is a postop residual pneumothorax less problematic than continuing chest drainage?*

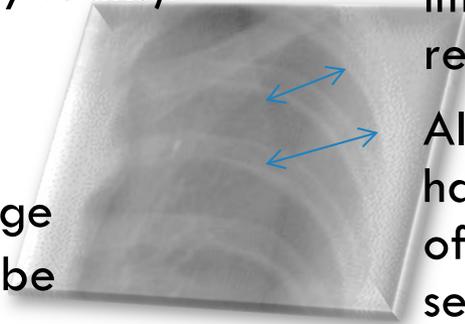


1. Prokakis C, et al 2008

# Considering Lung Resection Patients

We are learning through research that when suction increases flow by pulling air through tiny openings in the suture/staple line, it keeps tissue apart; this lack of approximation slows and may prevent healing (and thus, sealing of any tiny leaks).<sup>4</sup>

Increased fluid drainage that may be seen can be caused by pleural irritation and “weeping” – not by superior drainage of normal postop fluids.<sup>21</sup>



We are also now realizing that not all air spaces seen on CXR (see blue arrows) are what we would normally think of as PTX; some are pleural deficits that occur when persons with COPD have lobectomy and the remaining lung is not able to immediately expand to fill the remaining space.<sup>4</sup>

Also, remember that most persons having lobectomy have a measure of COPD, so anesthesia’s effect on secretion mobility can result in atelectasis with reduced lung expansion in the immediate postoperative phase as well.

## Evaluating the research

- Read the definitions carefully:  
how is suction defined?
  - Was suction applied initially in the OR / on arrival to postoperative care or was the drain never connected to suction?
  - Is suction initially applied and then stopped at a certain point?<sup>1,2</sup> What determines when?
- What is the outcome?
  - Air leak, residual pneumothorax, ??



1. Bertholet JW et al 2011. 2. Leo et al 2013

## Suction or Gravity?

- Successful change to 1 chest tube postop lobectomy, -10cm H<sub>2</sub>O suction, stop when air leak gone<sup>1</sup> decreased air leak, chest tube and LOS
- Compare continuous gravity with gravity day and suction HS when air leak on AM rounds; HS had less prolonged leak, tube time and LOS<sup>2</sup>
- Systematic review compared suction to gravity drainage; no difference in duration of leak or chest tubes or LOS<sup>3,4</sup>
- Report of 500 pts in a 1500 pt study showed suction did not reduce postop complications; persistent air leaks after lobectomy and segmentectomy more common in no-suction<sup>5</sup>
- Study compared “customized” suction with no suction after lobectomy; no suction was “at least as effective and safe” as suction<sup>6</sup>



1. Bertholet JW et al 2011 2. Brunelli A et al 2005 3. Coughlin SM et al 2012 4. Deng B et al 2010 5. Leo 2013 6. Brunelli et al 2013

# Evaluating Research

Many patients in the “no suction” arms actually had suction overnight day of surgery and were not randomized until POD 1; in others, only patients with air leaks on POD 1 were randomized. Know what method was used and whether all resection patients were included when reviewing research.<sup>8,9</sup>

These are samples of the literature;<sup>2-3,8-11</sup> for more summaries of the literature on suction and gravity drainage, see the annotated references on AtriumU.com (click on Evidence)

# Tube Manipulation

Research has demonstrated no benefit to tube manipulation of pleural or mediastinal tubes and potential for significant tissue damage due to high pressures.<sup>1,2-21</sup>

Possible that increased fluid with manipulation is due to tissue irritation, not better postop drainage<sup>21</sup>

**Do not strip or milk tubing**

Tube positioning is key to effective drainage; dependent loops can create positive pressure in the pleural space<sup>1,6,18,20,22-24</sup>

**Avoid dependent loops in tubing**

## Chest Tube Manipulation

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- Stripping is bad, causing dangerously high negative intrapleural pressures ( $-400 \text{ cmH}_2\text{O}$ )<sup>1,2</sup>
- "Milking," fan-folding, tapping are not standardized and hard to compare, but in any case do not significantly improve fluid drainage<sup>2-4,6-8</sup> 72% of nurses surveyed said stripping was **not** allowed, but 74% of surgeons allowed it<sup>9</sup>
- Milking increases fluid in one study; *is this due to irritation and not from surgery?*<sup>10</sup>



Avoid

1. Duncan & Erickson 1982 2. Day TG et al 2008 3. Wallen M, et al 2004 4. Halm MA 2007 5. Gordon PA et al 1995  
6. Isaacson JJ et al 1986 7. Lim-Levy F et al 1986 8. Pierce JD et al 1991 9. Shalh et al 2009 10. Dango S et al 2010

## Chest Tube Clearance

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- Position tubing and use physics and gravity to facilitate fluid drainage
  - Dependent loop can change pleural pressure from  $-18 \text{ cmH}_2\text{O}$  to  $+8 \text{ cmH}_2\text{O}$  and decrease fluid drained to zero in less than 30 minutes<sup>1,2,3</sup>
  - Nursing time is an increasing challenge; **key is avoiding dependent loops**<sup>4,5,6</sup>
- "Automatic" tube clearing



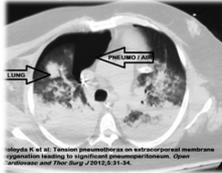
Strong  
Guidance



1. Gordon PA et al 1997.  
2. Schmelz JO et al 1999  
3. Gordon PA 1995  
4. Lim-Levy F et al 1986  
5. Tang et al 2002  
6. Shalh et al 2009

**CT considered the gold standard to detect pneumothorax**

- PTX detected on CT not on radiograph "occult pneumothorax"<sup>1</sup> 2-17% in trauma<sup>2</sup>
- Bedside ultrasound equivalent to CXR and in some cases, identifies pneumothorax not detected on CXR<sup>1-4</sup>
- One study showed ultrasound equivalent to CT in laboratory simulation<sup>5</sup>



1. Yarnus L et al 2012 2. Ball CG et al 2009 3. Saucier S et al 2010 4. Galbois A et al 2010 5. Oveland NP et al 2013



# Imaging

“Occult pneumothorax” is the term for pneumothorax seen on CT that was not visible on traditional chest x-ray. We are now more aware of them since more patients have chest CT, but they have always been there.<sup>25,26,30,31</sup>

Ultrasound’s ability to detect pneumothorax is equivalent to CT, and will likely see more use in the future.<sup>25-29</sup> Ultrasound can be done by APRNs, less expensive and much less time<sup>32-33</sup>

We once thought that if pneumothorax was visible and patient was receiving positive pressure ventilation, chest tube was essential; now we know that watchful waiting is a reasonable option.<sup>25,30,31</sup>

**Can observe asymptomatic pneumothorax not initially detected on CXR**

**OPTICC (Occult Pneumothorax in Critical Care) Study**  
[www.opticc.com](http://www.opticc.com)

- Half of all trauma-related pneumothorax are asymptomatic and only seen on CT<sup>1</sup>
- Initially, 50 pts observed, 40 pts had decompression
- One observed patient developed tension PTX, recognized and treated
- Ten observed patients ended up with chest tube for effusion later on
- No harm in observed patients
- 15% of decompression had malpositioned tubes that required intervention

1. Kirkpatrick 2013



# Imaging / Dressings

Malpositioned chest tubes is the other diagnostic challenge for traditional chest x-ray; malpositioning often only detected on CT.

First research on chest tube dressings reported at 2013 NTI; poster session reported low incidence of air leak and infection when petroleum gauze eliminated<sup>34</sup>

Unfortunately, no peer-reviewed research has been published on chest tube dressings

## Imaging

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- How many patients with occult pneumothorax are never detected?<sup>1</sup>
- Malpositioning of chest tubes often missed on portable CXR when 3D view is needed, requires CT<sup>2</sup>
- Ultrasound costs much less and quicker than CT but dressings & subQ air block imaging<sup>3</sup>
- Ultrasound 4<sup>4</sup> to 11min<sup>3</sup> CXR 79<sup>4</sup> to 166min<sup>3</sup>



1. Moore FO et al 2011 2. Ball CG et al 2007 3. Goudie E et al 2012 4. Saucier S et al 2010

## Chest Tube Dressings

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- **No research specific to chest tubes and insertion sites has been published**
  - Poster at 2013 NTI<sup>1</sup>
    - Retrospective review 4361 thoracic surgery patients – dry sterile dressing only, no petroleum gauze
    - Air leak 3.1%, infection 0.48%
    - Eliminating petroleum gauze resulted in equivalent or better outcomes



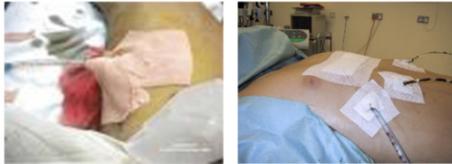
1. Jeffries 2013

## Chest Tube Dressings

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### ▪ No research specific to chest tubes and insertion sites has been published

- One bench study examined effect of petroleum on sutures: knots *failed* after exposure to petroleum v. saline



Muffy TM, B Couri, A Edwards, N Kow, AJ Bonham, MF Paraiso. Effect of petroleum gauze packing on the mechanical properties of suture materials. *Journal of surgical education* 2012;69(1):37-40.

## Chest Tube Dressings

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### Based on research on surgical dressings for CABG<sup>1,2,3</sup>

- Do not routinely change dressing unless it is compromised or a change in the patient's condition requires assessment of the wound
- Use a dry, sterile dressing
- Secure the dressing with wide paper tape



1. Wikblad K et al 1995 2. Weber BB et al 1987 3. Wynne R 2004.

# Dressings

A bench test examined the effect of petroleum on suture materials and discovered knots failed<sup>35</sup>

If we extrapolate from research done on dressings for median sternotomy: there is no evidence to support routine dressing changes; use a simple dry, sterile dressing; and secure the dressing with wide paper tape; this provides cover for the wound with the least damage to the surrounding skin<sup>36-38</sup>

# Tube Removal

Trend is toward earlier removal because duration of chest tube is the main determinant of hospital LOS in lung surgery patients<sup>39-40</sup>

In ICU, duration of chest tube is related to risk of hospital-acquired infection<sup>39</sup>

Chest tube duration > 18d associated with higher ICU mortality and ICU LOS<sup>41</sup>

Small amount of bubbling not a contraindication to chest tube removal; key is to assess whole patient situation

Patients do not need to have a chest tube just because they are receiving mechanical ventilation<sup>48</sup>

## Criteria for Tube Removal

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### Pleural chest tubes

- *Being aggressive with chest tube removal decreases hospital length of stay and all related potential complications<sup>1</sup>*
- Length of time chest tube is in place is main determinant of hospital LOS
- In a study of ICU patients, the risk of developing hospital-acquired infection was directly related to number of days a patient had a chest tube



Equivocal

1. Oldfield MM, El-Masri MM, Fox-Wasylyshyn SM. Examining the association between chest tube-related factors and the risk of developing healthcare-associated infections in the ICU of a community hospital: a retrospective case-control study. *Intensive & Critical Care Nursing* 2009;25(1):38-44. 2. Dearden, et al 2013

## Criteria for Tube Removal

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### Pleural chest tubes

- Bubbling in water seal is not an *absolute* contraindication when patients are breathing spontaneously
- Electronic drains' ability to provide trending data key for decision-making
- Review of studies of VATS for pleurodesis showed OK to remove on POD 2 and send home POD 3<sup>2</sup>



Equivocal

1. Oldfield MM, El-Masri MM, Fox-Wasylyshyn SM. Examining the association between chest tube-related factors and the risk of developing healthcare-associated infections in the ICU of a community hospital: a retrospective case-control study. *Intensive & Critical Care Nursing* 2009;25(1):38-44. 2. Dearden, et al 2013

## Criteria for Tube Removal

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### Electronic drains

- Compare e-trending to visualization of bubbles; trending allowed tubes to be removed sooner (by POD 2), reduced LOS by 0.9 day<sup>1</sup>



Strong  
Guidance

1. Brunelli A, M Salati, M Refai, L Di Nunzio, F Xiume, A Sabbatini. Evaluation of a new chest tube removal protocol using digital air leak monitoring after lobectomy, a prospective randomised trial. *Eur J Cardiothorac Surg* 2010;37(1):56-60.

# Tube Removal

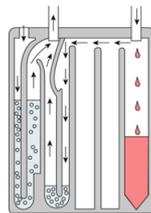
Trending<sup>42</sup> can be useful when surgeons want information about patient air leak to decide whether to remove tube and are only at the bedside once in the morning before surgery

## Criteria for Tube Removal

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### Pleural fluid thresholds:

- < 400 mL or 5 mL/kg/day<sup>1,2,3</sup> more than 80% removed within 48 hr
- < 200 mL /d<sup>4,5,6</sup>
- Is positive pressure ventilation a contraindication to removal?
  - Not in trauma patients<sup>7</sup>



Equivocal

1. Gottgens KW, et al 2011 2. Jiwani S et al 2012 3. Cerfolio RJ et al 2008 4. Tawil I et al 2010 5. Grodzki T 2008.  
6. Younes RN et al 2002 7. Hessami MA et al 2009

Pleural fluid thresholds for tube removal vary between about 200mL/d to about 400mL/d (5 mL/kg/d in pediatrics)<sup>43-49</sup>

# Tube Removal

Cardiac surgery fluid thresholds vary in volume and timeframe<sup>50-52</sup>

Statistically, by the time you get to postop hour 8, drainage is about 31 mL/h or less; in cardiac surgery, patients are either bleeding or not; there is usually not much of a question<sup>50-53</sup>

An interesting study of pleural tube removal technique in which there was less pneumothorax when tubes were removed at full exhalation compared with full inspiration<sup>54</sup>

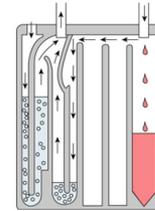
***“This supports the importance of prospective randomized trials and the need to question surgical dogma. Despite our traditions and opinions, often our biases are proven incorrect.”***

## Criteria for Tube Removal

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### Cardiac surgery thresholds

- With 73% pleural breach, tubes removed when < 20 mL /2h and no air leak<sup>1</sup> without complication
- < 100mL /8h (within 24 h)<sup>2</sup> or wait until serosanguineous and < 50 mL x 5h<sup>3</sup>
- Statistically, drainage plateaus at 31 mL/h by postop hour 8<sup>4</sup>



1. Khan T et al 2008 2. Abramov D et al 2005 3. Gercekoglu H et al 2003 4. Wynne R et al 2007

## Chest Tube Removal Technique

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### Not what was expected

- Study of postop thoracotomy pts: half removed at full inspiration, half at full exhalation, all did Valsalva
  - 32% of full inspiration had new or larger PTX compared with 19% in exhalation group
  - Only clinically significant in 5 patients (1.5%)
  - Findings the opposite of what was expected



1. Cerfolio et al 2013

**Not essential**

- Are we treating the patient or treating an image of the patient?
  - After CABG, routine CXR not needed; incidence of pneumothorax is low and patient symptoms will identify those who need follow up<sup>1,2,3,4</sup>
  - Routine elimination of one CXR in program with 750 cases/yr = \$15,500<sup>2</sup> minimal savings



1. Khan T et al 2008 2. Sepehrpour AH et al 2012 3. Eisenberg RL et al 2011 4. McCormick JT et al 2002

**Similar findings for thoracotomy tubes**

- No need for routine post-removal films, only if change in patient condition and assessment<sup>1</sup>
- In fact, best evidence review of 7 studies says only do CXR after pulmonary surgery for change in symptoms; no routine daily films<sup>2</sup>
- Same findings in neonates<sup>3</sup>



1. Whitehouse MR, et al 2009 2. Reeb at al 2013 3. van den Boom J et al 2007

# Routine CXR

Historically, it has been routine to get a chest x-ray after chest tube removal. Research shows that whether it is pleural or mediastinal tubes, routine chest x-rays are not needed; instead, “on demand” imaging based on changes in patient condition (e.g., increased RR, dyspnea, desaturation) provide more useful information, reduce radiation exposure, and save money.<sup>50,55-60</sup>

If a routine CXR shows a pneumothorax after tube removal and the patient is fine, is a tube going to be reinserted? Treat the patient, not the picture.

***Avoid routine CXR that are not related to patient condition***

# Summary

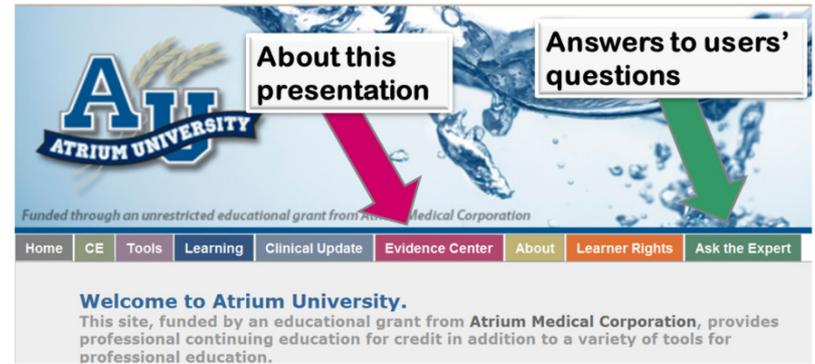
## Rules to Live By

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- Treat the patient, not an image
- Trust the body's healing power
- Use technology wisely to complete physical assessment, not to replace it
- Just because we've always done it doesn't mean we should always continue to do it

## For More...

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