Evidence-Based Care of Patients with Chest Tubes

2015 AACN NTI ExpoEd

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Learning 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

Tradition or Science?
- Chest drains need to be connected to vacuum source
- Set drain suction levels at -20 cmH₂O
- Maintain routine suction until chest tube removal
Tradition or Science?
- Chest tubes should not be removed until bubbling stops in water seal
- Chest x-rays should be obtained after pleural tube removal to check for residual pneumothorax

Tradition or Science?
- Regular chest tube manipulation (milking) is the most effective way to ensure drainage
- Dressings around chest tubes should start with petroleum gauze
What is Evidence?
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“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

Continuum of Evidence
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Drain Suction Level
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• No research, published on best suction levels
• Probably originated from height of glass bottles

1. Carroll

Applying Suction
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Strong Evidence
• In routine cases, chest tube duration and LOS significantly reduced with minimal or no suction (i.e., gravity drainage) 2-4
• Without suction, patient not tethered to the wall; ambulation contributes to quicker recovery
• Even when chest drain measures are equivalent, overall care favors gravity to allow ambulation

Pathophysiology

- Suction pulls greater volume of air through opening in lung tissue
- If air is moving through opening, it separates tissue, which then cannot come together and heal
- Hypothesis that suction promotes faster leak closure disproven in trauma study
- Increased fluid drainage: pleural irritation & weeping – not better drainage

Applying Suction

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Lack of Lung Re-expansion

- air leak
- other pleural deficit or
- atelectasis from small airway plugging?

Pleural deficit occurs when persons with COPD have resection and remaining lung does not immediately expand to fill space

Resection patients more likely to have COPD, so at greater risk for anesthesia effects on secretions


5. Prokakis
New question: Is a residual pneumothorax after surgery less of a problem than continuing chest drainage with suction?

Asked another way:
How important is ambulating as soon as possible after lung resection?

Financial Benefit
Early mobilization postop can reduce length of stay by at least 1 day\(^7\)

Base cost of hospitalization per day: $2090 \(^{(2012, \text{Kaiser Family Foundation data})}\)

Embolus precautions: $16.79/d

Note: details of financial analysis available at AtriumU.com

7. Antanavicius
Goal of stripping, milking, fan-folding are to increase negative pressure to suck clots out of chest tube

**Strong Evidence**

Stripping produces dangerously high pressures (-400 cmH2O)\(^8\)

Milking, fan-folding, and tapping are not standardized and hard to compare

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**Survey of Practice**

72% of nurses reported they were not permitted to strip tubing

74% of surgeons allowed stripping for their patients\(^9\)

Overall, studies show no advantage to tube manipulation to enhance drainage\(^10-13\)

Hot off the Presses!

Presented March at International Anesthesia Research Society¹⁴

Impact of Retained Blood on Outcome after Cardiac Surgery

Study identified incidence of complications associated with retention of blood in pericardial and pleural spaces and the impact on outcomes postop.

6909 adult cardiac surgery patients

Retained blood 985 / 14.25%: pleural/pericardial effusion, tamponade, hemothorax

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Postoperative Care With and Without Retained Blood¹⁴

<table>
<thead>
<tr>
<th></th>
<th>All Patients</th>
<th>No Retained Blood</th>
<th>Retained Blood</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-hospital mortality</td>
<td>475 / 6.9%</td>
<td>303 / 5.1%</td>
<td>172 / 17.5%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hospital LOS (d)</td>
<td>13.0 [9-21]</td>
<td>12.0 [9-18]</td>
<td>27.0 [17-49]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ICU LOS (d)</td>
<td>5.0 [3-8]</td>
<td>5.0 [3-8]</td>
<td>15.0 [7.75-33]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ventilation time (h)</td>
<td>23.0 [10-54]</td>
<td>20.0 [9-43]</td>
<td>84.0 [29-303]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hemodialysis</td>
<td>1117 / 16.2%</td>
<td>684 / 11.5%</td>
<td>433 / 44%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Postoperative PRBC transfusion</td>
<td>1273 / 18.4%</td>
<td>734 / 12.4%</td>
<td>539 / 54.7%</td>
<td>&lt;0.001</td>
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Chest Tube Manipulation for Patency

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It's what you can't see…

- Retained blood can't be seen: pleural/pericardial effusion, hemothorax, cardiac tamponade
- Tube occlusion inside the chest is much more challenging
- Initial reports: 20% to 36% of post-op mediastinal and pleural tubes have some degree of occlusion\(^{14,15}\)
- Active tube clearance reduced\(^{14,15}\) post-op atrial fibrillation from 29% to 20% \(p=0.0033\)


Dependent Loops

- Position tubing and use physics and gravity to facilitate fluid drainage
- Dependent loop can change pleural pressure from -18 cmH\(_2\)O to +8 cmH\(_2\)O and decrease fluid drained to zero \textit{in less than 30 minutes}\(^{16}\)

Avoid dependent loops

16. Schmelz
CT considered gold standard to detect pneumothorax

*Occult pneumothorax* is seen on CT but not on standard radiograph\(^\text{17,18}\)

- In trauma, 2% to 17%\(^\text{19}\)
- If no CT, patient may have PTX we never know about; these patients were OK before CT was so common
- Evidence: watchful waiting


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Ultrasound detects pneumothorax with the accuracy of CT when done by experienced professional\(^\text{20-21}\)

- Ultrasound detects PTX not seen on radiograph
- No radiation with ultrasound
- Results in 4 to 11 minutes v. 79 to 166 minutes for radiograph\(^\text{20}\)

Financial Benefit

• Chest ultrasound and chest radiograph each ~ $115*  
• Your time waiting for or tracking down results?  
  • 10 minutes = $7.30 per film  
• Delays in care waiting for results?  
• Not having to move the patient?  
• CT cost ~$1189*

Note: details of financial analysis available at AtriumU.com

* SFGeneral chargemaster data

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Chest Tube Dressings

No published research on chest tubes and insertion site dressings

Two studies can guide practice

• Poster presentation at 2013 NTI22  
  • Retrospective review of lung resection patients comparing dry sterile dressing alone to DSD + petroleum gauze  
  • 4682 patients total, no difference in air leak or infection related to dressing  
  • Petroleum gauze eliminated 2003  
• Bench test of sutures23  
  • Knots tied in various suture materials, each then wrapped in dry gauze, saline gauze and petroleum gauze  
  • Knots exposed to petroleum failed at significantly higher rate

22. Jeffries, 23. Muffly
Research on sternotomy incision dressings\textsuperscript{24-26}

- 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


Research or Evidence?

As of yet, no peer reviewed research on chest tube dressings

But we can use nursing judgement and expert opinion to guide care through evidence

Evidence supports dry sterile dressing – no petroleum gauze, change only when indicated, not on a schedule
Financial Benefit

- Cost of petroleum gauze $10
- Reduction from daily dressing changes: 3 fewer at $27.74 = $83.22 (CABG)
- From baseline daily dressing changes with petroleum gauze, savings = $137.09 for CABG
- Thoracic surgery = $115.48

Note: details of financial analysis available at AtriumU.com

Chest Tube Dressings
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Criteria for Chest Tube Removal: Pleural

- Being aggressive with tube removal reduces LOS and complications related to hospitalization associated with higher ICU mortality and ICU LOS

- Chest tube duration > 18d

27. Oldfield, 28. Kao

Chest Tube Directly Related to LOS

- Being aggressive with tube removal reduces LOS and complications related to hospitalization associated with higher ICU mortality and ICU LOS

- Chest tube duration > 18d

27. Oldfield, 28. Kao
Criteria for Chest Tube Removal: Pleural 2015 National Teaching Institute ExpoEd

**Air Leak: No Clear Rules**²⁹⁻³¹

- Bubbling in water seal is not an absolute contraindication when patients are breathing spontaneously
- Mechanical ventilation alone is not an indication for a chest tube
- Review of studies of VATS for pleurodesis showed OK to remove on POD 2 and D/C POD 3

More important to make empiric decision based on individualized assessment


**Fluid Drainage: No Clear Rules Either**³²⁻³³

- Range of drainage with successful removal 200 mL/d to 400 mL/d
- In pediatrics, 5 mL/kg/d
- One study: to fast track, tubes removed if drainage ≤ 500mL/24 h, 2.8% required subsequent treatment
- Chylothorax as complication of surgery: remove tube at 450mL/d once fluid is clear³⁴

More important to make empiric decision based on individualized assessment

³². Hessami, 33. Grodzki, 34. Bryant
After cardiac surgery, thresholds variable\textsuperscript{35,36}

- Statistically, by post-op hour 8, drainage averages 31mL/h
- Typically, patients are either bleeding or they are not bleeding
- Fluid volume recommendations average about 10 mL/h, but measured volume not usually key to decision-making

Most important controllable variable affecting post-op bleeding?\textsuperscript{37} \textbf{The surgeon!}

\textsuperscript{35.} Abramov, \textsuperscript{36.} Gercekoglu, \textsuperscript{37.} Dixon

Criteria for Chest Tube Removal: Pleural Technique

Unexpected Results

- Study of postop thoracotomy pts: Half removed at full inspiration, half at full exhalation\textsuperscript{38}
- 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

Recommend: Remove after full exhale

\textsuperscript{38.} Cerfolio
Evidence does not support routine post-removal imaging\textsuperscript{39-41}

- After CABG: pleural or mediastinal
- After thoracic surgery: only if patient becomes symptomatic
- Validated in adults and peds/neonatal

Bedside ultrasound imaging is a reliable option if there are any questions about air in the pleural space

Treat the patient, not a picture of the patient

\textsuperscript{39}. Sepehripour, \textsuperscript{40}. Reeb, \textsuperscript{41}. van den Bloom

Unnecessary imaging not without risk

- Displaced lines and tubes when moving patient
- Patient’s discomfort
- “Routine” imaging often finds “abnormalities” not causing symptoms
- Clinicians are tempted to treat even when the patient’s condition is unchanged

Financial cost of these issues are not available, but could be significant

“Oh, I hate it when that happens”
Financial benefit

- Eliminate one CXR per patient in a program that does 750 cases / yr (~ 3/day)
- Hospital cost
  - Image: $103
  - Interpretation: $25
- Hospital charge for portable: $595
- Medicare reimbursement: $61.42 ($67 loss on every CXR)

Eliminate 750 CXR per year = $96,000 in cost

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Financial benefit – cardiac

- Dressings/nursing care = $137.09
- Time associated with CXR x3 = $21.90
- Eliminate one CXR = $128
- Preventing retained blood major complication = priceless

Total financial benefit realized in reduced costs of care per patient

$286.99

Note: details of financial analysis available at AtriumU.com
Financial Benefits Summary
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Financial benefit – thoracic
• Reduce LOS 1 day = $2090
• Reduce embolism precaution = $16.79
• Dressings/care $115.48
• Time associated with CXR x3 = $21.90
• Eliminate one CXR = $128

Total financial benefit realized in reduced costs of care per patient
$2372.17

Note: details of financial analysis available at AtriumU.com

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If your hospital does 750 CABG per year and 750 thoracic surgery cases per year, your potential cost savings could be

CABG: $215,242
Thoracic: $1,779,127.50

Grand total: $1,994,370
Words of Wisdom

- Treat the patient, not an image
- Trust the body's healing power
- Trust your assessments and judgement as a professional registered critical care nurse
- Don't go looking for trouble – it will find you soon enough


