

**American College of Physicians - Internal Medicine Meeting 2024  
Boston, MA**

**Ultrasound-Guided Thoracentesis**

*Director:*

**Aaron J. Calderon, MD, FACP, SFHM**

**Alyssa V. Burkhart, MD, FACP, FHM**

**Alice Gallo De Moraes, MD, FACP**

**Emily Gilbert, MD**

**Sophia Raia, MD, MS, Resident/Fellow Member**

**Neil Winawer, MD, Member, SFHM**


**Shilpa Sridhar, Resident/Fellow Member**

**Timothy Yang, MD, Resident/Fellow Member**

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American College of Physicians  
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# THORACENTESIS

April 18-20, 2024

Aaron J. Calderon, MD, FACP, SFHM  
Director, Academic Department of Internal Medicine  
Program Director, Internal Medicine Residency, Saint Joseph Hospital  
Founder, GME Simulation/Procedural Skills Lab, Saint Joseph Hospital  
Clinical Professor of Medicine, University of Colorado SOM  
Aaron.Calderon@imail.org

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## OUR TEAM

- Alyssa Burkhart, MD
  - Billings Clinic, Montana
- Alice Gallo de Moraes, MD
  - Mayo Clinic, Rochester
- Emily Gilbert, MD
  - Loyola University Chicago
- Shilpa Sridhar, MD
  - Ohio State University
- Sophia Raia, MD
  - National Jewish Health-Saint Joseph Hospital, Denver
- Neil Winawer, MD
  - Emory University-Grady Hospital
- Timothy Yang, MD
  - Kaiser Permanente Oakland Medical Center

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## Outline

- Relative Contraindications
- Optimal Site & Management
- Complications



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## Relative Contraindications

- PT and/or PTT  $\geq$  2x normal
- Platelet count  $\leq$  20,000 – 50,000
- Creatinine  $\geq$  6.0
- Unstable patient
- Infection over insertion site
- Mechanical Ventilation
- If doesn't meet Light's criteria for landmark



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Check for updates

**STANDARDS OF PRACTICE**

### **Society of Interventional Radiology Consensus Guidelines for the Periprocedural Management of Thrombotic and Bleeding Risk in Patients Undergoing Percutaneous Image-Guided Interventions – Part II: Recommendations**

Endorsed by the Canadian Association for Interventional Radiology and the Cardiovascular and  
Interventional Radiological Society of Europe  
Indravadan J. Patel, MD, Shiraz Rahim, MD, Jon C. Davidson, MD, Sue E. Hanks, MD,  
Alda L. Tam, MD, T. Gregory Walker, MD, Luke R. Wilkins, MD, Ravi Sarode, MD, and  
Ido Weinberg, MD







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## Coagulation & Hemostasis

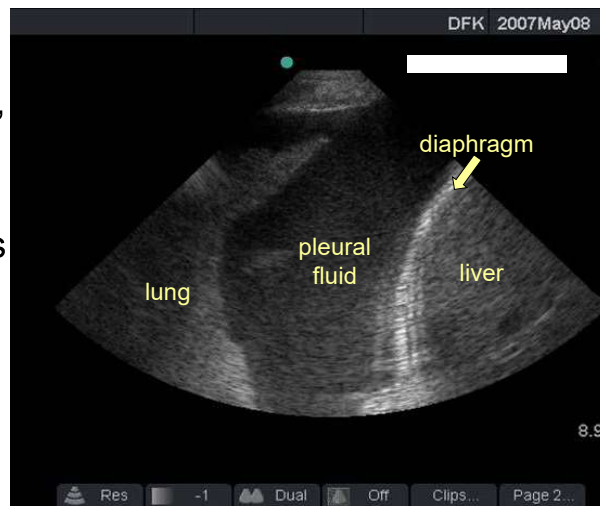
- Coags & Platelet counts not routinely indicated
- Lower INR to 2-3 if on warfarin
- Transfuse platelets if less than 20,000
- Don't routinely need to hold DOACS, LMWH, P2Y12 inh
- **Caveats:**
  1. Observational data
  2. Controversial (other countries recs differ)
  3. Assumes a skilled operator; use of ultrasound
  4. RISK vs BENEFIT
  5. Each patient is an "N of 1"



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## Thoracentesis Procedure

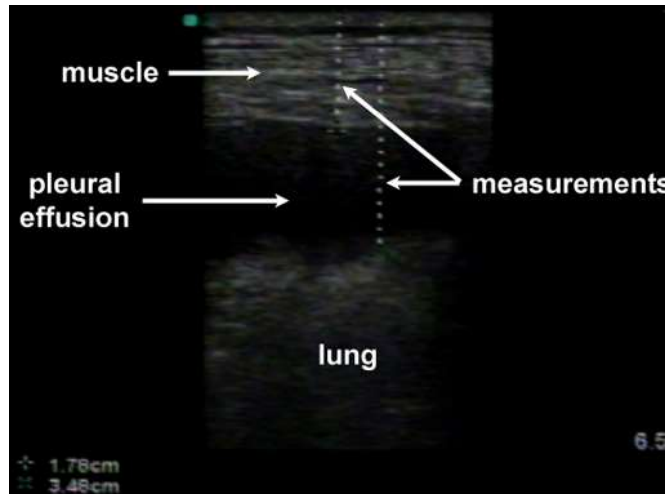
- Besides fluid must identify, diaphragm, inner chest wall and lung
- The lung is seen as an echogenic structure moving with respiration



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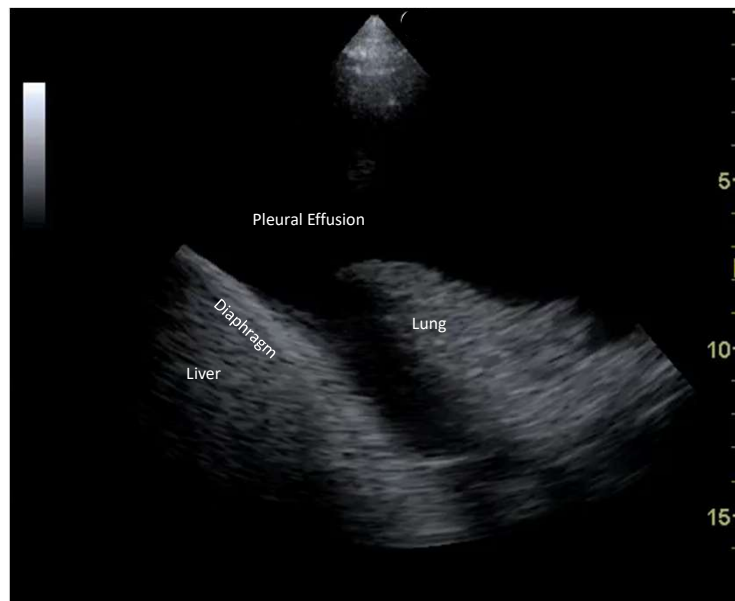
## Thoracentesis Procedure

- Look for the deepest pocket of fluid superficial to the lung
- Measure to determine needle depth



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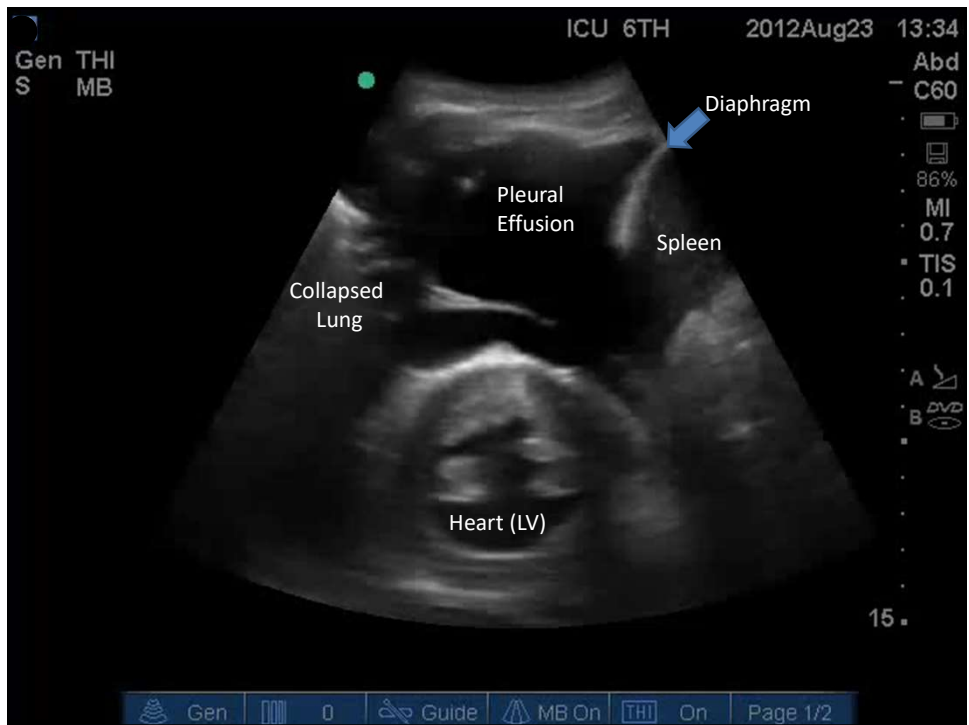
## Anechoic Pleural Effusion



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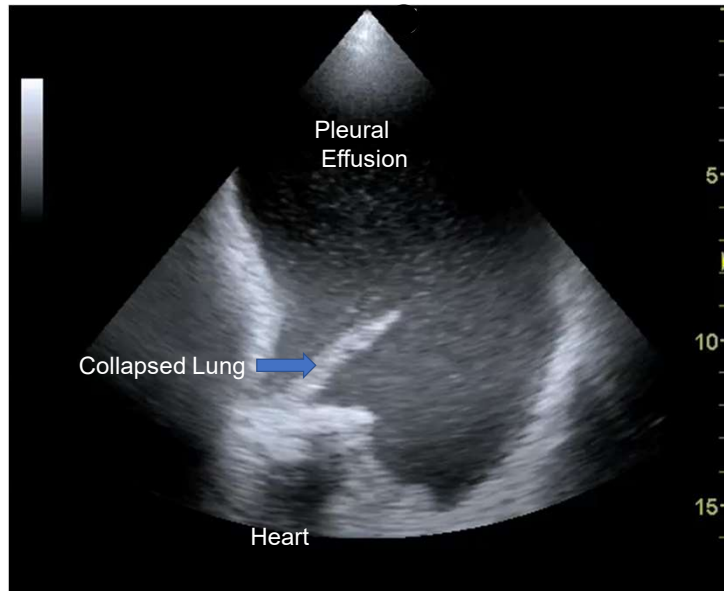


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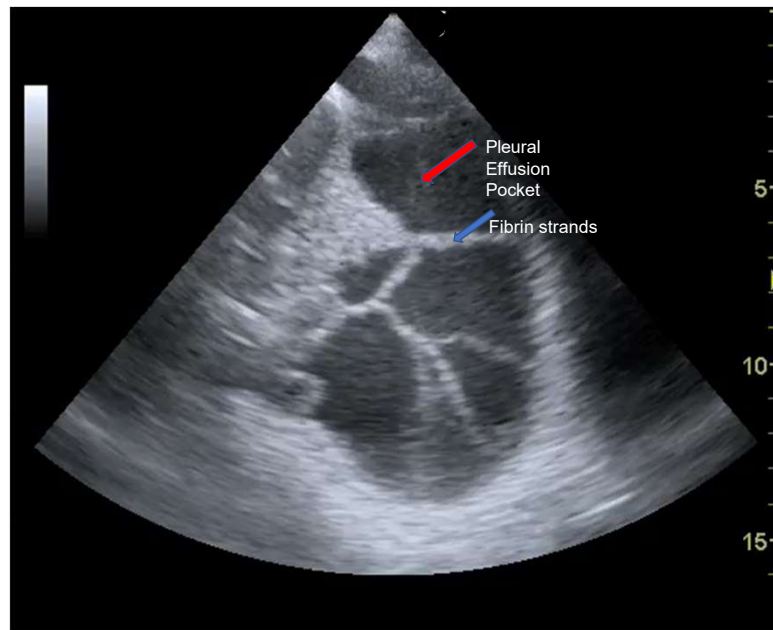
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## Plankton sign



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## Loculated Pleural effusion



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# Complications

- Pneumothorax
- Reexpansion pulmonary edema
- Intercostal artery laceration
- Bleeding
- Infection
- Vagal reaction



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## REVIEW ARTICLE

# Pneumothorax Following Thoracentesis

## *A Systematic Review and Meta-analysis*

Craig E. Gordon, MD, MS; David Feller-Kopman, MD; Ethan M. Balk, MD, MPH; Gerald W. Smetana, MD

**Background:** Little is known about the factors related to the development of pneumothorax following thoracentesis. We aimed to determine the mean pneumothorax rate following thoracentesis and to identify risk factors for pneumothorax through a systematic review and meta-analysis.

**Methods:** We reviewed MEDLINE-indexed studies from January 1, 1966, through April 1, 2009, and included studies of any design with at least 10 patients that reported the pneumothorax rate following thoracentesis. Two investigators independently extracted data on the pneumothorax rate, risk factors for pneumothorax, and study methodological quality.

**Results:** Twenty-four studies reported pneumothorax rates following 6605 thoracenteses. The overall pneumothorax rate was 6.0% (95% confidence interval [CI], 4.6%-7.8%), and 34.1% of pneumothoraces required chest tube insertion. Ultrasonography use was associated with significantly lower risk of pneumothorax (odds ratio [OR], 0.3; 95% CI, 0.2-0.7). Lower pneumothorax rates were observed with experienced operators (3.9% vs 8.5%,  $P=.04$ ),

but this was nonsignificant within studies directly comparing this factor (OR, 0.7; 95% CI, 0.2-2.3). Pneumothorax was more likely following therapeutic thoracentesis (OR, 2.6; 95% CI, 1.8-3.8), in conjunction with periprocedural symptoms (OR, 26.6; 95% CI, 2.7-262.5), and in association with, although nonsignificantly, mechanical ventilation (OR, 4.0; 95% CI, 0.95-16.8). Two or more needle passes conferred a nonsignificant increased risk of pneumothorax (OR, 2.5; 95% CI, 0.3-20.1).

**Conclusions:** Iatrogenic pneumothorax is a common complication of thoracentesis and frequently requires chest tube insertion. Real-time ultrasonography use is a modifiable factor that reduces the pneumothorax rate. Performance of thoracentesis for therapeutic purposes and in patients undergoing mechanical ventilation confers a higher likelihood of pneumothorax. Experienced operators may have lower pneumothorax rates. Patient safety may be improved by changes in clinical practice in accord with these findings.

*Arch Intern Med.* 2010;170(4):332-339

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## Complication Rate

Table 1 Complication rates of pleural aspiration by operator and image guidance

Ultrasound guidance	Operator	Frequency of post-procedure pneumothorax	Frequency that a chest drain was required post procedure	Frequency of dry tap/procedure failure
Yes	Radiologist in training	2.7%	1.8%	2.7%
Yes	Senior physician	3.6%	0.9%	3.2%
Yes	Radiologist	2.7%	0.5%	
No	Physician in training	15.0%	4.7%	12.9%
No	Senior physician	5.7%	1.4%	1.6%

The calculations and references used in this table are shown in appendix 1 in the online supplement.<sup>132-134</sup>

*Thorax* 2010;65(Suppl 2):i61-i76. doi:10.1136/thx.2010.137026

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## Tension Pneumothorax

- Chest pain, hypotension, tachycardia
- Emergent needle decompression
- **Use no smaller than 3.25 inch 14 gauge needle**
- Smaller needle size associated with high failure rate
- 2<sup>nd</sup> intercostal space; mid-clavicular line

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## 2010 British Thoracic Society Guidelines

- **Follow Up CXR?**
- A chest x-ray after a simple pleural aspiration is **not required unless** air is withdrawn, the procedure is difficult, multiple attempts are required or the patient becomes symptomatic. (C)



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# CHEST

Original Research

PULMONARY PROCEDURES

## Diagnosis of Pneumothorax by Radiography and Ultrasonography

### A Meta-analysis

*Wu Ding, MM; Yuehong Shen, MM; Jianxin Yang, MM; Xiaojun He, MM; and Mao Zhang, MD*

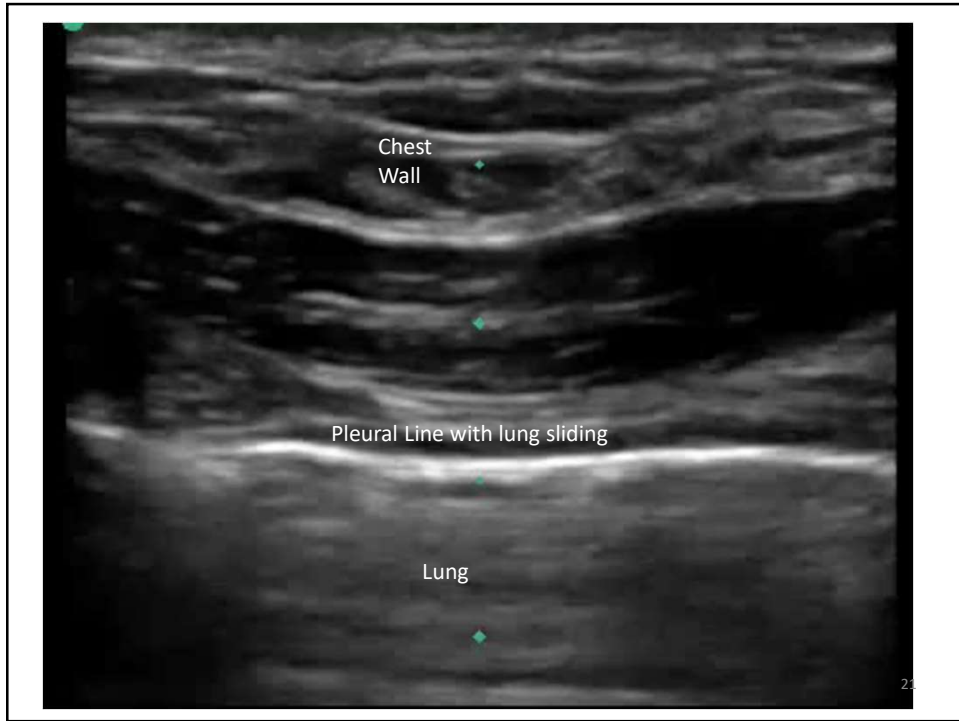
**Conclusions:** “bedside ultrasound performed by clinicians had a higher sensitivity and similar specificity compared to CXR for the diagnosis of pneumothorax, **but** the accuracy of ultrasound depended on the skill of the operators.”

Chest 2011; 140(4):859-866

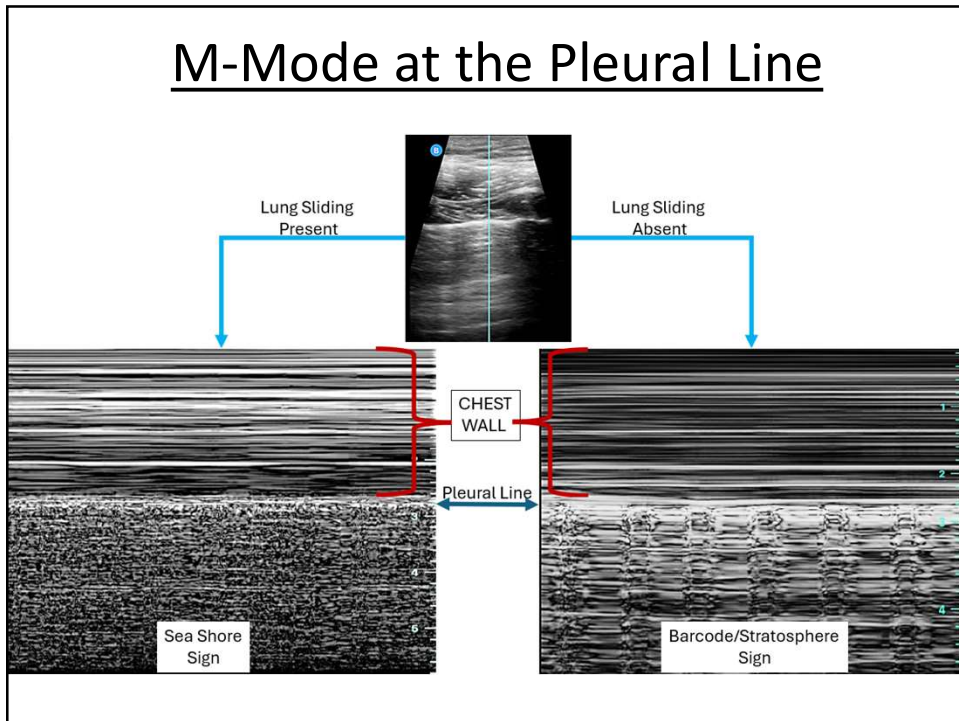


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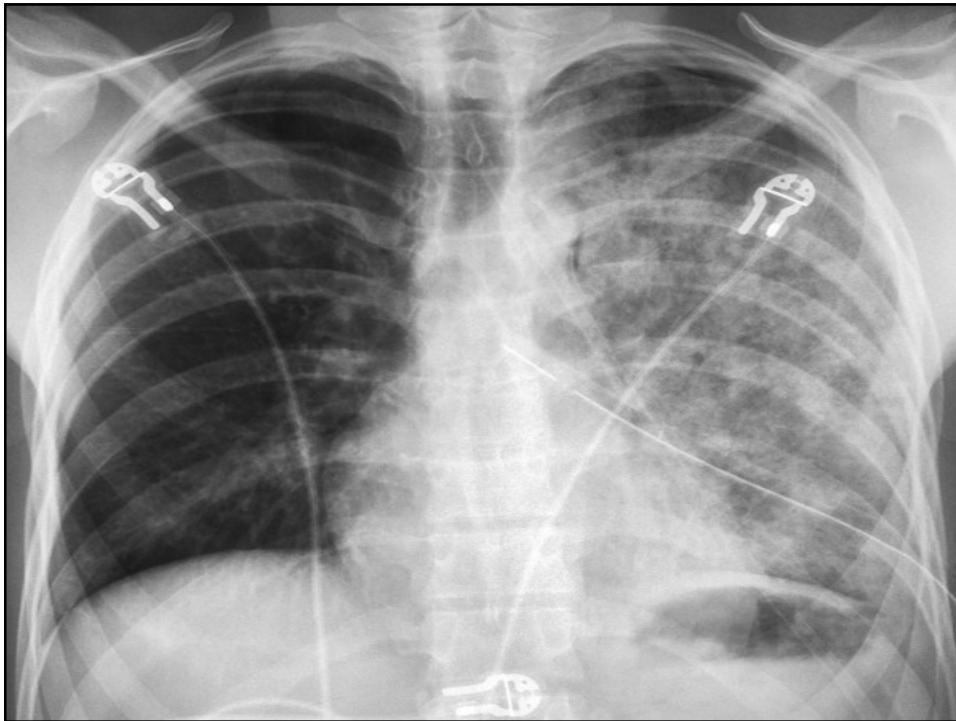


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## Reexpansion Pulmonary Edema

- Very rare complication; mechanism unknown
- Dyspnea, tachypnea, cough, fever, tachycardia
- **Unilateral pulmonary edema** in lung that rapidly reexpands; can be bilateral
- Lung has typically been collapsed for  $\geq 3$  days
- Usually occurs within 3 hours of procedure; almost all by 24hrs
- May last 2-5 days
- **“Rule of 3’s”**

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## Reexpansion Pulmonary Edema

### Treatment

- Supportive care (oxygen, mechanical ventilation)
- Diuretics not routinely recommended

### Prevention

- Limit fluid removal to 1-1.5 liters (myth)
- Keep pleural pressure > than -20 cm H<sub>2</sub>O
- Chest tightness/discomfort correlates



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## Large-Volume Thoracentesis and the Risk of Reexpansion Pulmonary Edema

David Feller-Kopman, MD, David Berkowitz, MD, Phillip Boiselle, MD, and Armin Ernst, MD

Departments of Interventional Pulmonology and Radiology, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts

**Background.** To avoid reexpansion pulmonary edema (RPE), thoracenteses are often limited to draining no more than 1 L. There are, however, significant clinical benefits to removing more than 1 L of fluid. The purpose of this study was to define the incidence of RPE among patients undergoing large-volume ( $\geq 1$  L) thoracentesis.

**Methods.** One hundred eighty-five patients undergoing large-volume thoracentesis were included in this study. The volume of fluid removed, absolute pleural pressure, pleural elastance, and symptoms during thoracentesis were compared in patients who did and did not experience RPE.

**Results.** Of the 185 patients, 98 (53%) had between 1 L and 1.5 L withdrawn, 40 (22%) had between 1.5 L and 2 L withdrawn, 38 (20%) had between 2 L and 3 L withdrawn, and 9 (5%) had more than 3 L withdrawn. Only 1 patient (0.5%, 95% confidence interval: 0.01% to 3%) experienced

clinical RPE. Four patients (2.2%, 95% confidence interval: 0.06% to 5.4%) had radiographic RPE (diagnosed only on postprocedure imaging without clinical symptoms). The incidence of RPE was not associated with the absolute change in pleural pressure, pleural elastance, or symptoms during thoracentesis.

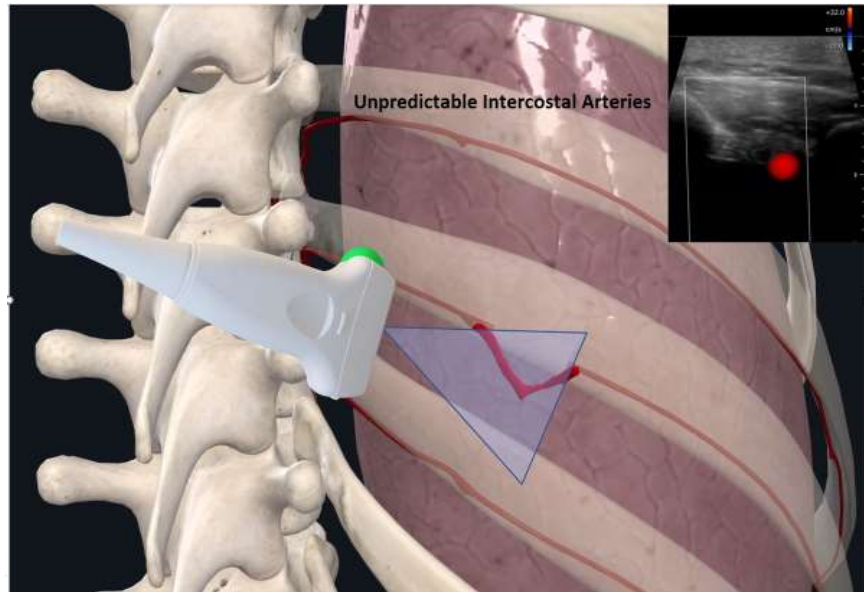
**Conclusions.** Clinical and radiographic RPE after large-volume thoracentesis is rare and independent of the volume of fluid removed, pleural pressures, and pleural elastance. The recommendation to terminate thoracentesis after removing 1 L of fluid needs to be reconsidered; large effusions can, and should, be drained completely as long as chest discomfort or end-expiratory pleural pressure less than -20 cm H<sub>2</sub>O does not develop.

(Ann Thorac Surg 2007;84:1656-62)

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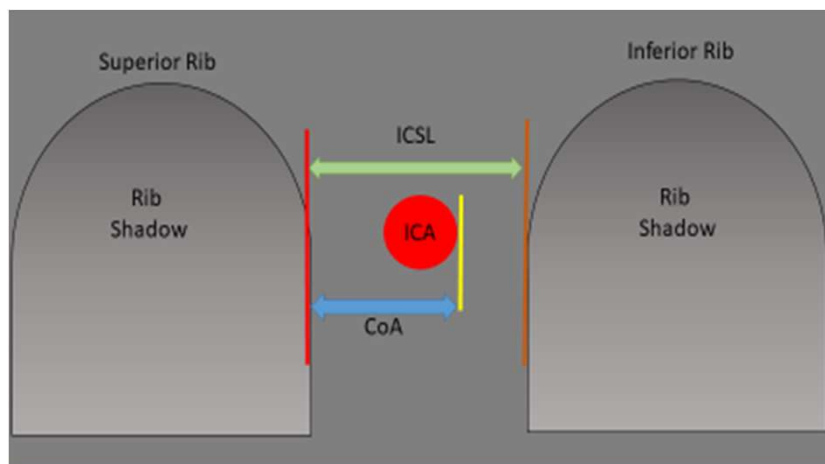
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## Intercostal Artery Laceration



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## Intercostal Artery Laceration



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Thank You!



Aaron J. Calderon, MD, FACP, SFHM  
**[Aaron.Calderon@imail.org](mailto:Aaron.Calderon@imail.org)**