

**Selected Best Practices and Suggestions for Improvement**

**PSI 6: Iatrogenic Pneumothorax**

**Why Focus on Iatrogenic Pneumothorax?**

- Iatrogenic pneumothorax (IP) is a life-threatening complication seen in 3% of ICU patients.<sup>1</sup>
- IP occurs primarily due to barotrauma related to mechanical ventilation or as a postprocedural event. Due to the development of improved equipment and techniques, IP can be largely preventable.<sup>1</sup>
- Patients with accidental IP had an extra 4.4 days added to their LOS, \$18,000 in additional charges, and had a 6% higher risk of hospital death.<sup>2</sup>
- At least part of this cost is likely to be shouldered by hospitals. In 2008 the Centers for Medicaid and Medicare Services (CMS) identified iatrogenic pneumothorax with venous catheterization as one of a number of conditions for which hospitals do not receive the higher payment for cases when the condition was acquired during hospitalization.<sup>3</sup>
- Starting in 2015, the iatrogenic pneumothorax PSI will be one of the measures used for Medicare’s Hospital Value-Based Purchasing (as part of a composite indicator) that links quality to payment.<sup>4</sup>

This indicator is also reported on Medicare’s Hospital COMPARE as part of the Hospital Inpatient Quality Reporting Program.<sup>5</sup>

<b>Recommended Practice</b>	<b>Details of Recommended Practice</b>
Identification of Patients at Risk	Develop a process to address common iatrogenic pneumothorax risk factors identified in the literature. <sup>1</sup>
Safe Insertion Techniques During Pleural Procedures	Standardize procedures and position techniques during pleural procedures, such as thoracentesis and chest tube insertion. <sup>6-9</sup>
Physician Training	Develop specified training components and criteria and establish a plan for continued competency <sup>6,7</sup>
Standardized Practices	Develop and standardize practices for site identification, marking, and procedural practice. <sup>6,7,10-12</sup>

**Best Processes/Systems of Care**

**Introduction: Essential First Steps**

- Engage key procedural personnel, including nurses, physicians, technicians, and representatives from the quality improvement department, to develop evidence-based protocols for care of the patient preprocedure, intraprocedure, and postprocedure to prevent iatrogenic pneumothorax.
- The above team:
  - Identifies the purpose, goals, and scope and defines the target population for this guideline.
  - Analyzes problems with guidelines compliance, identifies opportunities for improvement, and communicates best practices to frontline teams.

- Establishes measures to indicate if changes are leading to improvement; identifies process and outcome metrics, and tracks performance using these metrics based on a standard performance improvement methodology (e.g., FOCUS-PDSA).
- Determines appropriate facility resources for effective and permanent adoption of practices.

**Recommended Practice: Identification of Patients at Risk**

- Determine risk for iatrogenic pneumothorax during the history and physical.
- Consider the many factors identified in the literature that are associated with a higher risk of iatrogenic pneumothorax. These can be categorized as either patient related or procedure related.<sup>2,13</sup>

Patient-related factors include:

- Body habitus.
- Effusion size.
- Localized fluid.
- Chronic obstructive pulmonary disease.
- Diagnosis of cardiogenic pulmonary edema at admission.
- Diagnosis of acute respiratory distress syndrome at admission.
- Insertion during the first 24 hours of a central venous catheter or pulmonary artery catheter.
- Use of vasoactive agents within 24 hours postprocedure.<sup>1</sup>
- Cancer of kidney and renal pelvis (risk is likely due to the need for transthoracic needle aspiration, which is used for diagnostic purposes).

Procedure-related factors include:

- Transthoracic needle aspiration.
- Thoracentesis.
- Subclavian venipuncture.
- Positive pressure ventilation.
- Bronchoscopy.
- Respiratory and mechanical ventilation.
- Abdominal cavity operations.
- Pleural biopsy.
- Coughing during the procedure (patient).

**Recommended Practice: Safe Insertion Techniques During Pleural Procedures**

- Standardize procedures and equipment.<sup>7</sup>
  - Use of real-time ultrasound to identify and mark site and/or guidance for thoracentesis.<sup>8,9,12,14-16</sup>
  - Requirement of preprocedural verification of the correct patient using two identifiers.
  - Requirement of preprocedural verification of the intended procedure and the correct site selection.

- Use a lateral approach; avoid posterior approach if possible. A lateral approach minimizes risks of vessel laceration.<sup>6,8</sup>
- Use blunt dissection vs. trocar use for chest tube insertion.<sup>6,9</sup>

**Recommended Practice: Physician Training**

- Provide specified training, including three components:
  - Theoretical didactic training,
  - Simulated practice, and
  - Formal, supervised practice with minimum observation criteria.<sup>6,7</sup>
- Consider identifying a subset of practitioners (e.g., focus group) who receive specific training to perform the procedure (thoracentesis, chest tube insertion) regularly. Establish criteria for continued competency with minimum procedural number.<sup>6,7</sup>

**Recommended Practice: Standardized Practices**

- Appropriate site selection, including use of the "safe triangle" (defined by the anterior border of the latissimus dorsi, the lateral border of the pectoralis major, and a horizontal line through the anatomical position of the ipsilateral nipple) as a default to reduce chances of visceral perforation. Consider using pleural ultrasound to provide real-time localization of pleural fluid.<sup>6,10</sup>
- Site marking performed immediately prior to the procedure to reduce the likelihood of fluid redistribution or tissue/organ movement secondary to patient repositioning.<sup>6,11</sup>
- Implementation of procedural guidelines (e.g., American College of Chest Physicians).

**Educational Recommendation**

- Plan and provide education on protocols to physician, nursing, and all other staff involved in procedural cases. Education should occur upon hire, annually, and when this protocol is added to job responsibilities.

**Effectiveness of Action Items**

- Track compliance with elements of established protocol by using checklists, appropriate documentation, etc.
- Evaluate effectiveness of new processes, determine gaps, modify processes as needed, and reimplement practices.
- Mandate that all personnel follow the safety protocols developed by the team to prevent iatrogenic pneumothorax and develop a plan of action for staff in noncompliance.
- Provide feedback to all stakeholders (physician, nursing, and ancillary staff; senior medical staff; and executive leadership) on the level of compliance with process.
- Conduct surveillance and determine prevalence to evaluate outcomes of new process.
- Monitor and evaluate performance regularly to sustain improvements achieved.

**Additional Resources**

**Systems/Processes**

- World Health Organization. Summary based on Surgical care at the district hospital. Available at: <http://www.who.int/surgery/publications/Postoperativecare.pdf>. Accessed June 25, 2014.

- Baumann M, Strange C, Sahn S, et al. Management of spontaneous pneumothorax: an American College of Chest Physicians Delphi Consensus Statement. *Chest* 2001;119(2):590-602. Available at: <http://journal.publications.chestnet.org/article.aspx?articleid=1079496>. Accessed February 18, 2014.
- Henry M, Arnold T, Harvey J. BTS guidelines for the management of spontaneous pneumothorax. *Thorax* 2003;58 Suppl 2:ii39-ii52. Available at: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1766020/pdf/v058p0ii39.pdf>. Accessed June 25, 2014.

#### Tools

- Agency for Healthcare Research and Quality. Problems and prevention: Chest tube insertion [DVD]. For information on DVD, see Patient Safety: Findings in Action (fact sheet). Available at: <http://www.ahrq.gov/research/findings/factsheets/errors-safety/chesttubes/index.html>. Accessed June 25, 2014.

#### Staff Required

- Physicians
- Registered nurses
- Respiratory therapists

#### Equipment

- Computerized tomography (CT)
- Ultrasound

#### Communication

- Education on policy/protocol of monitoring and treatment of pneumothorax
- Communication system to escalate up the chain of command when provider not responding to diagnosis of pneumothorax or signs and symptoms of pneumothorax

#### Authority/Accountability

- Senior leaders such as chief/chairs of surgery and medicine, nursing leadership, and unit managers

#### References

1. De Lassence A, Timsit JF, Tafflet M, et al. Pneumothorax in the intensive care unit. *Anesthesiology* 2006;104(1):5-13. Available at: [http://journals.lww.com/anesthesiology/Fulltext/2006/01000/Pneumothorax\\_in\\_the\\_Intensive\\_Care\\_Unit\\_3.aspx](http://journals.lww.com/anesthesiology/Fulltext/2006/01000/Pneumothorax_in_the_Intensive_Care_Unit_3.aspx). Accessed June 25, 2014.
2. Zhan C, Smith M, Stryer D. Accidental iatrogenic pneumothorax in hospitalized patients. *Med Care* 2006;44(2):182-86.
3. Hospital-acquired conditions (HAC) in acute inpatient prospective payment system (IPPS) hospitals. Fact sheet. Baltimore, MD: Centers for Medicare & Medicaid Services; October 2012. Available at: <http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HospitalAcqCond/downloads/HACFactSheet.pdf>. Accessed June 24, 2014.
4. Hospital Inpatient Quality Reporting (IQR) Program measures (calendar year 2014 discharges). (Prepared by Telligen under contract to the Centers for Medicare & Medicaid Services.) Available at:

- <http://qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic/Page/QnetTier3&cid=1138900298473>. Accessed June 24, 2014.
5. Hospital COMPARE. Measures displayed on Hospital Compare. Baltimore, MD: Centers for Medicare & Medicaid Services. Available at <http://www.medicare.gov/hospitalcompare/Data/Measures-Displayed.html>. Accessed June 25, 2014.
  6. Wrightson J, Fysh E, Maskell N, et al. Risk reduction in pleural procedures: sonography, simulation, and supervision. *Curr Opin Pulm Med* 2010;16:340-50.
  7. Duncan DR, Morgenthaler TI, Ryu JH, et al. Reducing iatrogenic risk in thoracentesis: establishing best practice via experiential training in a zero-risk environment. *Chest* 2009;135:1315-20. Available at: <http://journal.publications.chestnet.org/article.aspx?articleid=1089807>. Accessed June 25, 2014.
  8. Mayo P, Beaulieu Y, Doelken P., et al. American College of Chest Physicians/La Société de Réanimation de Langue Française: competence in critical care ultrasonography. *Chest* 2009;135:1050-60. Available at: <http://journal.publications.chestnet.org/article.aspx?articleid=1089755>. Accessed June 25, 2014.
  9. Barnes TW, Morgenthaler TI, Olson EJ, et al. Sonographically guided thoracentesis and rate of pneumothorax. *J Clin Ultrasound* 2005;33:442-6.
  10. Wraight W, Tweedie D, Parkin I. Neurovascular anatomy and variation in the fourth, fifth, and sixth intercostal spaces in the midaxillary line: a cadaveric study in respect to chest drain insertion. *Clin Anat* 2005;18:346-49.
  11. Deneuille M. Morbidity of percutaneous tube thoracostomy in trauma patients. *Eur J Cardiothorac Surg* 2002;22:673-8. Available at: <http://ejcts.oxfordjournals.org/content/22/5/673.long>. Accessed June 25, 2014.
  12. Grogan D, Irwin R, Channick R. Complications associated with thoracentesis. A prospective, randomized study comparing three different methods. *Arch Intern Med* 1990;150:873-7.
  13. Despars J, Sassoon C, Light R. Significance of iatrogenic pneumothoraces. *Chest* 1994;105:1147-50. Available at: <http://journal.publications.chestnet.org/data/Journals/CHEST/21693/1147.pdf>. Accessed June 25, 2014.
  14. Sadeghi B, Baron R, Zrelak P, et al. Cases of iatrogenic pneumothorax can be identified from ICD-9-CM coded data. *Am J Med Qual* 2010;25(3):218-24. Available at: <http://ajm.sagepub.com/content/25/3/218.long>. Accessed June 25, 2014.
  15. Celik B, Sahin E, Nadir A, et al. Iatrogenic pneumothorax: etiology, incidence, and risk factors. *Thorac Cardiovasc Surg* 2009;57:286-90.
  16. Jones P, Moyers J, Rogers J. Ultrasound-guided thoracentesis: is it a safer method? *Chest* 2003;123:418-23. Available at: <http://journal.publications.chestnet.org/article.aspx?articleid=1081311>. Accessed June 25, 2014.