Texas Children's Hospital

DATE: April 2017

TEXAS CHILDREN'S HOSPITAL
EVIDENCE-BASED OUTCOMES CENTER
Primary Spontaneous Pneumothorax (PSP)
Evidence-Based Guideline

Definition: Pneumothorax refers to air in the pleural cavity (i.e., interspersed between the lung and the chest wall). [1,2] Primary spontaneous pneumothorax (PSP) occurs in otherwise healthy patients; secondary pneumothorax is associated with underlying lung disease. [1-4]

Etiology: Anatomical abnormalities have been demonstrated, even in the absence of overt underlying lung disease. [2] Smoking has been implicated in the etiology of PSP.

Inclusion Criteria
- Initial or recurrent spontaneous pneumothorax in otherwise healthy patients

Exclusion Criteria
- Underlying chronic lung disease
- Explained pneumothorax (e.g., traumatic, iatrogenic, or resulting from birth)
- Pregnant women

Differential Diagnosis
Tension pneumothorax
Secondary spontaneous pneumothorax
Traumatic pneumothorax

Diagnostic Evaluation [2,4]
History: Assess for
- Abrupt onset when at rest or with minimal exertion
- Exclusion of explained pneumothorax

Physical Examination
- Chest pain
- Dyspnea
- Asymmetric lung expansion
- Diminished breath sounds
- Hyperresonance on percussion
- Sweating, tachypnea, tachycardia

Critical Points of Evidence*

Evidence Supports
- Utilize inspiratory chest x-ray to detect and diagnose primary spontaneous pneumothorax. [1-16] – Strong recommendation, moderate quality evidence
- Obtain a CT for recurrent (>1) pneumothorax or suspected underlying lung pathology, or for surgical planning if persistent air leak >4 days. [5-16] – Strong recommendation, very low quality evidence
- Observe patients with a small pneumothorax and administer oxygen. Obtain a chest x-ray at 4-6 hours and if no progression of size, remove oxygen and consider discharging the patient, if the pneumothorax has increased in size at the time of the subsequent chest x-ray, insert a pleural (pigtail) catheter or chest tube. [1-4,10,13,15,17-30]
  – Strong recommendation, very low quality evidence
- Insert a pleural (pigtail) catheter or chest tube for patients with a large pneumothorax. [1,3,10,13,14,17-30] – Strong recommendation, very low quality evidence
- Perform surgical intervention for patients with a recurrent pneumothorax or persistent air leak >4 days. [1-3,5,10,13,14,17-30] – Strong recommendation, very low quality evidence
- Consider surgical intervention for patients with blebs/bullae on CT, if obtained. [10,13,14,17-30] – Weak recommendation, very low quality evidence
- Consider bilateral surgical intervention if contralateral blebs/bullae are detected. [10,13,14,17-30] – Weak recommendation, very low quality evidence
- Insert a pleural (pigtail) catheter vs. a chest tube to minimize patient discomfort. [1,2,26,32-39] – Strong recommendation, very low quality evidence
- Provide supervision for learners inserting a chest tube or pleural (pigtail) catheter. [33,40-42] – Strong recommendation, very low quality evidence

Evidence Lacking/Inconclusive
- Manage each pneumothorax independently in the case of bilateral pneumothoraces. – Consensus recommendation
- Position the patient in a supine position when inserting a pleural (pigtail) catheter/chest tube. – Consensus recommendation
- Utilize chest x-ray to confirm adequate placement of a pleural (pigtail) catheter/chest tube. [33] – Consensus recommendation
- Administer oxygen via non-rebreather mask on initial diagnosis. If no further intervention is needed, transition to nasal cannula. – Consensus recommendation
- Remove the pleural (pigtail) catheter/chest tube in a staged manner once a chest x-ray demonstrates complete resolution and there is no clinical evidence of air leak. Any suction should be discontinued. [1,3,33] – Consensus recommendation

*NOTE: The references cited represent the entire body of evidence reviewed to make each recommendation.

Condition-Specific Elements of Clinical Management

Admission Criteria

- Significant chest pain
- Oxygen requirement
- Respiratory distress (tachypnea, dyspnea, retractions)
- Need for chest tube placement

Discharge Criteria

- Afebrile
- Oxygen saturations >90% on room air
- Resolution of chest pain and/or respiratory distress
- Stable or resolving small pneumothorax by chest X-ray
- Removal of chest tube with normal/stable chest X-ray

Consults/Referrals

Consult surgery after radiologic confirmation of PSP.

Follow-Up Care

Outpatient visit with Surgery within 3 weeks

Measures

Process

- CXR vs. CT as initial diagnostic study
- Placement of chest tube by IR vs. surgery
- Chest tube requirement for patients who were initially only observed

Outcome

- "Immediate" recurrence after chest tube removal
- Length of stay
- Readmission for chest pain or dyspnea
- Ipsilateral recurrence within 30 days

TCH Evidence-Based Outcomes Center
Diagnosis and Management of Primary Spontaneous Pneumothorax

Inclusion Criteria:
Initial or recurrent spontaneous pneumothorax in otherwise healthy patients

Exclusion Criteria:
Underlying chronic lung disease, explained pneumothorax (e.g., traumatic, iatrogenic, or resulting from birth)

Begin^

^If tension pneumothorax is suspected at any time, notify Emergency Medicine and Surgery attendings. If unstable, perform needle thoracostomy.

Spontaneous pneumothorax confirmed by inspiratory chest x-ray

No → OFF algorithm

Yes

- Administer oxygen via non-rebreather mask.
- Consult Surgery.

Yes

Recurrent (>1) pneumothorax or suspected underlying lung pathology

Yes →
- Obtain a non-contrast CT, if clinically indicated.
- If suspected underlying lung pathology, consult Pulmonary.

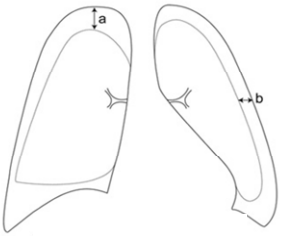
→ Surgical intervention as needed

No

- Assess size* and degree of clinical compromise.
- If bilateral pneumothoraces, manage each pneumothorax independently.

*The size of the pneumothorax is less important than the degree of clinical compromise.

For children >12 years, a pneumothorax is considered 'large' based on the following measurements:
- Measurement of the vertical distance between the lung and thoracic cage at the apex (a); if ≥3 cm, pneumothorax is large
OR
- Measurement of the distance between the lateral lung edge and chest wall at the level of the hilum (b); if >2 cm, pneumothorax is large



Small*

- Transition to nasal cannula as appropriate.
- Obtain a chest x-ray at 4-6 hours.

Progression of size

No → Remove oxygen and consider discharge if the patient no longer requires oxygen on room air.

Yes →
- Insert a pleural (pigtail) catheter (preferred) or chest tube.
- Confirm adequate placement with chest x-ray.

Large*

- Insert a pleural (pigtail) catheter (preferred) or chest tube.
- Confirm adequate placement with chest x-ray.

- Remove the catheter in a staged manner once a chest x-ray demonstrates complete resolution and there is no clinical evidence of air leak.
- Manage as appropriate to clinical findings.

References

1. Belgian Society of Pneumology. (2005). Management of spontaneous pneumothorax. *Acta Chirurgica Belgica, 105*(3), 265-267.
2. MacDuff, A., Arnold, A., Harvey, J., on behalf of the BTS Pleural Disease Guideline Group. (2010). Management of spontaneous pneumothorax: British Thoracic Society pleural disease guideline 2010. *Thorax, 65*(Suppl 2), ii18-ii31.
3. Baumann, M. H., Strange, C., Heffner, J. E., Light, R., Kirby, T. J., Klein, J., et al. (2001). Management of spontaneous pneumothorax: An American College of Chest Physicians Delphi consensus statement. *CHEST, 119*(2), 590-602.
4. The Royal Children's Hospital Melbourne. Primary spontaneous pneumothorax.
5. Balesa, J., Rathi, V., Kumar, S., & Tandon, A. (2015). Chest sonography in the diagnosis of pneumothorax. *Indian Journal of Chest Disease and Allied Science, 57*(1), 7-11.
6. Druda, D., & Kelly, A. M. (2009). What is the difference in size of spontaneous pneumothorax between inspiratory and expiratory x-rays? *Emergency Medicine Journal, 26*(12), 861-863.
7. Guimaraes, C. V., Donnelly, L. F., & Warner, B. W. (2007). CT findings for blebs and bullae in children with spontaneous pneumothorax and comparison with findings in normal age-matched controls. *Pediatric Radiology, 37*(9), 879-884.
8. Jalli, R., Sefidbakht, S., & Jafari, S. H. (2013). Value of ultrasound in diagnosis of pneumothorax: A prospective study. *Emergency Radiology, 20*(2), 131-134.
9. Kawaguchi, T., Kushibe, K., Yasukawa, M., & Kawai, N. (2013). Can preoperative imaging studies accurately predict the occurrence of bullae or blebs? Correlation between preoperative radiological and intraoperative findings. *Respiratory Investigation, 51*(4), 224-228.
10. Kim, D. H. (2011). The feasibility of axial and coronal combined imaging using multi-detector row computed tomography for the diagnosis and treatment of a primary spontaneous pneumothorax. *Journal of Cardiothoracic Surgery, 6*, 71.
11. Laituri, C. A., Valusek, P. A., Rivard, D. C., Garey, C. L., Ostlie, D. J., Snyder, C. L., et al. (2011). The utility of computed tomography in the management of patients with spontaneous pneumothorax. *Journal of Pediatric Surgery, 46*(8), 1523-1525.
12. Lee, K. H., Kim, K. W., Kim, E. Y., Lee, J. I., Kim, Y. S., Hyun, S. Y., et al. (2014). Detection of blebs and bullae in patients with primary spontaneous pneumothorax by multi-detector CT reconstruction using different slice thicknesses. *Journal of Medical Imaging and Radiation Oncology, 58*(6), 663-667.
13. Lopez, M. E., Fallon, S. C., Lee, T. C., Rodriguez, J. R., Brandt, M. L., & Mazziotti, M. V. (2014). Management of the pediatric spontaneous pneumothorax: Is primary surgery the treatment of choice? *The American Journal of Surgery, 208*(4), 571-576.
14. Nathan, N., Guilbert, J., Larroquet, M., Lenoir, M., Clement, A., & Epaud, R. (2010). Efficacy of blebs detection for preventive surgery in children's idiopathic spontaneous pneumothorax. *World Journal of Surgery, 34*(1), 185-189.
15. Thomsen, L., Natho, O., Feigen, U., Schulz, U., & Kivelitz, D. (2014). Value of digital radiography in expiration in detection of pneumothorax. *RoFo, 186*(3), 267-273.
16. Volpicelli, G., Boero, E., Sverzellati, N., Cardinale, L., Busso, M., Boccuzzi, F., et al. (2014). Semi-quantification of pneumothorax volume by lung ultrasound. *Intensive Care Medicine, 40*(10), 1460-1467.
17. Casali, C., Stefani, A., Ligabue, G., Natalie, P., Aramini, B., Torricelli, P., et al. (2013). Role of blebs and bullae detected by high-resolution computed tomography and recurrent spontaneous pneumothorax. *Annals of Thoracic Surgery, 95*(1), 249-256.
18. Chiu, C. Y., Chen, T. P., Wang, C. J., Tsai, M. H., & Wong, K. S. (2014). Factors associated with proceeding to surgical intervention and recurrence of primary spontaneous pneumothorax in adolescent patients. *European Journal of Pediatrics, 173*(11), 1483-1490.
19. Choi, S. Y., Park, C. B., Song, S. W., Kim, Y. H., Jeong, S. C., Kim, K. S., et al. (2014). What factors predict recurrence after an initial episode of primary spontaneous pneumothorax in children? *Annals of Thoracic and Cardiovascular Surgery, 20*(6), 961-967.
20. Ganesalingam, R., O'Neil, R. A., Shadbolt, B., & Tharion, J. (2010). Radiological predictors of recurrent primary spontaneous pneumothorax following non-surgical management. *Heart, Lung and Circulation, 19*(10), 606-610.
21. Haga, T., Kurihara, M., & Kataoka, H. (2013). Spontaneous pneumothorax with persistent air leakage and invasive procedures. *Internal Medicine, 52*(19), 2189-2192.
22. Huang, T.-W., Lee, S.-C., Cheng, Y.-L., Tzao, C., Hsu, H.-H., Chang, H., et al. (2007). Contralateral recurrence of primary spontaneous pneumothorax. *CHEST, 132*(4), 1146-1150.
23. Kelly, A. M., Kerr, D., & Clooney, M. (2008). Outcomes of emergency department patients treated for primary spontaneous pneumothorax. *CHEST, 134*(5), 1033-1036.
24. Noh, D., Lee, S., Haam, S. J., Paik, H. C., & Lee, D. Y. (2015). Recurrence of primary spontaneous pneumothorax in young adults and children. *Interactive Cardiovascular and Thoracic Surgery, 21*(2), 195-199.
25. Olesen, W. H., Lindahl-Jacobsen, R., Katballe, N., Sindby, J. E., Titlestad, I. L., Andersen, P. E., et al. (2016). Recurrent primary spontaneous pneumothorax is common following chest tube and conservative treatment. *World Journal of Surgery, 40*(9), 2163-2170.
26. Ouanes-Besbes, L., Golli, M., Knani, J., Dachraoui, F., Nciri, N., El Atrous, S., et al. (2007). Prediction of recurrent spontaneous pneumothorax: CT scan findings versus management features. *Respiratory Medicine, 101*(2), 230-236.
27. Qureshi, F. G., Sandulache, V. C., Richardson, W., Ergun, O., Ford, H. R., & Hackam, D. J. (2005). Primary vs delayed surgery for spontaneous pneumothorax in children: Which is better? *Journal of Pediatric Surgery, 40*(1), 166-169.
28. Ryu, K. M., Seo, P. W., Park, S., & Ryu, J. W. (2009). Complete atelectasis of the lung in patients with primary spontaneous pneumothorax. *Annals of Thoracic Surgery, 87*(3), 875-879.
29. Sayar, A., Kok, A., Citak, N., Metin, M., Buyukkale, S., & Gurses, A. (2014). Size of pneumothorax can be a new indication for surgical treatment in primary spontaneous pneumothorax: A prospective study. *Annals of Thoracic and Cardiovascular Surgery, 20*(3), 192-197.
30. Seguier-Lipszyc, E., Elizur, A., Klin, B., Vaiman, M., & Lotan, G. (2011). Management of primary spontaneous pneumothorax in children. *Clinical Pediatrics, 50*(9), 797-802.
31. Benton, I. J., & Benfield, G. F. (2009). Comparison of a large and small-calibre tube drain for managing spontaneous pneumothoraces. *Respiratory Medicine, 103*(10), 1436-1440.
32. Havelock, T., Teoh, R., Laws, D., Gleeson, F., on behalf of the BTS Pleural Disease Guideline Group. (2010). Pleural procedures and thoracic ultrasound: British Thoracic Society pleural disease guideline 2010. *Thorax, 65*(Suppl 2), ii61-ii76.
33. Balfour-Lynn, I. M., Abrahamson, E., Cohen, G., Hartley, J., King, S., Parikh, D., et al. (2005). BTS guidelines for the management of pleural infection in children. *Thorax, 60*(Suppl 1), i1-i21.
34. Cho, S., & Lee, E. B. (2010). Management of primary and secondary pneumothorax using a small-bore thoracic catheter. *Interactive CardioVascular and Thoracic Surgery, 11*(2), 146-149.
35. Dull, K. E., & Fleisher, G. R. (2002). Pigtail catheters versus large-bore chest tubes for pneumothoraces in children treated in the emergency department. *Pediatric Emergency Care, 18*(4), 265-267.
36. Iepsen, U. W., & Ringbaek, T. (2013). Small-bore chest tubes seem to perform better than larger tubes in treatment of spontaneous pneumothorax. *Danish Medical Journal, 60*(6), A4644.
37. Kuo, H. C., Lin, Y. J., Huang, C. F., Chien, S. J., Lin, I. C., Lo, M. H., et al. (2013). Small-bore pigtail catheters for the treatment of primary spontaneous pneumothorax in young adolescents. *Emergency Medicine Journal, 30*(3), e17.
38. Liu, C. M., Hang, L. W., Chen, W. K., Hsia, T. C., & Hsu, W. H. (2003). Pigtail tube drainage in the treatment of spontaneous pneumothorax. *American Journal of Emergency Medicine, 21*(3), 241-244.

39. Vedam, H., & Barnes, D. J. (2003). Comparison of large- and small-bore intercostal catheters in the management of spontaneous pneumothorax. *Internal Medicine Journal 33*(11), 495-499.
40. Carter, P., Conroy, S., Blakeney, J., & Sood, B. (2014). Identifying the site for intercostal catheter insertion in the emergency department: is clinical examination reliable? *Emergency Medicine Australasia, 26*(5), 450-454.
41. Elsayed, H., Roberts, R., Emadi, M., Whittle, I., & Shackcloth, M. (2010). Chest drain insertion is not a harmless procedure--are we doing it safely? *Interactive CardioVascular and Thoracic Surgery, 11*(6), 745-748.
42. Griffiths, J. R., & Roberts, N. (2005). Do junior doctors know where to insert chest drains safely? *Postgraduate Medical Journal, 81*(957), 456-458.

Clinical Standards Preparation

This clinical standard was prepared by the Evidence-Based Outcomes Center (EBOC) team in collaboration with content experts at Texas Children's Hospital. Development of this clinical standard supports the TCH Quality and Patient Safety Program initiative to promote clinical standards and outcomes that build a culture of quality and safety within the organization.

Primary Spontaneous Pneumothorax Content Expert Team
Danny Castro, MD, Critical Care Medicine
Julia Lawrence, RT, Respiratory Therapy
Monica Lopez, MD, Surgery
Binita Patel, MD, Emergency Medicine
Krista Preisberga, MD, Pediatric Hospital Medicine
Daniel Rubalcava, MD, MSPH, Emergency Medicine
Alan Schlesinger, MD, Radiology
Manuel Silva Carmona, MD, Pulmonary
Elizabeth Wuestner, CS, RN, Emergency Center

EBOC Team
Jennifer Loveless, MPH, Research Specialist
Ellis Arjmand, MD, PhD, MMM, Associate Medical Director
Charles Macias, MD, MPH, Medical Director

Additional EBOC Support
Tom Burke, Research Assistant
Sherin Titus, Research Assistant
Karen Gibbs, MSN/MPH, RN, Research Specialist
Andrea Jackson, MBA, RN, Research Specialist
Sheesha Porter, MS, RN, Research Specialist
Christina Davidson, MD, Associate Medical Director
Anne Dykes, MSN, RN, Assistant Director
Kathy Carberry, MPH, RN, Director

No relevant financial or intellectual conflicts to report.

Development Process

This clinical standard was developed using the process outlined in the EBOC Manual. The literature appraisal documents the following steps:

1. Review Preparation
   - PICO questions established
   - Evidence search confirmed with content experts

2. Review of Existing External Guidelines
   - Belgian Society of Pneumology Management of Spontaneous Pneumothorax, British Thoracic Society Management of Spontaneous Pneumothorax, British Thoracic Society Pleural Procedures and Thoracic Ultrasound, British Thoracic Society Management of Pleural Infection in Children, American College of Chest Physicians Management of Spontaneous Pneumothorax, The Royal Children's Hospital Melbourne Primary Spontaneous Pneumothorax

3. Literature Review of Relevant Evidence
   - Searched: Cochrane, PubMed, Google

4. Critically Analyze the Evidence
   - 1 randomized controlled trial and 39 nonrandomized studies

5. Summarize the Evidence
   - Materials used in the development of the guideline, evidence summary, and order sets are maintained in primary spontaneous pneumothorax evidence-based review manual within EBOC.

Evaluating the Quality of the Evidence

Published clinical guidelines were evaluated for this review using the **AGREE II** criteria. The summary of these guidelines are included in the literature appraisal. AGREE II criteria evaluate Guideline Scope and Purpose, Stakeholder Involvement, Rigor of Development, Clarity and Presentation, Applicability, and Editorial Independence using a 4-point Likert scale. The higher the score, the more comprehensive the guideline.

This clinical standard specifically summarizes the evidence *in support of* or *against* specific interventions and identifies where evidence is *lacking/inconclusive*. The following categories describe how research findings provide support for treatment interventions.
"Evidence Supports" provides evidence to support an intervention
"Evidence Against" provides evidence against an intervention.
"Evidence Lacking/Inconclusive" indicates there is insufficient evidence to support or refute an intervention and no conclusion can be drawn *from the evidence.*

The **GRADE** criteria were utilized to evaluate the body of evidence used to make practice recommendations. The table below defines how the quality of the evidence is rated and how a strong versus weak recommendation is established. The literature appraisal reflects the critical points of evidence.

Recommendation	
STRONG	Desirable effects clearly outweigh undesirable effects or vice versa
WEAK	Desirable effects closely balanced with undesirable effects
Quality	**Type of Evidence**
High	Consistent evidence from well-performed RCTs or exceptionally strong evidence from unbiased observational studies
Moderate	Evidence from RCTs with important limitations (e.g., inconsistent results, methodological flaws, indirect evidence, or imprecise results) or unusually strong evidence from unbiased observational studies
Low	Evidence for at least 1 critical outcome from observational studies, RCTs with serious flaws or indirect evidence
Very Low	Evidence for at least 1 critical outcome from unsystematic clinical observations or very indirect evidence

Recommendations

Practice recommendations were directed by the existing evidence and consensus amongst the content experts. Patient and family preferences were included when possible. The Content Expert Team and EBOC team remain aware of the controversies in the diagnosis and management of primary spontaneous pneumothorax in children. When evidence is lacking, options in care are provided in the clinical standard and the accompanying order sets (if applicable).

Approval Process

Clinical standards are reviewed and approved by hospital committees as deemed appropriate for its intended use. Clinical standards are reviewed as necessary within EBOC at Texas Children's Hospital. Content Expert Teams are involved with every review and update.

Disclaimer

Practice recommendations are based upon the evidence available at the time the clinical standard was developed. Clinical standards (guidelines, summaries, or pathways) do not set out the standard of care, and are not intended to be used to dictate a course of care. Each physician/practitioner must use his or her independent judgment in the management of any specific patient and is responsible, in consultation with the patient and/or the patient family, to make the ultimate judgment regarding care.

Version History

Date	Comments
Apr 2017	Originally completed