

Selected Best Practices and Suggestions for Improvement

NQI 01/PDI 05: Iatrogenic Pneumothorax

Why focus on iatrogenic pneumothorax in neonates and children?

- Complex procedures performed near the lungs can be more difficult in children than in older patients because of their smaller lung size.
- Iatrogenic pneumothorax in children occurs at rates that are at least comparable to those in adults at 0.48 per 1,000 discharges in pediatric patients.¹
- Neonates have an even higher risk of iatrogenic pneumothorax due to barotrauma.²
- Iatrogenic pneumothorax leads to significantly increased length of stay and cost, with one study finding an increased mean length of stay of 11.6 days and increased charges of \$61,991 in affected pediatric patients. Children with iatrogenic pneumothorax also had 7.5 times the odds of in-hospital mortality, even after adjusting for numerous risk factors.³ These results were supported by another study that found an average of \$53,604 in excess total charges associated with iatrogenic pneumothorax in children.⁴

Recommended Practice	Details of Recommended Practice
Identification of Patients at Risk	Develop a process to address common iatrogenic pneumothorax risk factors identified in the literature for the neonate and pediatric population. ⁵
Safe Insertion Techniques During Pleural Procedures	Standardize procedures and position techniques during pleural procedures, such as thoracentesis and chest tube insertion. ⁶⁻⁹
Provider Training	Develop specified training components and criteria and establish a plan for continued competency. ^{6,7}
Standardized Practices	Develop and standardize practices for site identification, marking, and procedural practice. ^{6,7,10-12}

Best Processes/Systems of Care

Introduction: Essential First Steps

- Engage key procedural personnel who care for pediatric patients, including nurses, physicians and other providers, technicians, and representatives from the quality improvement department, to develop evidence-based protocols for care of the neonatal and pediatric 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 guideline 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 Neonatal and Pediatric 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 pneumothorax. Some common risk factors among neonates and children are¹³⁻¹⁵:
 - Respiratory distress syndrome.
 - Meconium aspiration syndrome.
 - Pulmonary hypoplasia.
 - Infants who need resuscitation at birth.
 - Below-average body mass index.
 - Previous pneumothorax.
 - Ventilated patients (CPAP, PPV).
 - Suctioning during ventilation.
 - Reintubation.
 - Chest compressions.
 - Active expiration.
 - Smoking (if applicable).
 - Cystic fibrosis.

Recommended Practice: Safe Insertion Techniques During Pleural Procedures

- Standardize procedures and equipment.⁷
 - Use of real-time ultrasound to identify and mark site and/or guidance for thoracentesis.^{8,9,10,12,13,16-18}
 - 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.^{6,8}
- Use blunt dissection vs. trocar use for chest tube insertion.^{6,9}

Recommended Practice: Provider Training

- Provide specified training, including three components:
 - Theoretical didactic training,
 - Simulated practice, and
 - Formal, supervised practice with minimum observation criteria.^{6,7}
- 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.^{6,7}

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.^{6,10}
- Site marking performed immediately prior to the procedure to reduce the likelihood of fluid redistribution or tissue/organ movement secondary to patient repositioning.^{6,11}
- Implementation of procedural guidelines (e.g., American College of Chest Physicians).

Educational Recommendation

- Plan and provide education on protocols to physicians and other providers, nursing, and all other staff involved in procedural cases in children and neonates. 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 (physicians and other providers, 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

- WHO Surgical Care at the District Hospital 2003, World Health Organization
<http://www.who.int/surgery/publications/Postoperativecare.pdf>
- 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.
- Henry M, Arnold T, Harvey J. BTS guidelines for the management of spontaneous pneumothorax. *Thorax* 2003;58 Suppl 2:ii39-ii52

Policies/Protocols

- University of Iowa Children's Hospital - Technique for Insertion of a Chest Tube
<http://www.uichildrens.org/childrens-content.aspx?id=234467>

Tools

- AHRQ Innovations Quality Tool: Problems and Prevention: Chest Tube Insertion
<https://innovations.ahrq.gov/qualitytools/problems-and-prevention-chest-tube-insertion>

- NHS Chest Drain Protocol
<http://www.bsuh.nhs.uk/EasySiteWeb/GatewayLink.aspx?allId=383931>

Staff Required

- Physicians and other providers (pediatric surgeons, neonatologists, pediatricians)
- 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, medicine and pediatrics, nursing leadership, and unit managers

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