HOSPITAL HARM IMPROVEMENT RESOURCE

Pneumothorax

cpsi icsp
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ACKNOWLEDGEMENTS

The Canadian Institute for Health Information and the Canadian Patient Safety Institute have collaborated on a body of work to address gaps in measuring harm and to support patient safety improvement efforts in Canadian hospitals.

The Hospital Harm Improvement Resource was developed by the Canadian Patient Safety Institute to complement the Hospital Harm measure developed by the Canadian Institute for Health Information. It links measurement and improvement by providing resources that will support patient safety improvement efforts.

DISCHARGE ABSTRACT DATABASE (DAD) CODES INCLUDED IN THIS CLINICAL CATEGORY:

D22: Pneumothorax

Concept	Pneumothorax associated with a medical or surgical procedure.
Selection criteria	
Codes	**Conditions**
J95.80	Identified as diagnosis type (2) **AND** Y60–Y84 **in the same diagnosis cluster**
S27.0– S27.2–	Identified as diagnosis type (3) **AND** T80–T88 as diagnosis type (2) **AND** Y60–Y84 **in the same diagnosis cluster** **OR** Identified as diagnosis type (2) **AND** Y60–Y84 **in the same diagnosis cluster**
Codes	**Code descriptions**
J95.80	Post-procedural pneumothorax
S27.0–	Traumatic pneumothorax
S27.2–	Traumatic hemopneumothorax
Additional Codes	**Inclusions**
Codes	**Code descriptions**
T80–T88	Complications of surgical and medical care not elsewhere classified. Refer to Appendix A of the Hospital Harm Indicator General Methodology Notes
Y60–Y84	Complications of medical and surgical care. Refer to Appendix A of the Hospital Harm Indicator General Methodology Notes.

OVERVIEW AND IMPLICATIONS

A pneumothorax is present when there is air in the pleural space. Pneumothoraces are classified as spontaneous, which develop without preceding trauma or other obvious cause, and traumatic, which develop as a result of direct or indirect trauma to the chest. Traumatic pneumothoraces can be either iatrogenic or non-iatrogenic (Light & Lee, 2016). An iatrogenic pneumothorax (IP) is a known complication of invasive procedures such as pulmonary needle biopsy (transthoracic and transbronchial), placement of a central venous line, or positive pressure ventilation. However, this condition can arise from many other procedures involving the thorax and abdomen. Subclavian insertion of a central venous line (CVL) is the most common procedure associated with an iatrogenic pneumothorax (Ojeda Rodriguez & Hipskind, 2021) and is the focus of this indicator.

In the *Measuring Patient Harm in Canadian Hospitals*, the Canadian Institute for Health Information (CIHI) reported that of the 181,596 harmful events identified in the Data Quality Study of the 2015–2016 Discharge Abstract Database; 1.1 per cent were due to pneumothorax from a medical or surgical procedure (Chan et al., 2016) and 2,100 pneumothoraces were reported in 2019-2020 (CIHI, 2020). AHRQ reports the 2020 rate of IP per 1,000 at 0.19 in the United States (AHRQ, 2020).

A tension pneumothorax is present when the air accumulates in the pleural space to a point where the increasing pressure impedes normal cardiovascular function. [It] can occur with any of the types of pneumothorax but occur more commonly in patients receiving positive pressure ventilation or CPR [and] can lead – often quite suddenly – to life-threatening hypotension and shock (Light & Lee, 2016).

Iatrogenic pneumothoraces is a potentially life-threatening complication seen in three per cent of ICU patients (Chen et al., 2002; Anzueto et al., 2004; de Lassence et al., 2006). It has been associated with an increase in ICU and hospital length of stay, and resource utilization (Amato et al., 1998; Anzueto et al., 2004; de Lassence et al., 2006; Zhan et al., 2006), as well as an increase in the risk of death (Gattinoni et al., 1994, Schnapp et al., 1995, Esteban et al., 2002).

IP is largely preventable (de Lassence et al., 2006). In the ICU setting, the currently low three per cent incidence of IP was around eight per cent in the 1980s (de Lassence et al., 2006). This decrease is believed to be due to improved equipment, techniques, and safer practices both for mechanical ventilation and procedure- related pneumothorax (Çelik et al., 2009).

The incidence of procedure-related pneumothorax has also been reduced by improved equipment (e.g., ultrasound), education, and training; these improvements have equally been noted in the non-ICU and pediatric settings (Duncan et al., 2009; Gordon et al., 2010; Havelock et al., 2010; Lenchus et al., 2010; Cavanna et al., 2010; Troianos et al., 2012).

Procedures associated with iatrogenic pneumothorax[§]

Any intervention in proximity to the abdomen, especially the thorax, can cause an iatrogenic pneumothorax. This is especially true when placing a subclavian central venous catheter

[§] Anzueto et al., 2004; de Lassence et al., 2006; Zhan et al., 2006; Çelik et al., 2009; Loiselle et al., 2013; Light & Lee, 2016, Ojeda Rodriguez & Hipskind, 2021

without the use of ultrasound (i.e., "blindly") using landmarks. In landmark-based subclavian central venous catheter placement, per Kilbourne et al., six common technical errors include inadequate landmark identification, improper insertion position, insertion of the needle through periosteum, taking too shallow a trajectory with the needle, aiming the needle to cephalad, and failure to keep the needle in place for wire passage. Landmark technique also depends on the ability and experience of the medical professional performing the procedure, making iatrogenic pneumothorax more likely in a tertiary teaching hospital (Ojeda Rodriguez & Hipskind, 2021).

Other procedures associated with IP:

- *Dry needling* (Health Quality Council of Alberta, 2014).
- *Airway-related:* endotracheal tube insertion (intubation) or misplacement (neonates), inadequate clearance of trapped secretions, positive airway pressure devices (Carron et al., 2007; Chebel et al., 2010; Hegde & Prodhan, 2013; Milési et al., 2014).
- *Surgical:* tracheostomy, thoracotomy, mediastinoscopy, cardiac surgery, insertion/revision/replacement/removal of cardiac pacemaker or cardioverter/defibrillator, breast augmentation, rarely: abdominal cavity operations.
- *C*ardiopulmonary resuscitation (CPR).

Patient Risk Factors

Patient factors that increase the risk of pneumothorax in the setting of an intervention include:

- Age.
- Low body weight.*
- Poor healing ability (chronic corticosteroid use, malnutrition).
- Severity of acute illness.*
- Acute or chronic pulmonary≠ or pleural∞ disease.
- Agitation.
- AIDS.*

GOAL

To prevent iatrogenic pneumothorax in hospitalized adult patients by implementing best practices for risk reduction.

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* Noted for ICU patients of all ages (de Lassence et al., 2006).

≠ Bronchopulmonary dysplasia, acute bronchiolitis, COPD, Adult or neonatal Respiratory Distress Syndrome, cardiogenic pulmonary edema, pneumonia, primary lung cancer (Anzueto et al., 2004).

∞ Malignant and parapneumonic pleural effusion, empyema (Nyman et al., 2008).

IMPORTANCE TO PATIENTS AND FAMILIES

A pneumothorax (a term for collapsed lung) occurs when air leaks into the space between a patient's lung and chest wall, creating pressure against the lung. Depending on how much air has leaked in, the patient's lung may only be partially collapsed, or it may collapse completely. The greater the pneumothorax, the more it will interfere with normal breathing and may even become life-threatening. The occurrence of a pneumothorax during hospitalization is likely to prolong hospital stay. After being treated for a collapsed lung with a tube, chances of having a recurrence is low, but possible. Patients should avoid scuba diving and flying in a plane for at least 72 hours**.**

Patient Story

A Case of Iatrogenic Pneumothorax

Ms. I. Ava Numeau, a 72-year old woman, underwent insertion of a central venous catheter via a subclavian approach in preparation for a right hemicolectomy. Now, she's restless and complains of shortness of breath and pleuritic chest pain. You take her vital signs: blood pressure 175/95, heart rate 115, respirations 28, and room air SpO2 89 per cent. On examination, she appears in mild-moderate respiratory distress. Over the left hemi thorax there is hyper-resonance to percussion and diminished air entry to auscultation.

Ms. Numeau was admitted the previous day for resection of a cecal adenocarcinoma, which caused significant weight loss from symptomatic recurrent intermittent incomplete bowel obstruction. Her past medical history includes hypertension controlled with medication and rheumatoid arthritis, for which she is on chronic corticosteroids. Her preadmission examination was unremarkable except for integumentary signs of chronic steroid use, early muscle wasting, and mild abdominal distension. After unsuccessful attempts at obtaining peripheral venous access and inability to insert an internal jugular venous catheter due to limited cervical spine and shoulder mobility, the physician inserted a central venous catheter via the left subclavian vein.

Ms. Numeau's history reveals several risk factors for pneumothorax and the bedside assessment is suggestive of an iatrogenic pneumothorax.

The event could have been prevented by the use of bedside ultrasound-guided insertion of the internal jugular vein, which may have required only minimal neck/shoulder positioning. In addition, a Trendelenburg positioning would have increased the size of the great thoracic veins thus facilitating central venous insertion/cannulation. Finally, a peripherally-inserted central catheter (PICC) could also have been entertained, depending on the skillset of the medical provider.

Ms. Numeau's nurse provided her with 100 per cent oxygen while monitoring her vital signs. A stat portable chest X-ray was done, confirming the diagnosis and the rapid response team prepared to insert a chest tube with a 14-gauge I.V. catheter at the bedside if the patient developed signs of tension pneumothorax. The patient received appropriate procedural sedation and analgesia. Within minutes of chest tube insertion, her vital signs normalized, and her chest

pain and dyspnea resolved. Repeat chest X-ray confirmed proper positioning of the chest tube and resolution of the pneumothorax.

Clinical and System Reviews, Incident Analyses

Given the broad range of potential causes of hospital associated Pneumothorax, clinical and system reviews should be conducted to identify latent causes and determine appropriate recommendations.

Occurrences of harm are often complex with many contributing factors. Organizations need to:

1. Measure and monitor the types and frequency of these occurrences.
2. Use appropriate analytical methods to understand the contributing factors.
3. Identify and implement solutions or interventions that are designed to prevent recurrence and reduce risk of harm.
4. Have mechanisms in place to mitigate consequences of harm when it occurs.

To develop a more in-depth understanding of the care delivered to patients, chart audits, incident analyses and prospective analyses can be helpful in identifying quality improvement opportunities. Links to key resources for conducting chart audits and analysis methods are included in the Hospital Harm Improvement Resources Introduction.

If your review reveals that your cases of Pneumothorax are linked to specific processes or procedures, you may find these resources helpful:

- Agency for Healthcare Research and Quality (AHRQ) www.ahrq.gov
    - Agency for Healthcare Research and Quality. Selected best practices and suggestions for improvement PSI 6: Iatrogenic pneumothorax. QI Toolkit Roadmap. Published 2014. Accessed March 2021. http://www.ahrq.gov/professionals/systems/hospital/qitoolkit/d4e-pneumothorax-bestpractices.pdf

- Journal of Hospital Medicine https://www.journalofhospitalmedicine.com
    - Shieh L, Go M, Gessner D, Chen JH, Hopkins J, Maggio P. Improving and sustaining a reduction in iatrogenic pneumothorax through a multifaceted quality-improvement approach. *Journal of hospital medicine*. 2015;10(9):599-607. doi: 10.1002/jhm.2388

- Seminars in Respiratory and Critical Care Medicine https://www.thieme.in/seminars-in-respiratory-and-critical-care-medicine
    - Hallifax R, Janssen JP. Pneumothorax - time for new guidelines? *Semin Respir Crit Care Med.* 2019;40(3):314-322. doi:10.1055/s-0039-1693499

- Thorax www.thorax.bmj.com
    - Johnston SL (Ed.). BTS Pleural Disease Guideline 2010. *Thorax*. August 2010; 65(Suppl 2). https://thorax.bmj.com/content/65/Suppl_2

MEASURES

Vital to quality improvement is measurement, and this applies specifically to implementation of interventions. The chosen measures will help to determine whether an impact is being made (primary outcome), whether the intervention is being carried out (process measures), and whether any unintended consequences ensue (balancing measures).

In selecting your measures, consider the following:

- Whenever possible, use measures you are already collecting for other programs.
- Evaluate your choice of measures in terms of the usefulness of the final results and the resources required to obtain them; try to maximize the former while minimizing the latter.
- Try to include both process and outcome measures in your measurement scheme.
- You may use different measures or modify the measures described below to make them more appropriate and/or useful to your particular setting. However, be aware that modifying measures may limit the comparability of your results to others.
- Posting your measure results within your hospital is a great way to keep your teams motivated and aware of progress. Try to include measures that your team will find meaningful and exciting (IHI, 2012).

GLOBAL PATIENT SAFETY ALERTS

Global Patient Safety Alerts provides access and the opportunity to learn from other organizations about specific patient safety incidents including alerts, advisories and recommendations and solutions for improving care and preventing incidents. (CPSI, n.d.). Learning from the experience of other organizations can accelerate improvement.

Recommended search terms:

- Pneumothorax
- Iatrogenic pneumothorax
- tension pneumothorax

SUCCESS STORIES

In an academic tertiary care hospital, an interprofessional team including physicians, nurses, and administrative leaders improved and sustained a reduction in iatrogenic pneumothoraces. This was done by implementing clinical documentation standards, cognitive aids, simulation training, purchase/employment of ultrasound equipment, and feedback to clinical services. The role of interprofessional communication and care coordination between health professionals cannot be understated when considering patient outcomes (Shieh et al., 2015).

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