Pneumothorax

Definition / Supporting Information

Pneumothorax is a collection of air in the potential space between the parietal and visceral layers of the pleura. Pneumothorax may be primary or secondary and may be spontaneous, traumatic, or iatrogenic.

A tension pneumothorax is a life-threatening condition that develops from a lung / chest wall injury which facilitates the trapping of air in the pleural space. This accumulation of air leads to a progressive increase in pressure in the pleural space that compresses the lung, subsequently pushing the mediastinum to the opposite hemithorax and obstructs venous return to the heart leading to shock. Tension pneumothorax is a life-threatening emergency requiring prompt recognition and intervention with emergency chest decompression. [Patient]

Keywords / also known as: air leak, collapsed lung, free air in the chest

Essential History

Ask about:

- Risk factors for primary spontaneous pneumothorax
  - Tall stature
  - Thin build
  - Male gender
  - Age greater than 10 years
  - Smoking
  - Inherited disorders, such as:
    - α_1-antitrypsin deficiency
    - Marfan's syndrome
    - Ehlers–Danlos syndrome
- Risk factors for secondary spontaneous pneumothorax
  - Underlying lung disease such as pneumonia, asthma, or cystic fibrosis
- Blunt or penetrating trauma to the chest (eg, vehicular accidents, stab wounds)
- Recent medical or surgical procedure known to be associated with the development of pneumothorax
- Mechanical ventilation

‘Red Flag’ Symptoms and Signs

Evaluation should progress only after the ABCs (airway, breathing, and circulation) of resuscitation have been addressed. Do not delay transfer to hospital if pneumothorax is suspected in the context of respiratory distress or hypoxaemia.

Ask about:

- Abrupt, persistent ipsilateral pleuritic chest pain, with or without acute dyspnoea
- Sudden dyspnoea and irritability
- Anxiety, cough, general malaise and fatigue are less commonly observed

Look for:

- Evidence of respiratory distress
  - Tachycardia (most common finding) and / or tachypnoea
  - Grunting respirations (neonates / infants)
- Diminished or absent breath sounds
- Hyper-resonance to percussion on the involved side, and chest asymmetry as size of pneumothorax increases
- Hypoxaemia
- Tracheal deviation
  - In the setting of diminished breath sounds and profound hypoxaemia, this may indicate tension pneumothorax, a life-threatening emergency.
- Hypercarbia
-
- Shift of the apical heart impulse away from side of the pneumothorax
- Hypotension

Differential Diagnosis / Conditions

- Pneumomediastinum
  - Spontaneous oesophageal perforation (Boerhaave’s syndrome)
  - Mediastinitis
- In young infants, neonatal pneumothorax must be differentiated from congenital lobar emphysema
- As pneumothorax presents with chest pain and shortness of breath other causes of these presentations may be suspected at first

Investigations

To be undertaken by specialist practitioners (eg, Emergency Department / Paediatric Intensive Care / Paediatric Respiratory Team(s)):

Imaging

If tension pneumothorax is suspected, intervention should not be delayed for radiological imaging to confirm the diagnosis.

- Chest X-ray (CXR)
  - Preferably done with the patient in an upright position and on inspiration
  - The radiological features are:
    - A white visceral pleural line, separated from the parietal pleura by avascular collection of gas (Figure 1) – in many instances, no pulmonary vessels are visible beyond the visceral pleural edge
    - Mediastinal shift towards contralateral side
    - Flattening or inversion of the diaphragm of the affected side
    - Commonly small pleural effusions are also present
  - If the patient is in a supine position the radiological features seen with a pneumothorax are:
    - Hyperlucency on the affected side
    - Abnormally deepened lucency along the costophrenic angle – deep sulcus sign

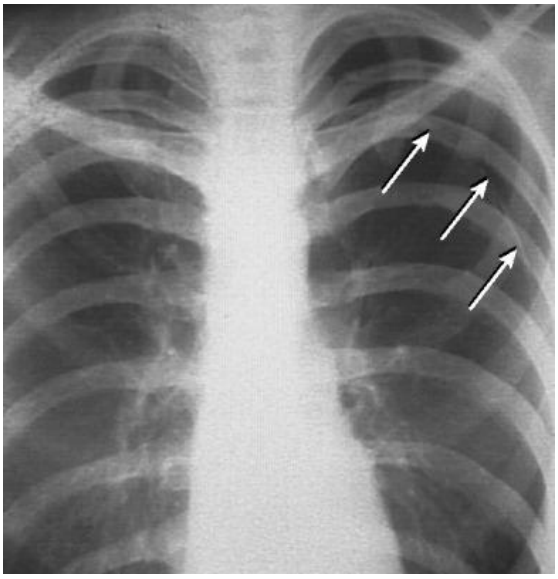

Figure 1: Pneumothorax: a white visceral pleural line, separated from the parietal pleura by radiolucent air. (Used with permission by Richard Wiggins, MD.)

Diagnostic procedures

- Fibreoptic bronchoscopy (may be required in the presence of chest trauma)
  - Assesses the possibility of a bronchial tear
  - Used in trauma patients with a large pneumothorax and persistent air leak into the pleural space despite tube thoracostomy
- Clinicians must rule out traumatic rupture of the oesophagus, as mortality approaches 100% if surgical treatment is not prompt.
  - Obtain contrast oesophagram or contrast CT if suspected.

Treatment Approach

To be undertaken by non-specialist practitioners (eg, General Practitioner (GP) Team):

- Supplemental oxygen should be administered to all patients with suspected pneumothorax
- Arrange emergency transfer for assessment by specialist practitioners (eg, Emergency Department / Paediatric Intensive Care / Paediatric Respiratory Team(s))

Specific treatments

To be undertaken by specialist practitioners (eg, Emergency Department / Paediatric Intensive Care / Paediatric Surgical / Paediatric Respiratory Team(s)):

- Primary or secondary spontaneous pneumothorax
  - Observation with supplemental oxygen in the emergency department for 3–6 hours, under paediatric specialist guidance, followed by repeat CXR to exclude progression of pneumothorax, is recommended for adolescents and young adults if all of the following apply:
    - Severity of acute symptoms is mild with unlaboured breathing.
    - Room air saturations are > 90%.
    - Pneumothorax is small (≤ 2 cm rim of air on CXR).
  - Simple aspiration versus chest tube placement for children with large pneumothorax is based on the experience of the treating specialist teams.
    - Published paediatric series suggest that hospital admission with placement of a pleural catheter or chest drain (Table 1) is usual practice.
  - Patients are then managed with either:
    - Chest tube to water seal or suction (usual approach)
    - Heimlich valve (one-way valve)
  - For secondary spontaneous pneumothorax, treat underlying condition
    - Pneumothorax secondary to underlying respiratory diseases such as cystic fibrosis are often associated with underlying infection
- Traumatic pneumothorax (Advanced Paediatric Life Support [APLS] guidelines)

  - If tension pneumothorax is suspected, perform emergency needle aspiration of the second intercostal space in the mid-clavicular line
    - If the patient improves with needle aspiration, a chest drain should immediately be placed in that side of the chest
  - Placement of a larger calibre chest drain for a symptomatic or large pneumothorax among trauma victims is customary treatment
    - There may be an accompanying haemothorax
    - Many patients require positive pressure ventilation
- Iatrogenic pneumothorax
  - Patients receiving positive pressure ventilation are at risk of extension of pneumothorax and generally require chest drain placement
  - Provide supportive care with close observation for patients not on mechanical support who have a small pneumothorax and limited symptoms

Table 1: Chest drain insertion and management

Planning for chest drain insertion	Positioning of chest drain	Thoracostomy tube size selection	Insertion techniques	Management of chest drain

▪ If possible, obtain informed consent and provide sedation with standard monitoring.
▪ Consider and control risks of chest drain placement
  ▪ Bleeding
  ▫ Routine platelet count and bleeding times are recommended only for patients with known risk factors.
  ▪ Infection
  ▪ Failure of pneumothorax resolution
  ▪ Laceration of the lung
  ▪ Extrathoracic placement with potential injury of abdominal organs
	▪ The preferred position for chest drain insertion is supine with the ipsilateral arm above the patient's head to expose the axilla.
	▪ Alternative positions are:
	  ▪ Patient sitting upright leaning over an adjacent table with a pillow
	  ▪ Lateral decubitus position
	▪ The safe area is bordered by:
	  ▪ Lateral margin of pectoralis major muscle
	  ▪ Anterior margin of the latissimus dorsi muscle
	  ▪ Line superior to the horizontal level of the nipple
	  ▪ Apex below the axilla
	▪ A more posterior position is chosen if the pneumothorax is loculated and posterior.
	▪ Loculated collections are most safely approached under fluoroscopic guidance.
	▪ A more posterior position is safe.
	▪ The second intercostal space in the midclavicular line may be chosen for apical pneumothorax.
	  ▪ May leave a visible scar
		▪ Smaller tubes are recommended for aspirating air.
		  ▪ More comfortable than larger tubes, which are recommended for draining blood or a large air leak
		▪ Age-based sizes for thoracostomy tubes recommended for trauma victims by the American Heart Association are:
		  ▪ Newborns (2–5 kg): 8–12 French
		  ▪ < 1 year (5–11 kg): 14–20 French
		  ▪ Children 1–8 years (12–30 kg): 20–28 French
		  ▪ Children > 8 years (> 30 kg): 29–36 French
			▪ Small-bore chest tubes are usually inserted with the aid of a needle and guidewire using a modified Seldinger technique.
			  ▪ Blunt dissection is not needed because a dilator is used.
			▪ Blunt dissection of subcutaneous tissue and muscle into the pleural cavity is performed for insertion of medium and large chest drains.
			  ▪ A trocar should NOT be used as it may result in damage to both intra-thoracic and intra-abdominal organs
			▪ A finger-sized opening allows exploration to ensure that no underlying organs will be damaged.
			▪ Once the tube is past the chest wall, it is directed:
			  ▪ Apically to drain air
			  ▪ Basally to drain fluid
			▪ The chest tube is sutured in place.
			▪ If an incision has been made:
			  ▪ One stitch is placed to assist with wound closure after tube removal.
			  ▪ One stitch is placed to secure drain.
			▪ Chest X-ray is done to check the placement and resolution of pneumothorax.
				▪ The chest drain is connected to a closed system with an underwater seal device.
				▪ If the lung fails to expand quickly:
				  ▪ Continuous suction is delivered through a measured column of water until the lung has completely re-expanded.
				▪ The closed system allows detection of air bubbles through a water chamber, suggesting continued visceral pleural air leak.
				▪ Air leak may be caused by a leak in the system.
				  ▪ Chest tube air holes are outside the chest.
				  ▪ Chest tubing connections are not airtight.
				▪ The chest tube should remain in place as long as a persistent air leak is present.
				▪ Chest tubes are removed in a staged manner after pneumothorax is resolved.
				  ▪ The suction is discontinued.
				  ▪ The chest tube is placed on a water seal for 3–24 hours.
				  ▪ Chest X-ray is performed to rule out recurrence, and the chest tube may be removed.
				  ▪ The chest tube should never be clamped unless:
				  ▫ The clinician is expert in chest tube management.
				  ▫ The patient has constant nursing supervision.

When to Refer

Refer all patients with suspected pneumothorax to specialist practitioners (eg, Emergency Department / Paediatric Intensive Care / Paediatric Respiratory Team(s)) for evaluation and management.

- Children with spontaneous pneumothorax should be referred to a Paediatric Respiratory Team because of the risk of recurrent pneumothorax.
- Infants and children with iatrogenic pneumothorax should be cared for by specialist practitioners with expertise in chest drain insertion and management.

Escalate care to surgical team if:

- Air leak persists for > 4–7 days after chest drain insertion in patients without pre-existing lung disease
  - Earlier referral is recommended if the lung fails to re-expand and / or a large air leak and underlying lung disease are present

When to Admit

Admit to hospital:

- Children with symptomatic pneumothorax of any size for observation or management
- All infants with pneumothorax
- Any trauma victim with pneumothorax
  - Refer and admit to a trauma centre for evaluation and management

‘Safety-Netting’ Advice

Follow-up

- Children can be discharged from the emergency department following review by a paediatric specialist with follow-up within 24 hours if they have:
  - Asymptomatic small primary spontaneous pneumothorax
  - Been observed for 6 hours in the emergency department
  - Reliable transportation and social circumstances
- Patients must have careful instructions to return if worsening shortness of breath and have follow-up in 12 hours to 2 days with planned chest radiography to document improvement.
- Children and their families should also be advised that the child should not:
  - Fly until their medical team has agreed it is safe to do so
  - Go to remote places where access to medical care is limited
  - Scuba dive

  - Smoke
- All patients should be followed up by a Paediatric Respiratory Team.

Prevention

- Smoking cessation should be encouraged in known smokers to try to prevent primary spontaneous pneumothorax recurrence

Patient / Carer Information

Please note: whilst these resources have been developed to a high standard they may not be applicable to children.

- Pneumothorax (Web page), Patient
- Pneumothorax in children (Web page), British Lung Foundation

Resources

National Clinical Guidance

Bronchiectasis (non-cystic fibrosis), acute exacerbation: antimicrobial prescribing (Web page), NICE guideline NG117, National Institute for Health and Care Excellence

MacDuff A, Arnold A, et al. Management of spontaneous pneumothorax: British Thoracic Society Pleural Disease Guideline 2010. Thorax. 2010;65(Suppl 2): ii18-31[PubMed]

Du Rand IA, Blaikley J, Booton R, et al. British Thoracic Society guideline for diagnostic flexible bronchoscopy in adults. Thorax. 2013;68(Suppl 1):i1-i44 [PubMed]

Suggested Resources

Please note: these resources include links to external websites. These resources may not have national accreditation and therefore PCO UK cannot guarantee the accuracy of the content.

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GP Reviewer: Dr Ian A Dunn

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