

# SPONTANEOUS PNEUMOTHORAX: PRIMARY MANAGEMENT PRACTICE GUIDELINE<sup>®</sup>

## DOCUMENT SUMMARY/KEY POINTS

**Note:** This protocol is for spontaneous pneumothorax management and should **not** be used for cases of traumatic pneumothorax.

## CHANGE SUMMARY

- Document due for review – no changes made at this time.

## READ/ACKNOWLEDGEMENT

- Clinical staff in CHW Emergency Department should be aware of this document.

This document reflects what is currently regarded as safe practice. However, as in any clinical situation, there may be factors which cannot be covered by a single set of guidelines. This document does not replace the need for the application of clinical judgement to each individual presentation.

<b>Approved by:</b>	SCHN Policy, Procedure and Guidelines Committee	
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<b>Team Leader:</b>	Staff Specialist	<b>Area/Dept:</b> Emergency

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## Background

### Classification

#### 1. Spontaneous

- i. Primary (PSP)
- ii. Secondary (pre-existing lung disease)

#### 1. Traumatic

- i. Penetrating or blunt trauma to chest

#### 2. Iatrogenic

- i. Complication of diagnostic or therapeutic intervention

### Estimated incidence of Primary Spontaneous Pneumothorax (PSP)

The estimated incidence of PSP is 7.4 – 18 per 100,000/yr in males and 1.2 – 6 per 100,000/yr in women<sup>1,2</sup>. The true paediatric incidence is unclear. Typically, patients are tall thin males aged 10-30, with PSP rare in people >40 yrs<sup>3</sup>. Most have no clinically apparent lung disease.

### Clinical

Most occur at rest<sup>4</sup>. Virtually all have ipsilateral chest pain or acute shortness of breath (SOB). Pain may be minimal or severe. Initially it may be described as “sharp” and later as a “steady ache”. Symptoms usually resolve in 24 hours, even if the pneumothorax doesn't.

Examination may be normal if the pneumothorax is small. Clinically it becomes more detectable as the size increases, with decreased air entry, hyper-resonant percussion note, and decreased chest wall movement.

**Important:** Exclude signs of **tension pneumothorax** – mediastinal shift (tracheal deviation, displaced apex), increasing respiratory distress, cyanosis, hypotension and tachycardia. If suspected then proceed immediately to needle thoracocentesis.

Chest X-ray (CXR) is diagnostic (however tension pneumothorax is a clinical diagnosis). An expiratory film may reveal a small apical pneumothorax not evident on the inspiratory film but routine use does not improve diagnostic yield<sup>5</sup>. In younger children, a lateral decubitus may be useful to demonstrate a localised collection. Clinical manifestations are not reliable indicators of size<sup>4,6</sup>

### Prognosis

Recurrence occurs in an average of 30% of patients (16-52%) in 11 studies. Most occur within 6 months to 2 years after the initial episode<sup>7</sup>. Younger age and smoking are identified risk factors<sup>7</sup>. Ipsilateral subpleural bullae have been reported in 89% of CT scans in patients with PSP compared to 20% in controls (matched for age and smoking status). However CT presence of bullae is not predictive of recurrence<sup>8</sup>. Thus the presence of bullae alone, should not determine the treatment decisions regarding prevention.

## Secondary pneumothorax

- Airway disease (e.g. Cystic fibrosis, Asthma)
- Infectious lung disease (e.g. PCP pneumonia, Necrotizing pneumonias (Anaerobic, gram negative bacteria, staph aureus)
- Interstitial lung disease
- Connective Tissue disease (e.g. Marfan's, Ehlers-danlos)

There are a number of important differences to PSP<sup>9</sup>:

- The SOB is usually more severe and hypercapnia may be present
- Symptoms do not resolve spontaneously
- Examination findings may be more subtle as they can be masked by underlying disease
- Higher rates of recurrence occur, with >50% reported in patients with cystic fibrosis<sup>10</sup>

## Management for Pneumothorax

### Aims of Management

The aims of management are to:

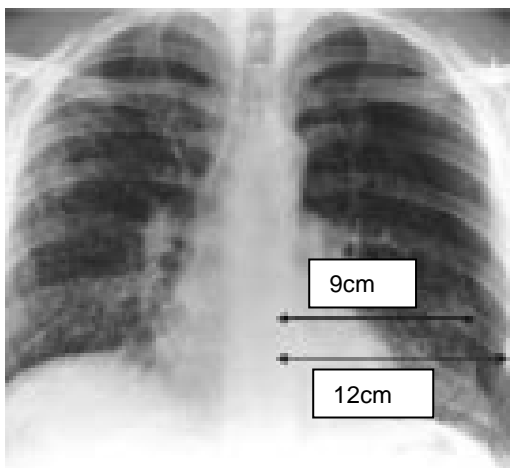
- Eliminate the intrapleural collection of air.
- Facilitate pleural healing.
- Attempt to prevent recurrence.

Pneumothorax should be considered in all children who develop unexplained shortness of breath, particularly when associated with unilateral chest pain.

### Size Definition

ACCP<sup>11</sup> and BTS<sup>12</sup> definitions of size classification differ and rely on uniformity of lung dehiscence which in reality is not always encountered. The suggested classification is based on features of both, to incorporate localised apical pneumothoraces:

- A pneumothorax is defined as "Large" when the volume of pneumothorax is >30% or ≥3cm apex to cupola distance



Volume of Pneumothorax (%) =

$$\frac{\text{Hemithorax diameter}^3 - \text{Lung diameter}^3}{\text{Hemithorax diameter}^3} \times 100$$

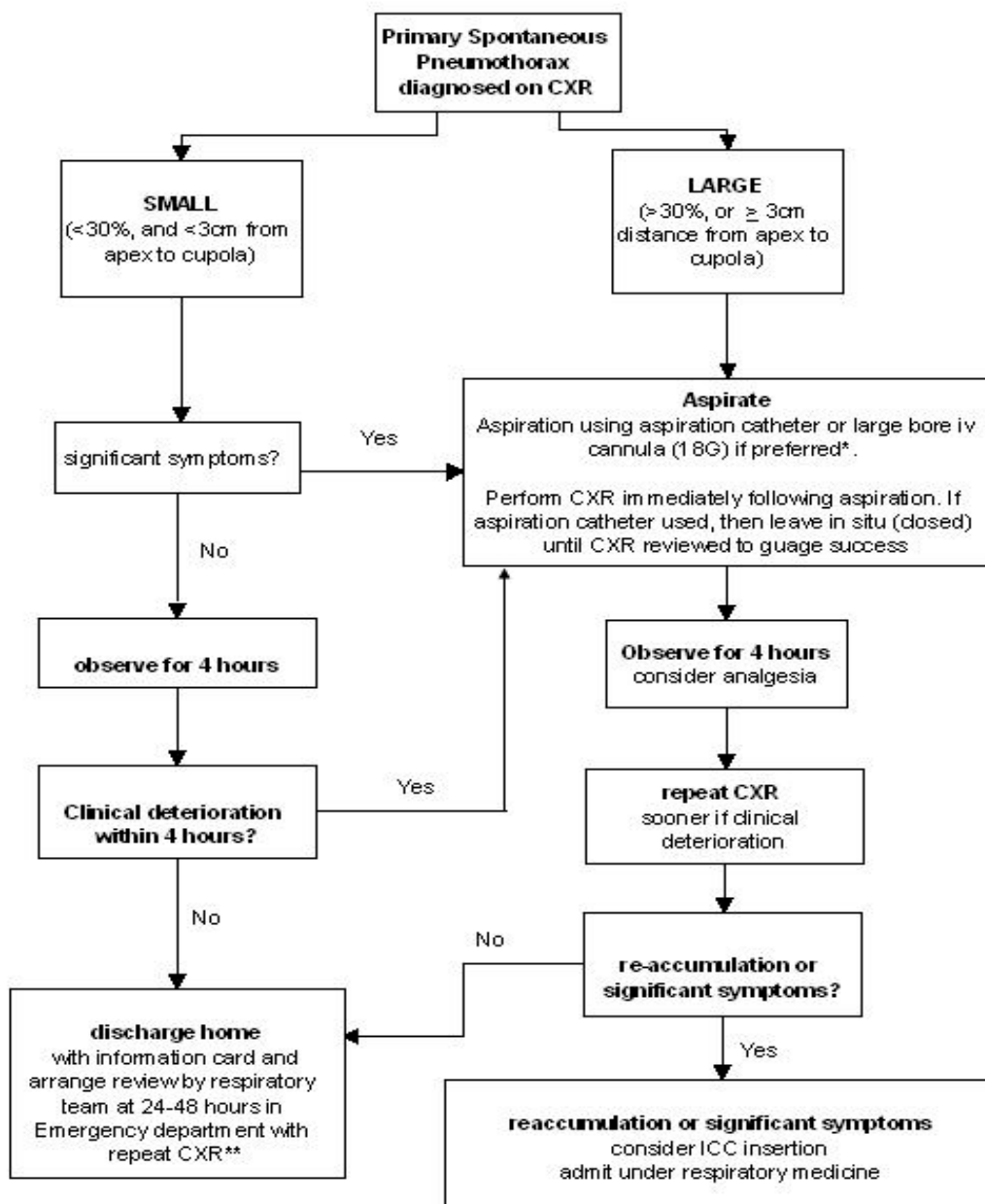
Measurements should be performed at the **hilum**.

For example:

$$(12^3 - 9^3) / 12^3 \times 100 = 50\%$$

The flowchart below outlines recommended management for PSP. All cases of PSP should be discussed with the Emergency physician on call to decide initial management. The Respiratory physician on call should be consulted if there are questions regarding initial management following discussion with the ED physician on call, if the child is being admitted, or to arrange [follow up](#) as outlined later in the protocol.

As a general approach, patients presenting with respiratory distress or significant persistent chest pain should have intervention regardless of the size of the pneumothorax. However this document outlines management guidelines and each case should be evaluated on its own merits. **Specific points about secondary spontaneous pneumothorax management can be found in the further notes section.**



\*Conversion to an ICC should be considered if  $\geq 2$  litres of air is aspirated, due to the likelihood of ongoing air leak

\*\* Timing of review by the respiratory team is at the discretion of the respiratory physician. If discharge and review is not logistically feasible, then the patient should be admitted for observation under the respiratory team

## Further Notes regarding acute management

### *Use of oxygen*

All patients **admitted** for observation with radiological evidence of residual pneumothorax should be placed on continuous oxygen to aid air reabsorption (increased by fourfold compared to breathing room air) and nursing staff should be aware of the reasoning to avoid inappropriate discontinuation due to “adequate saturations”. The indication for oxygen is based on maintaining adequate oxygen saturations in other patients.

### *Anaesthetic for Aspiration and ICC insertion*

Nitrous oxide **IS CONTRAINDICATED** during either procedure, as it enters the pleural space by diffusion, and can cause a rapid increase in the volume of the pneumothorax<sup>13</sup>. The choice of anaesthetic used is at the discretion of the physician performing/supervising the procedure. Supervision by the anaesthetist on call may be necessary in some patients. The use of intravenous ketamine is not recommended.

### *Aspiration and Insertion of Intercostal chest catheters*

Please see separate protocol (below) for performing these procedures. The [insertion](#) of intercostal chest catheters (ICC) or [aspiration](#) should only be performed by medical staff experienced in the procedure, or under supervision by an experienced physician. Small bore ICC are as effective as large bore with fewer associated complications. Large bore ICC should only be considered in cases of persistent air leak where small bore ICC have failed (may indicate bronchopleural fistula). Small bore ICC are stocked in ED, PICU and Radiology.

If an aspiration catheter is used, the aspiration catheter should be occluded and adequately secured until the repeat CXR performed to assess success is reviewed. If the patient is transferred between departments with an aspiration catheter in situ, a Heimlich valve **must** be attached. Following insertion of an ICC, all ICC should be connected to underwater seal drainage (except in secondary pneumothorax when [suction](#) should be commenced – see below).

Consultation with the Interventional Radiologist on call should be considered in the event of:

- Younger children (age <12 years) with smaller body size making procedures more difficult
- Pneumothorax not accessible using standard approach
- Failure to aspirate air during attempted aspiration or failure of ICC insertion. Further imaging may aid correct drainage

### *Use of Suction*

Suction should not be used initially with ICC, due to the documented risk of re-expansion pulmonary oedema, which has been reported in  $\leq 14\%$  treated initially with suction<sup>14</sup>. Risk factors include large pneumothoraces and age < 40 years. Mostly it is limited to being a radiological phenomenon, but has a reported mortality of 20% in patients who become clinically symptomatic. Suction should be used only if there is persisting air leak or failure lung re-expansion at 24 hours after ICC insertion, and should be a high volume, low pressure (10-20cm H<sub>2</sub>O) circuit.

### ***If secondary pneumothorax***

There should be a lower threshold for intervention and a preference for ICC insertion given decreased baseline lung reserve and ability to compensate. The protocol for management differs from PSP in the following manner.

- All cases should be admitted for to the ward for observation under the Respiratory team.
- Aspiration should be considered for small pneumothoraces
- ICC should be considered for large pneumothoraces, in preference to aspiration, given the poorer success rates of aspiration in these patients
- If ICC inserted, attach suction at 10-20cm H<sub>2</sub>O to aid lung re-expansion

### ***Transport of patients referred from other hospitals***

Transport of patients with a pneumothorax should ideally occur by road. However, due to potential distances involved this may not always be practical. If patients are being transferred by air they should be transported in a pressurised aircraft (pressurised to sea level).

According to Boyle's law, as altitude increases the gas within a closed system is subject to expansion, therefore pneumothorax enlargement can occur. For all forms of transport the patient should be accompanied by appropriate medical staff, experienced in needle thoracocentesis, in the event of tension pneumothorax development on route. Ideally the patient should have an aspiration catheter or ICC *in-situ*; however this may not be possible due to limitations in local experience at the referring hospital.

## **Further management following admission**

### ***Removal of ICC***

There is no evidence that clamping improves success rate or prevents recurrence<sup>15</sup>. A bubbling chest drain should never be clamped, as this may precipitate a tension pneumothorax. However, division of opinion exists anecdotally, and if the ICC is clamped for 4-6 hours prior to repeat CXR and possible removal, the child must remain on the ward throughout, with the nursing staff aware to unclamp should the child become symptomatic. The ICC should be removed using aseptic technique, and during full inspiration or if possible during a valsalva manoeuvre. If small bore ICC is used then a steristrip with tegaderm dressing is sufficient. A repeat CXR should be performed if symptoms recur following removal.

### ***Indications for surgical referral***

- Persisting air leak at 4 days
- 2<sup>nd</sup> ipsilateral pneumothorax
- 1<sup>st</sup> contralateral pneumothorax
- Bilateral pneumothoraces
- Patient intends to pursue a career with known risk factors (e.g. aviation, retrieval diver)
- Presence of apical bullae on CXR

## Follow up

All patients should be discussed with the respiratory physician on call. Those patients who do not require admission should be reviewed by the respiratory team within 48 hours of discharge from ED. Patients admitted to the ward will be followed up in respiratory clinic.

### ***Advice prior to discharge from ED or the ward***

- Smoking is related to risk of recurrence, with the lifetime risk of SP in smoking males  $\leq 12\%$  compared to  $0.1\%$  in non-smoking males<sup>2</sup>, although less prominent in women. The majority of young adults, 80-86%, continue to smoke following SP<sup>16</sup>
- Symptoms to look out for, namely chest pain, and acute shortness of breath
- Not to fly until full re-expansion has occurred, with commercial airlines commonly stating 6 weeks. The main risk is related to the location of recurrence rather than the risk of recurrence itself.
- No scuba diving (unless bilateral pleurectomy)<sup>17</sup>

### ***Episodes of Recurrence***

Patients who present with a 2<sup>nd</sup> episode of pneumothorax (based on radiological findings or suggested by clinical symptom history) require follow up in the respiratory outpatient clinic, and may warrant further investigation.

Success of ICC decreases with subsequent episodes – 90% vs 52% vs 15% for initial, 1<sup>st</sup> recurrence and 2<sup>nd</sup> recurrence respectively. A CT scan should be performed after the 1<sup>st</sup> episode of ipsilateral recurrence to look for subpleural blebs. If subpleural blebs are present then the patient should be referred for a surgical consult.



## Acknowledgements

Discussion with a number of other tertiary paediatric centres has contributed to the writing of this protocol, in particular, Royal Children's Hospital in Melbourne. The flowchart in this protocol has been derived from their current treatment algorithm.

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## Procedures

### 1. Pneumothorax Aspiration

#### Equipment

- Sterile gloves and gown
- antiseptic solution (70% alcoholic chlorhexidine)
- sterile drapes
- oximeter to monitor saturations during insertion
- 1% lignocaine or equivalent
- 5 or 10mL syringe with 25G and 21G needles for administration to superficial and deeper layers respectively (longer needles may be required for more obese patients)
- scalpel for incision
- 9G Cook aspiration catheter or 18G intravenous (IV) cannula
- 3 way connector (with outlets in "off" position)
- set this up prior to starting so that this can be quickly attached to the aspiration catheter or IV cannula when inserted, and also check that adaptors are correct for connection to the aspiration catheter used

#### Procedure

1. Check patient details
2. Explain procedure to the patient/parent
3. Obtain patient/parent consent. (**Note:** If procedure is deemed life saving then consent is not required)
4. Confirm side and positioning of pneumothorax by clinical signs and CXR
5. Mark position for aspiration catheter insertion on patient (ensure this is done in the position that the drain is being inserted to avoid movement of landmarks)
  - **Axillary approach**
    - i. 4<sup>th</sup> or 5<sup>th</sup> intercostal space in midaxillary or anterior axillary line in the region bounded by the:
      1. lateral border of pectoralis major
      2. anterior border of latissimus dorsi
      3. a line superior to the horizontal level of the nipple (in obese patients or pubertal females the rib spaces should be counted as the nipple line is unreliable)
      4. the apex in the axilla
    - ii. recline patient at 30 degrees, with arm raised and behind head to expose axilla or alternatively sit patient upright leaning over an adjacent table on a pillow

- **Anterior approach** (should only be considered for apical collections not accessible using axillary approach)
  1. 2<sup>nd</sup> intercostal space mid clavicular line
  2. patient reclining at 30 degrees on bed
- 6. Administer appropriate pre-medication
- 7. Monitor respiratory rate, heart rate and oxygen saturations throughout insertion
- 8. Infiltrate skin and deeper tissues including parietal pleura with local anaesthetic and wait for onset of action
- 9. Insert the aspiration catheter, using the seldinger technique, or IV cannula, above the upper edge of the rib (to avoid the neurovascular bundle which runs underneath the rib) and angle towards the apex of the lung. Aspirate as move through tissue layers.
- 10. Aspirate air using 3 way valve and 50mL syringe until no further air can be removed. Document cumulative total air aspirated (mL).
- 11. If using IV cannula then remove following aspiration.
- 12. If using Aspiration catheter, occlude and adequately secure until repeat CXR reviewed.
- 13. Obtain CXR to assess success of procedure

## 2. Chest drain insertion

### Equipment required

- Sterile gloves and gown
- antiseptic solution (70% alcoholic chlorhexidine)
- sterile drapes
- oximeter to monitor saturations during insertion
- 1% lignocaine or equivalent
- 5 or 10mL syringe with 25G and 21G needles for administration to superficial and deeper layers respectively (longer needles may be required for more obese patients)
- scalpel for incision
- appropriately sized Pigtail Intercostal Chest Catheter (ICC)
- underwater seal system
  - sterile tubing, adaptors, underwater seal drainage system primed according to manufacturers instructions, 500mL bottle normal saline, adhesive strapping
  - set this up prior to starting so that this can be quickly attached to the chest drain when inserted, and also check that adaptors are correct for connection to the chest drain used
- tube clamps
- securing equipment for drain
  - non-absorbable suture material, straight forceps, scissors if stitching
  - commercially available tube tether or adhesive strapping

## **Procedure**

1. Check patient details
2. Explain procedure to the patient/parent
3. Obtain patient/parent consent (**Note:** If procedure is deemed life saving then consent is not required)
4. Confirm side and positioning of pneumothorax by clinical signs and CXR
5. Mark position for ICC insertion on patient (ensure this is done in the position that the drain is being inserted to avoid movement of landmarks)
  - **Axillary approach**
    - i. 4<sup>th</sup> or 5<sup>th</sup> intercostal space in midaxillary or anterior axillary line in the region bounded by the
      1. lateral border of pectoralis major
      2. anterior border of latissimus dorsi
      3. a line superior to the horizontal level of the nipple (in obese patients or pubertal females the rib spaces should be counted as the nipple line is unreliable)
      4. the apex in the axilla
    - ii. recline patient at 30 degrees, with arm raised and behind head to expose axilla or alternatively sit patient upright leaning over an adjacent table on a pillow
  - **Anterior approach** (should only be considered for apical collections not accessible using axillary approach)
    - i. 2<sup>nd</sup> intercostal space mid clavicular line
    - ii. patient reclining at 30 degrees on bed
6. Administer appropriate pre-medication
7. Monitor respiratory rate, heart rate and oxygen saturations throughout insertion
8. Infiltrate skin and deeper tissues including parietal pleura with local anaesthetic and wait for onset of action
9. Make a small incision in the skin to aid insertion of the ICC (diameter of incision should be guided by the diameter of the ICC).
10. Insert the ICC, using the seldinger technique, above the upper edge of the rib (to avoid the neurovascular bundle which runs underneath the rib) and angle towards the apex of the lung. Aspirate as move through tissue layers.
11. Clamp the ICC following insertion to facilitate controlled evacuation of air
12. Connect to underwater seal system apparatus
13. Secure chest drain using stitches or commercial tethering system
14. Obtain CXR to assess the position of the ICC tip

### ***Potential Complications of ICC insertion include***

- Pain (ensure adequate pain control to facilitate full expansion of lung with breathing)
- Pleural infection (monitor temperature 4hrly and inspect insertion site each nursing shift)
- Incorrect placement (assessment of position with imaging)
- Haemorrhage (for medical review if blood drains into catheter)
- Hypotension (monitor blood pressure (BP) 4hrly along with heart rate (HR))
- Pulmonary oedema following lung re-expansion (rare – re-image if concerns)

## **3. Needle Thoracocentesis**

### **Equipment**

- 18G intravenous cannula
- 10mL or 20mL syringe
- alcohol swab
- tape

### **Procedure**

1. Identify the second intercostal space in the midclavicular line on the side of the pneumothorax (the opposite side to the direction of tracheal deviation).
2. Swab the chest wall with surgical prep or an alcohol swab.
3. Attach the syringe to the cannula.
4. Insert the cannula into the chest wall, just above the rib below, aspirating all the time.
5. If air is aspirated remove the needle, leaving the plastic cannula in place.
6. Tape the cannula in place and proceed to chest drain insertion as soon as possible.