

Pneumothorax

What is a pneumothorax?

A pneumothorax refers to a collection of air in the pleural cavity (between the lung and the chest wall) resulting in collapse of the lung on the affected side. The extent of the collapse of the lung is dependent upon the amount of air that is present. Pneumothoraces can be classified into:^[1]

- Primary spontaneous pneumothorax: pneumothorax occurring in healthy people.
- Secondary pneumothorax:
 - Associated with underlying lung disease – eg, rupture of a congenital bulla or a cyst in chronic obstructive pulmonary disease (COPD).
 - The consequences of a pneumothorax in patients with pre-existing lung disease are significantly greater and the management is potentially more difficult.

Other pneumothorax causes

Traumatic pneumothorax

This follows a penetrating chest trauma such as a stab wound, gunshot injury or a fractured rib.

Iatrogenic pneumothorax

This may follow a number of procedures such as mechanical ventilation and interventional procedures such as central line placement, lung biopsy and percutaneous liver biopsy.

Catamenial pneumothorax

This refers to pneumothorax at the time of menstruation. Over 90% occur in the right lung and it occurs up to 24 hours before or within 72 hours from the onset of menstruation. The aetiology is thoracic endometriosis leading to necrotic holes in the diaphragm which allow the passage of air from the genital tract, made possible when the cervical mucus plug is liquefied at the time of menstruation. It may be responsible for as many as 33% of spontaneous pneumothorax episodes in women who are referred for surgery.^[2] Recurrent thoracic catamenial pain is reported in 23% of women prior to a catamenial pneumothorax. Ovarian suppression for 6-12 months is used to prevent recurrence.^[3]

Do not forget that any person with acute severe asthma may have an underlying pneumothorax.

Tension pneumothorax

Tension pneumothorax is a life-threatening emergency that requires instant action. Severe symptoms and signs of respiratory distress suggest the presence of tension pneumothorax.^[1]

- Treatment is with oxygen and emergency needle decompression.
- Insert a large-bore needle into the pleural space through the second or third anterior intercostal space. A gush of air confirms the diagnosis. A standard cannula may be insufficiently long if used in the second intercostal space.
- Typical clinical situations where tension pneumothorax arises include:
 - Ventilated patients.
 - Trauma patients.
 - Resuscitation patients (CPR).
 - Lung disease, especially acute presentations of asthma and COPD.
 - Blocked, clamped or displaced chest drains.
 - Patients receiving non-invasive ventilation.
 - Patients undergoing hyperbaric oxygen treatment.

Pneumothorax epidemiology

- The incidence of primary spontaneous pneumothorax (PSP) is 24/100,000 a year in men and 9.9/100,000 a year in women in England and Wales. [4]
- A primary spontaneous pneumothorax is one of the most common thoracic diseases affecting adolescents and young adults, having an annual incidence ranging from 15.5 to 22.7 per 100,000 people and with a women/men ratio ranging from 1:3.3 to 1:5. [5]
- Men are most likely to have a pneumothorax under the age of 20 years with a second peak in incidence at around 60 years, mainly related to underlying lung disease. The incidence in women is delayed to 30–34 years, and again there is a second peak in incidence at around 60 years. [6]

Risk factors [1]

- Smoking is the most important risk factor: compared to non-smokers, men who smoke increase their risk of a first pneumothorax 22-fold and women 9-fold. [7]
- Patients affected by PSP tend to be tall. Marfan's syndrome or a Marfan's habitus increases the risk.
- Pneumothorax is not usually associated with physical exertion and the onset is just as likely to occur during sedentary activity.
- Women with endometriosis should be asked about pleuritic, shoulder or upper abdominal pain occurring at the time of their menses, as if present they are at high risk of PSP.
- Subpleural blebs and bullae are found at the lung apices at thoracoscopy and on CT scanning in up to 90% of cases of PSP .
- Secondary spontaneous pneumothorax (SSP) can occur with various underlying lung conditions, including COPD, tuberculosis, sarcoidosis, cystic fibrosis, malignancy, and idiopathic pulmonary fibrosis. It may also occur with *Pneumocystis jirovecii* infection in AIDS.
- Over 10% of patients with PSP report a positive family history of the disease. [8]

Pneumothorax symptoms and presentation

Symptoms in PSP may be minimal or absent. In contrast, symptoms are greater in SSP, even if the pneumothorax is relatively small in size^[1] .

- Sudden onset of pain is typical.
- There may well be some shortness of breath, depending upon the size of the lesion. It tends to be more severe in SSP as there is less reserve.
- Around two thirds of patients will have both pain and dyspnoea. However, a significant number may have no symptoms and thus a high index of suspicion is needed.

Examination

- The patient often looks distressed and is sweating. Dyspnoea may be apparent and even cyanosis, depending upon the degree of respiratory inadequacy.
- Pulse examination:
 - Tachycardia is common but a pulse rate above 135 beats per minute suggests tension pneumothorax.
 - Pulsus paradoxicus suggests a severe pneumothorax. Pulsus paradoxicus occurs when the pulse slows on inspiration. This is the opposite to sinus arrhythmia where there is a slight acceleration of the pulse with inspiration.
- Hypotension may occur and jugular venous pressure (JVP) may be raised, especially in tension pneumothorax.

- Examination of the chest:
 - May show that the affected side moves less than the normal side. The best way to elicit this is to place your hands on each side of the patient's chest and to feel the movement when you ask him or her to take a deep inspiration.
 - The trachea is deviated away from the side of collapse, especially in tension pneumothorax.
 - Percussion reveals hyper-resonance over the collapse.
 - Breath sounds are reduced or absent over the affected area.
 - Bilateral pneumothorax is unusual but the lack of asymmetry of the chest will make clinical diagnosis more difficult.
- There are specific problems for those who are being ventilated. High peak airway pressure suggests an impending pneumothorax. There will be difficulty ventilating the patient during resuscitation. A tension pneumothorax causes progressive difficulty with ventilation, as the normal lung is compressed.

Investigations

- CXR:^[1]
 - Standard erect CXR in inspiration is recommended for the initial diagnosis of pneumothorax.
 - Lateral X-rays may provide additional information when a suspected pneumothorax is not confirmed by a PA chest film, but are not routine.
 - Expiratory films do not confer any additional benefit in the routine assessment of pneumothorax. They are no longer used routinely.

- Ultrasound:
 - Specific features on ultrasound scanning are diagnostic of pneumothorax but the main value of ultrasound has been in the management of supine trauma patients.^[1]
 - Lung ultrasound is more sensitive in detecting traumatic pneumothorax than supine chest X-rays.^[9]
- CT scanning is recommended for uncertain or complex cases.^[1]
- Arterial blood gases will show hypoxia, the degree being dependent upon the severity of the condition. It tends to be more disturbed in SSP, as there is less reserve in the presence of pre-existing lung disease. They probably only need to be done if oxygen saturations are <92%.

The size of the pneumothorax determines the rate of resolution and is a relative indication for active intervention, although the degree of clinical compromise is more important. There are various methods that one can use to calculate the size of a pneumothorax but the technique recommended by the British Thoracic Society is to measure the distance between the pleural surface and the lung edge (at the level of the hilum). If this is 2 cm or more, it represents a pneumothorax of at least 50% of the hemithorax and is an indication for drainage.

Differential diagnosis

- **Pleural effusion** tends to be slower in onset and there is dullness on percussion.
- **Pulmonary embolism** may produce haemoptysis and a few rales over the affected area. It more commonly affects the lower rather than the upper lungs.
- Other causes of **breathlessness**.
- Other causes of **chest pain**.

Pneumothorax treatment and management

Tension pneumothorax requires urgent decompression (see above).

Conservative management can be the appropriate treatment in small to moderate-sized pneumothorax. Other factors when considering the best treatment include whether the patient is haemodynamically stable with few symptoms, whether there are other injuries present, and whether they may need intermittent positive pressure ventilation (IPPV), as these can increase the risk of complications such as a tension pneumothorax.^[10]

Having ruled out a tension pneumothorax, the aim of management is to relieve dyspnoea. Simple observation, needle aspiration and chest drain are all options and the choice will depend upon the severity of the condition. There is much national and international controversy surrounding the most appropriate initial treatment of a pneumothorax, especially those <50%.^[11]

Generally, the more symptomatic the patient, the more active intervention should be utilised. Large pneumothoraces should usually be drained, even if there are minimal or no symptoms, as this speeds the resolution. However, expanding the lung has adverse effects on stopping the air leak, and so observation without rapidly expanding the lung may be the best management. It has been reported that conservative management of even large pneumothoraces is possible if there is no underlying lung disease.^[12]

For those patients admitted to hospital, referral to a respiratory physician should be made within 24 hours of admission^[1].

Management of SSP^[1]

- All patients with SSP should be admitted to hospital for at least 24 hours and receive supplemental oxygen.
- Most patients will require the insertion of a small-bore chest drain.
- All patients will require early referral to a chest physician.
- Those with a persistent air leak should be discussed with a thoracic surgeon at 48 hours.

Immediate management

Oxygen should be given, although caution may be needed in patients at risk of carbon dioxide retention. Oxygen helps relieve hypoxia and it accelerates resorption of the pneumothorax four-fold compared with breathing air.^[7]

Observation

Patients with a small PSP without breathlessness should be considered for discharge with early outpatient review. These patients should also receive clear written advice to return in the event of worsening breathlessness.^[1]

- A small pneumothorax of 15% or less can be managed by observation, using both clinical assessment and CXR to ascertain that it is not enlarging.
- Iatrogenic pneumothorax does not normally require a chest drain.
- There is currently insufficient evidence to determine whether any particular intervention is more effective than no intervention for spontaneous pneumothorax.^[4]
- Breathlessness indicates the need for active intervention as well as supportive treatment (including oxygen).^[1]

Simple aspiration

Indications for simple aspiration, also called thoracentesis, include PSP (any size) and small SSP in patients aged under 50 years.^[1]

Needle (14-16 G) aspiration is as effective as large-bore (>20 F) chest drains and may be associated with reduced hospitalisation and length of stay.^[1]

- The puncture site is commonly in the second or third intercostal space in the midclavicular line or in the fourth or fifth intercostal space over the superior rib margin in the anterior axillary line.
- Entry should be just above a rib rather than just below it so as to reduce the risk of hitting the neurovascular bundle.
- Aspiration can even be used without admitting the patient to hospital but all patients who have had a pneumothorax should receive written instructions that if they develop sudden shortness of breath they must return immediately.
- Needle aspiration should not be repeated unless there were technical difficulties. Following failed needle aspiration, a small-bore (<14 F) chest drain insertion is recommended.^[1]

A Cochrane review comparing simple aspiration versus intercostal tube drainage for primary spontaneous pneumothorax in adults found low-to-moderate quality evidence that intercostal tube drainage produced higher rates of immediate success, while simple aspiration resulted in a shorter duration of hospitalisation.^[13]

Intercostal tube drainage

A chest drain tube is usually required for SSP and for all large lesions. Chest drains are usually required for patients with tension or bilateral pneumothorax who should be admitted to hospital.^[1]

Indications for a chest drain for pneumothorax include:^[1]

- In any ventilated patient.
- Tension pneumothorax after initial needle relief.
- Persistent or recurrent pneumothorax after simple aspiration.
- Large SSP in patients aged over 50 years.

Pain, intrapleural infection, wound infection, drain dislodgement and drain blockage are the most frequent complications of chest drain insertion. Visceral injury is the most serious complication.^[1]

Antibiotic prophylaxis is not recommended for non-trauma patients requiring a chest drain. Antibiotic prophylaxis should be considered for trauma patients requiring chest drains, especially after penetrating trauma.^[1]

There are concerns regarding the development of re-expansion pulmonary oedema.^[14] It is therefore recommended that suction should not be used routinely. Caution is required because of the risk of re-expansion pulmonary oedema. High-volume low-pressure suction systems are recommended.^[1]

Pleurodesis

- If there has been recurrence or the risk is considered high then prevention of further pneumothorax by obliterating the pleural space by pleurodesis should be considered.^[15]

- Surgical options are more effective but medical pleurodesis may be appropriate for patients who are either unwilling or unable to undergo surgery.^[1]
- Complications include failure to prevent recurrence, acute respiratory distress, infection of the pleural space, persistent air leak and re-expansion pulmonary oedema.
- Simple aspiration and drainage followed by minocycline pleurodesis has been shown to be safe and possibly more effective treatment for PSP than simple aspiration and drainage only.^[16]
- Pleural abrasion with minocycline pleurodesis has also been shown to be as effective as apical pleurectomy and it is therefore recommended that either technique is appropriate for treating PSP patients with high recurrence risk.^[17]
- One review found that, although the relative risk of recurrence was higher with pleural abrasion compared to pleurectomy, it was not statistically significant.^[18]
- A small study in which an intrapleural injection of autologous blood was used in SSP patients with advanced COPD and an ongoing air leak, suggests this may be a useful alternative to chemical pleurodesis.^[19]

Surgery^[1]

- For more difficult cases referral to thoracic surgeons may be considered.^[20]
- An early (3–5 days) thoracic surgical opinion should be sought in cases of persistent air leak or failure of the lung to re-expand.
- Open thoracotomy and pleurectomy remains the procedure with the lowest recurrence rate (approximately 1%) for difficult or recurrent pneumothoraces.
- Video-assisted thoracoscopic surgery (VATS) with pleurectomy and pleural abrasion is better tolerated than open surgery but has a higher recurrence rate of approximately 3%.
- Axillary mini-thoracotomy shows equivalent recurrence rates to VATS but is associated with lower patient satisfaction.

- Surgical chemical pleurodesis is best achieved by using sterile graded talc, which only rarely causes acute respiratory distress syndrome and empyema.
- Endobronchial valves, that allow collapse of distal lung and air leak, are being studied as an alternative to conventional surgical treatment of a persistent pneumothorax.^[7]

Special groups^[1]

- **Pregnancy:** pneumothorax recurrence is more common in pregnancy and poses risks to the mother and fetus. The less invasive strategies of simple observation and aspiration are usually effective during pregnancy, with elective assisted delivery and regional anaesthesia at or near term. A corrective surgical procedure (VATS) should be considered after delivery.
- **Catamenial pneumothorax:** is underdiagnosed in women with pneumothorax. A combination of surgical intervention and hormonal treatment is required.
- **HIV infection:** the combination of pneumothorax and HIV infection requires early intercostal tube drainage and surgical referral, in addition to appropriate treatment for HIV and *P. jiroveci* infection.
- **Cystic fibrosis:** the development of a pneumothorax in a patient with cystic fibrosis requires early and aggressive treatment with early surgical referral. Pleural procedures, including pleurodesis, do not have a significant adverse effect on the outcome of subsequent lung transplantation.

Prognosis^[1] ^[5]

- While death from spontaneous pneumothorax is rare, rates of recurrence are high: 15.8% at one year for PSP and 31.2% at one year for SSP.
- There is some evidence that recurrence rates may be less in those managed conservatively and this is the subject of an ongoing study.^[21]
- SSP is associated with a higher morbidity and mortality than PSP.^[7]

- The clinical course of primary spontaneous pneumothorax is variable with a recurrence rate ranging from 25% to 54%. The presence of underlying chronic lung disease is a significant determinant of recurrence.
- The risk of recurrence of PSP is as high as 54% within the first four years, with isolated risk factors including smoking, height and age over 60 years.
- Smoking cessation reduces the absolute risk of a recurrent PSP from 70% in those who continue to smoke to 40% in those who stop.^[7]
- Risk factors for recurrence of SSP include age, pulmonary fibrosis and emphysema.
- Diving should be permanently avoided unless a definitive procedure has been undertaken.
- Air travel need only be avoided until radiologically confirmed resolution.

Prevention

A patient who smokes must be advised to stop to reduce their risk of a first pneumothorax and that of a recurrence.

Further reading

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