Chronic Obstructive Pulmonary Disease (COPD)

Introduction

Chronic obstructive pulmonary disease (COPD) is a lung disease characterised by persistent respiratory symptoms and airflow obstruction, that is **not fully reversible**. Airflow obstruction occurs secondary to structural damage to the airways and parenchyma as a result of chronic inflammation. **COPD is a triad of emphysema, chronic bronchitis and small airway fibrosis**.

Prevalence

- In the UK, the prevalence of COPD is approximately 3 million, and the mortality rate is 30,000 per year.
- Furthermore, COPD accounts for 1.4 million GP appointments annually and is the second-largest cause of emergency admissions in the UK.

Pathophysiology

COPD develops as a significant and chronic inflammatory response to inhaled irritants which ultimately leads to bronchial and alveolar remodelling in the lung known as small airways disease. Thus, airway remodelling with narrowing of peripheral airway and emphysema are responsible for the alteration of lung function.

Risk factors

- **Tobacco smoking:** associated with 80% of COPD cases
- **Indoor air pollution:** this usually occurs in the developing world, where biomass is burnt inside homes for cooking and heating
- **Alpha-1 antitrypsin deficiency:** an autosomal dominant condition which presents in younger patients (aged 20-40). Alpha-1 antitrypsin is a protease inhibitor with one of its actions being to prevent neutrophil elastase from breaking down alveolar structures. Therefore, a deficiency in alpha-1 antitrypsin leads to the increased destruction of alveolar structures, resulting in early-onset emphysema.

Clinical features

Symptoms

Typical **symptoms** of COPD include:

- Worsening breathlessness
- Productive cough: the patient may have noticed a change in the volume, consistency or colour of their sputum.
- Malaise
- Fatigue/lethargy
- Increased wheeze: due to obstruction of alveoli and bronchi.

- Coryzal symptoms
- Haemoptysis
- Chest tightness or pain
- Peripheral oedema

Signs

Typical **clinical signs** of COPD include:

- Tachycardia
- Tachypnoea
- Hypoxia **(Hypoxaemia** is a typical clinical feature of COPD)
- Cyanosis
- Reduced level of consciousness

Examination & Investigations

A full respiratory examination should be performed in suspected cases of COPD.

History of presenting complaint

- **Dyspnoea**: initially exertional, but can progress to resting dyspnoea over the course of the condition (months to years). Dyspnoea is graded using the Medical Research Council (MRC) dyspnoea scale (Table 1)
- **Chronic productive cough**: usually colourless sputum, which *may* become green during lower respiratory tract infections (LRTIs)
- Recurrent LRTIs
- Fatigue
- Headache (due to CO_2 retention)

Table 1. MRC Dyspnoea Scale. Used with the permission of the MRC

Grade	Level of Activity
1	Breathless during strenuous exercise only
2	Breathless when hurrying or walking up a slight incline
3	Walks slower than people of the same age due to dyspnoea, or needs to pause for breath when walking at own pace
4	Pauses for breath after walking 100m/a few minutes on the level
5	Too breathless to leave the house, or breathless when dressing

Medication/allergies

- Regular medications (and any recent changes) *ACE-inhibitors can cause a dry cough
- Over-the-counter medications
- Allergies

Family history

- Lung disease
- Liver disease (may suggest alpha-1 antitrypsin deficiency)

Social history

- Smoking history: quantify in pack-years (1 pack-year = smoking 20 cigarettes a day for a year)
- Alcohol history
- Recreational drug use
- Occupation: may be exposed to indoor air pollution

Most common findings on Chest Auscultation

- **Tachypnoea:** due to an increased neural respiratory drive to breathe
- **Wheeze on auscultation:** due to inflammatory airway, oedema and mucous obstructing the airway

Less common findings

- **Barrel Chest** (Figure 1): due to gas trapping
- **Peripheral cyanosis** (Figure 2)
- **Cor pulmonale** (signs of right heart failure, such as peripheral oedema and hepatomegaly): due to pulmonary hypertension, which results from chronic hypoxic pulmonary vasoconstriction
- **CO_2 retention flap**: while the exact mechanism is unknown, some hypothesise that it is due to abnormal function of the diencephalon (which acts as a relay centre for sensory and motor impulses)

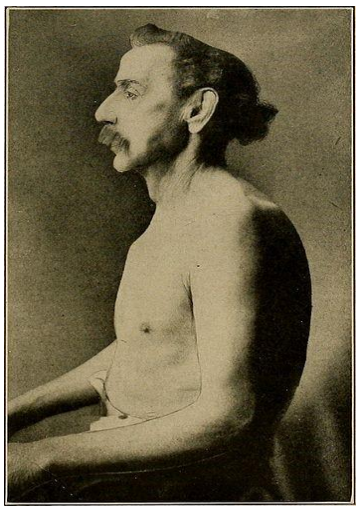


Figure 1. Patient with a barrel chest

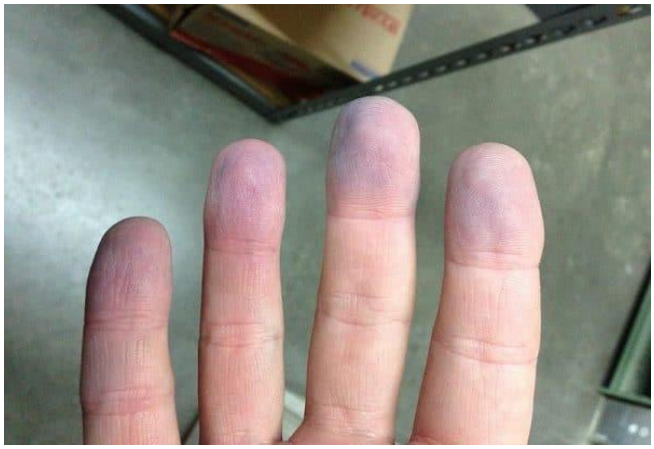


Figure 2. Peripheral cyanosis

Bedside investigations

Spirometry

- Typical finding in COPD: FEV1/FVC < 70%
- FEV1 is also used to classify the severity of COPD (Table 2)
- See the Geeky Medics spirometry interpretation guide for further information

Table 2. Severity grading of COPD

Severity of COPD	FEV1
Mild	>80%
Moderate	50-80%
Severe	30-50%
Very Severe	<30%

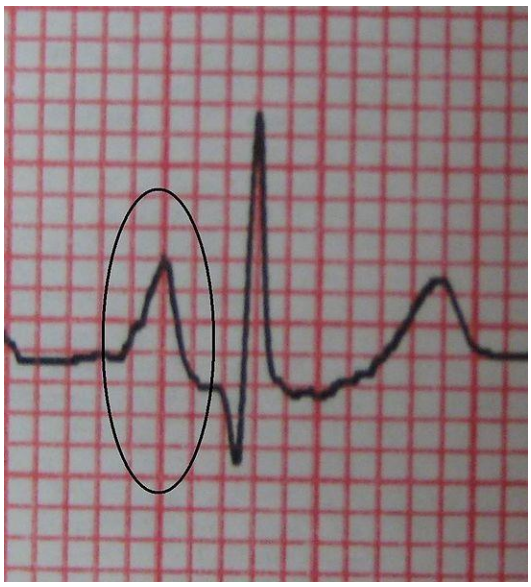
Pulse oximetry

- Aim for SpO_2 of 88-92%
- Avoid administering excessive amounts of O_2:
  - O_2 displaces CO_2 in haemoglobin, which increases CO_2 in the blood Increased CO_2 in the blood cannot be removed due to failure of alveolar ventilation in emphysema, leading to hypercapnic respiratory failure

Other investigations

Sputum culture: enables targeted antibiotic therapy during exacerbations of COPD

ECG: cor-pulmonale (peaked p waves and right axis deviation)



Peaked p wave ("p pulmonale"), indicating right atrial hypertrophy in cor pulmonale

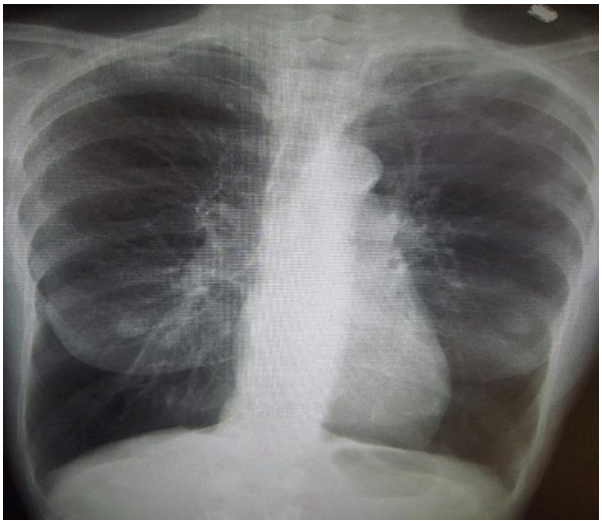
Laboratory investigations

- Baseline blood tests: CBC, U&E, LFTs, CRP
- Arterial blood gas (ABG)
  - During stable disease: $PaCO_2$ >6.0 & bicarbonate >30 indicates that the patient is a **"CO_2-retainer"**
  - During exacerbations: check for respiratory acidosis ($PaCO_2$ >6.0 & pH <7.35)

Imaging

Chest X-ray: hyperinflation

- >6 anterior ribs or >10 posterior ribs visible in the mid-clavicular line
- Flattened diaphragm
- Hyperlucent lungs



Hyperinflated lungs in a patient with COPD

Differential diagnoses

Dyspnoea and productive cough have important differential diagnoses. Table 2 outlines these differential diagnoses, and the features which differentiate them from COPD.

Table 2. Differential diagnoses of COPD

Differential diagnosis	Features differentiating from COPD diagnosis
Asthma	• Diurnal variation in symptoms and peak flow • History of atopy • Eosinophilia (blood and sputum) • Lung function tests: bronchodilator reversibility *Note that COPD and asthma can co-exist
Bronchiectasis	• Expectorate larger volumes of sputum • More frequent lower respiratory tract infections, often starting in childhood • High-resolution chest CT: bronchial dilation
Congestive cardiac failure	• Orthopnoea • Paroxysmal nocturnal dyspnoea • History of cardiovascular disease • Fine basal inspiratory crepitations • Bloods: elevated BNP • Echocardiogram: reduced ejection fraction
Lung cancer	• Weight loss • Haemoptysis • Chest X-ray and bronchoscopy: the presence of tumour
Tuberculosis	• Drenching night sweats • Weight loss • Positive sputum culture and microscopy

Management (long-term)

Conservative management

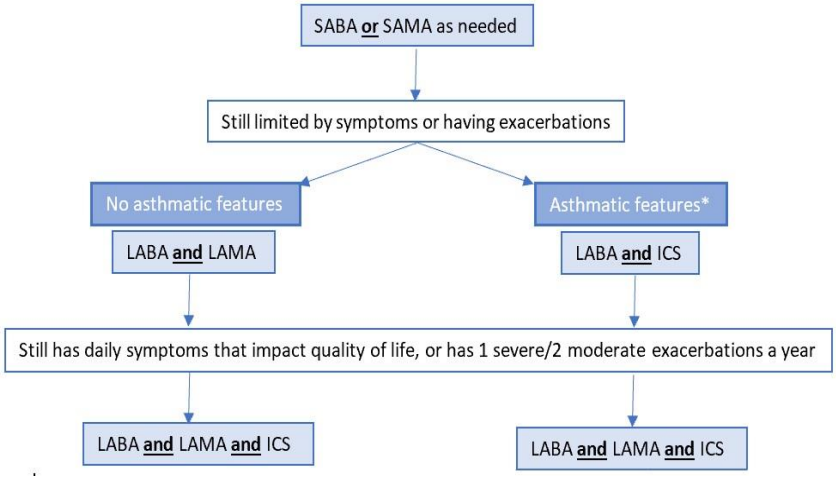
- Smoking cessation: see the Geeky Medics guide on smoking cessation for useful tips
- Pulmonary rehabilitation

- Annual influenza vaccine and one-off pneumococcal vaccine
- Personalised self-management plan

Medical management

Inhalers

Medical management of COPD is largely administered through inhalers, with a step-up process as needed.



Medical management of COPD (adapted from NICE guidelines). Asthmatic features include: previous diagnosis of asthma/atopy, increased blood eosinophils, diurnal variation of peak flow (>20%), variation of FEV1 over time (>400mL). SABA= short-acting beta-2 agonist; SAMA= short-acting muscarinic antagonist; LABA= long-acting beta-2 agonist; LAMA= long-acting muscarinic antagonist; ICS= inhaled corticosteroid.

**Note that some clinicians prefer to use the international GOLD guidelines for the management of COPD.*

Long-term oxygen therapy

- Indications (one of the following):
  - SpO_2 <88%
  - PaO_2 <7.3kPa
- Contraindicated in current smokers due to the risk of explosion and/or burns

Surgical management

- **Lung volume-reduction surgery**: for very severe COPD, which does not respond to optimal medical management
- **Lung transplantation**: if not suitable for other surgical options

Complications

- Hypercapnic respiratory failure (PaO_2 < 8.0 and $PaCO_2$ > 6.0)
- **Secondary polycythaemia (raised haemoglobin):** due to chronic hypoxaemia
  Cor pulmonale: right heart failure, caused by pulmonary hypertension as a result of chronic hypoxic pulmonary vasoconstriction
- **Bronchiectasis:** due to chronic and repeated infections
- Anxiety and depression
- **Osteoporosis**: due to chronic steroid use, smoking, lack of bone-strength exercise and vitamin D deficiency
- Sleep disturbance

COPD | Acute Management

What is an exacerbation of COPD?
An **exacerbation of COPD** is defined as a **sustained deterioration** in a patient's **respiratory symptoms** beyond their normal day-to-day variability. This worsening of respiratory symptoms occurs **acutely** and normally requires **additional medical therapy**.

What can trigger an exacerbation of COPD?

- The most common trigger for an exacerbation of COPD is **respiratory tract infection**. In the community, *Streptococcus pneumoniae* and *Haemophilus influenzae* are the most common bacterial culprits. Viral causes include *rhinoviruses*, *influenza* and *respiratory syncytial virus* (RSV). Pollutants can also trigger an exacerbation.
- Allergens, e.g., pollens, wood or cigarette smoke, pollution
- Toxins, including a variety of different chemicals
- Air pollution
- Failing to follow a drug therapy program, e.g. improper use of an inhaler

Management

Based on the severity different treatments may be used.

- Mild exacerbations are treated with short acting bronchodilators (SABDs).
- Moderate exacerbations are treated with SABDs together with antibiotics or oral corticosteroids, or both.
- Severe exacerbations need hospital treatment, and the prognosis is poor.

Oxygen

Oxygen therapy should be initiated if there is significantly low blood oxygen. High flow oxygen may be harmful in those with an acute exacerbation of COPD.

If the patient has COPD and a history of CO_2 retention you should use a **venturi mask** and **titrate oxygen appropriately**.

If the patient is conscious, sit them **upright** as this can also help with oxygenation.

Medication

Inhaled bronchodilators open up the airways in the lungs. These include salbutamol and terbutaline (both β_2-adrenergic agonists), and ipratropium (an anticholinergic). Medication can be administered via inhaler or nebuliser.

- **Salbutamol:** A high-dose inhaled **beta-2 agonist** (i.e. salbutamol) should be administered as a **first-line treatment** in the management of an acute exacerbation of COPD:
  - Prescribe the patient a dose of a short-acting bronchodilator (e.g. **salbutamol 5mg**).
  - If the patient is hypercapnic or acidotic, the nebuliser should be driven by compressed air rather than oxygen (to avoid worsening hypercapnia).
  - If the patient is also hypoxic, then oxygen therapy can be administered simultaneously via a nasal cannula underneath the nebuliser.

  Repeat doses of salbutamol at **15–30-minute intervals** or give continuous nebulised salbutamol at 5-10 mg/hour if there is an inadequate response to initial treatment.

- **Ipratropium bromide**
  - **Ipratropium bromide 500 micrograms** should be administered if the patient does not respond adequately to nebulised salbutamol.
  - Ipratropium bromide can be given with salbutamol **in the same nebuliser**.

- **Steroids**
  - All patients with an acute exacerbation of COPD should receive **oral corticosteroids** to reduce airway inflammation.

  NICE recommends **oral prednisolone 30 mg** once a day for 5 days.

- Antibiotics are often used but will only help if the exacerbation is due to an infection. Antibiotics are indicated when a patient notes **increased sputum production**, **purulent sputum**, increased dyspnoea or other features suggestive of pneumonia such as **fever**, **raised inflammatory markers** and signs of **consolidation** on chest X-ray. Examples of first-line antibiotics are amoxicillin, doxycycline, and co-trimoxazole.

COPD VS ASTHMA

POINTS	COPD	ASTHMA
1. Age of onset	Middle age, usually >40 years	Any age
2. Smoking history	Common, >20 pack years	May or not be present
3. Allergy	Uncommon	Common—rhinitis, eczema, skin prick positive, eosinophilia
4. Family history	Not common	Common
5. Cardinal features	Cough, expectoration and dyspnea	Dyspnea, cough, wheeze, and chest tightness
6. Sputum	Often copious	Infrequent
7. Symptom free period	It is chronic and progressive without any symptom free period	There is recurrent attack but the patient is usually symptom free in between attacks. However, in chronic bronchial asthma, the features may be persistent
8. Dyspnea	Progressive, persistent (with exacerbation)	Intermittent and variable, vary from day to day and peak at night and in early morning
9. Spirometry	Airway obstruction is irreversible	Airway obstruction is reversible
10. Durnal variation of PEFR	Less	More
11. Sputum microscopy	Increased neutrophil and helper T lymphocyte (CD4)	Increased eosinophil and cytotoxic T lymphocyte (CD8)
12. Bronchodilator response	May not be satisfactory	Usually satisfactory
13. Airway hyper-responsiveness	Absent in 50% cases	Present
14. Destruction of lung parenchyma	Common	Uncommon

CHRONIC BRONCHITIS

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PATHOLOGY & CAUSES

- Preventable, progressive pulmonary disease
  - Chronic airway inflammation, limited airflow
  - Bronchial tubes in lungs inflame → productive cough
- Subset of COPD
- Exposure to irritants → hypertrophy/hyperplasia of bronchial mucous glands, goblet cells in bronchioles, cilia less mobile → increased mucus production, less movement → mucus plugs → obstruction in bronchioles → air-trapping → productive cough
- Blocked airflow, air-trapping → increased partial pressure of CO_2 in lungs → less O_2 reaches blood → cyanosis (if severe); individuals referred to as "blue bloaters"

RISK FACTORS

- Smoking (primary cause), cystic fibrosis, sulfur, nitrogen dioxide, dust, silica, family history, genetic predisposition

COMPLICATIONS

- Pulmonary hypertension, increased workload of right ventricle, cor pulmonale, infections distal to mucus blockages, fibrosis of terminal bronchioles, compensatory polycythemia

SIGNS & SYMPTOMS

- Wheezing (due to mucus, narrow airway), crackles/rales (small airways pop open during air movement due to narrow passageway)
- Hypoxemia, hypercapnia (due to mucus plugs blocking air flow) → cyanosis → tissue hypoxia

DIAGNOSIS

DIAGNOSTIC IMAGING

Chest X-ray

- Large, horizontal heart, increased bronchial markings

LAB RESULTS

- ABGs
  - Respiratory acidosis (arterial PCO_2 > 45mmHg, bicarbonate > 30mEq/L)

OTHER DIAGNOSTICS

- Productive, mucinous cough
  - At least three months over two consecutive years
- PFTs
  - Increased TLC, air-trapping; decreased FVC1/FVC ratio
- Postmortem measurement
  - Reid index (measure ratio of thickness of bronchial mucinous glands, total thickness of airway, epithelium to cartilage)
  - > 40% (due to hyperplasia, hypertrophy of glands)

TREATMENT

MEDICATIONS

- Supplemental oxygen, bronchodilators, inhaled steroids, antibiotics
  - Manage symptoms
- Prophylactic vaccination against influenza, *Streptococcus pneumoniae* (*S. pneumoniae*)

OTHER INTERVENTIONS

- Smoking cessation, pulmonary rehabilitation

EMPHYSEMA

osms.it/emphysema

PATHOLOGY & CAUSES

- COPD subset
  - Exposure to irritants → degrades elastin in alveoli, airways → air-trapping, poor gas exchange.
- Irritants (e.g. cigarette smoke) → attraction of inflammatory cells → release leukotrienes, chemical mediators (e.g. B4; IL8; TNF alpha/proteases, elastases/collagenases) → destroy collagen, elastin → lose elasticity → low pressure during expiration pulls walls of alveoli inward → collapse → air-trapping distal to collapse → septa breaks down → neighboring alveoli coalesce into larger air spaces → decreased surface area available for gas exchange
  - Loss of elastin → lungs more compliant (lungs expand, hold air)
  - Alveolar air sacs permanently enlarge, lose elasticity → exhaling difficult

TYPES

Centriacinar/centrilobular emphysema

- Most common
- Damage to central/proximal alveoli of acinus sparing distal alveoli
  - Individuals who smoke (irritants can't reach distal alveoli); upper lobes of lungs

Panacinar emphysema

- Entire acinus uniformly affected
  - A1AT deficiency; lower lobes of lungs

Paraseptal emphysema

- Distal alveoli most affected
  - Lung tissue on periphery of lobules near interlobular septa
  - Ballooned alveoli on lung surface rupture → pneumothorax

CAUSES

- Smoking, A1AT deficiency

COMPLICATIONS

- Hypoxic vasoconstriction → cor pulmonale
  - Poor gas exchange → vessels vasoconstrict to shunt blood to better gas exchange → pulmonary hypertension → increased workload for right heart → right ventricular hypertrophy → cor pulmonale
- Hypoxemia
- Pneumothorax

SIGNS & SYMPTOMS

- Barrel chest (air-trapping, hyperinflation of lungs), apparent respiratory distress with use of accessory muscles, tripod positioning, weight loss, exhaling slowly through pursed lips ("pink puffers"), hyperventilation
- Pursing lips increases pressure in airway → keeps airway from collapsing → weight loss
- Dyspnea, cough (with less sputum)

DIAGNOSIS

DIAGNOSTIC IMAGING

Chest X-ray

- Increased anterior-posterior diameter, flattened diameter, increased lung field lucency (air-trapping)

OTHER DIAGNOSTICS

- Increased TLC
- FVC decreased (esp. FEV1)

TREATMENT

MEDICATIONS

- Bronchodilators
- Inhaled steroids
- Combination inhalers
  - Bronchodilators + inhaled steroids
- Oral steroids
  - Adverse effects: oral candidiasis, weight gain, diabetes, osteoporosis
- Antibiotics (e.g. azithromycin prevents exacerbations)
- *Supplemental oxygen*

SURGERY

- Lung volume reduction
  - Removal of areas of damaged lung tissue to create extra space in chest cavity for healthy lung tissue to expand
  - Can improve quality of life and prolong survival
- Lung transplant
- Bullectomy
  - Removal of bullae (large air spaces) to improve air flow

OTHER INTERVENTIONS

- Pulmonary rehabilitation program
  - Customized education plan consisting of exercising training, nutrition advice, and lifestyle counseling

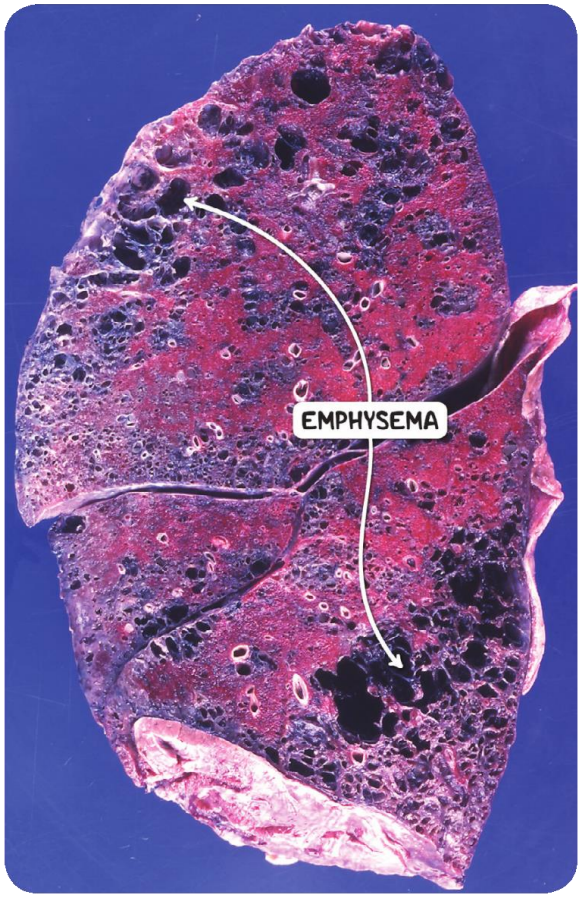

Figure 126.8 The gross pathological appearance of emphysema. There are numerous dilated airspaces in a peripheral distribution.

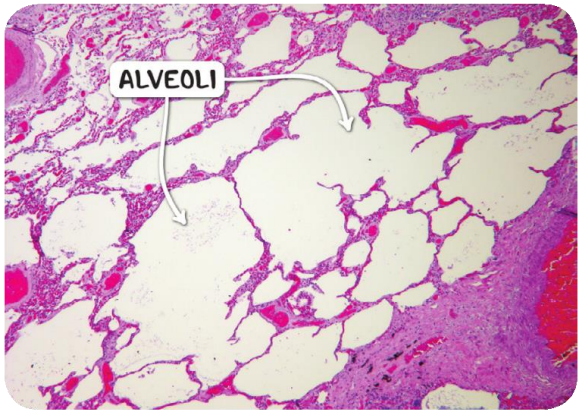

Figure 126.9 The histological appearance of emphysema There are numerous hyperexpanded alveoli.

COMPARISON OF SIGNS & SYMPTOMS: EMPHYSEMA VS. CHRONIC BRONCHITIS

	EMPHYSEMA	CHRONIC BRONCHITIS
pH	Normal to ↑	↓
$PaCO_2$	Normal to ↓	↑
PaO_2	↓	↓
CYANOSIS	Absent	Present
HYPOXEMIA	Presents late	Presents early
DYSPNEA	Presents early	Presents late
APPEARANCE	Thin, leans forward when sitting, barrel chest, in apparent respiratory distress with use of accessory muscles "Pink puffer"	Overweight, cyanotic, in no apparent respiratory distress with no apparent use of accessory muscles "Blue bloater"