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KEY POINTS

- Upper respiratory infections are commonplace, especially in young people, and are often contagious
- Lower respiratory infections are often contagious and some are potentially fatal
- Asthma is common and may be life-threatening
- Chronic obstructive pulmonary disease is common and disabling
- Tuberculosis worldwide is an important infection, affecting people with HIV/AIDS or malnutrition particularly
- Lung cancer is common and usually has a poor prognosis

The respiratory tract consists of the upper respiratory tract (URT – nose, paranasal sinuses, pharynx and larynx; discussed in Ch. 14) and the lower respiratory tract (LRT): the respiratory airways (trachea, bronchi and bronchioles) and lungs (respiratory bronchioles, alveolar ducts, alveolar sacs and alveoli), discussed in this chapter.

Protective mechanisms in the respiratory tracts include a mucociliary lining. Particles or pathogens are trapped in the mucus and driven by ciliary action (the ciliary elevator) to the pharynx. Mucociliary transport declines with age but any effect on clinical infection has not been proved. Lymphoid tissues of the Waldeyer ring (adenoids, palatine and lingual tonsils) are important in developing an immune response to pathogens. However, the best respiratory defence mechanism is the cough reflex, the components of which include cough receptors, afferent nerves, the cough centre, and efferent nerves and effector muscles. Impairment of any of these – as may be seen in older patients or those with conditions associated with lowered consciousness (e.g. sedative use and neurological disease) – can weaken protection. Dysphagia or impaired oesophageal motility may exacerbate the tendency to aspirate foreign material. The alveolar defence mechanisms include macrophages, immunocytes, surfactant, phospholipids, immunoglobulin G (IgG), IgE, secretory IgA, complement components and factor B; many immune defects manifest with recurrent respiratory infections.

Lung function is vital to gas exchange – the blood absorbs oxygen and releases carbon dioxide. Normal gas exchange requires adequate alveolar ventilation, normal ventilation/blood flow relationships and adequate alveolar–capillary membrane surface area. Breathing (ventilation) depends on respiratory drive, which reacts to the respiratory load. This process requires work and results in gas exchange.

Oxygen is transported in combination with haemoglobin in erythrocytes and a small amount dissolved in plasma. The oxyhaemoglobin dissociation curve is sigmoidal; once the oxygen saturation falls below 95%, the amount of O₂ transported to the tissues and brain falls rapidly. High temperatures, acidosis, raised CO₂ and raised 2,3-diphosphoglycerate (2,3-DPG) levels encourage oxygen offloading, whereas fetal haemoglobin and carboxyhaemoglobin have the contrary effect. Chronic hypoxaemia (e.g. at high altitudes) stimulates release of erythropoietin from the kidneys, with a rise in red cell production, and raised 2,3-DPG. Athletes have abused erythropoietin to gain competitive advantage (Ch. 33).

LOWER RESPIRATORY DISEASE

The most common LRT disorders are asthma and chronic obstructive pulmonary disease (COPD).

General aspects

Respiratory disorders are common, and are often caused or aggravated by tobacco smoking. They may significantly affect general anaesthesia (GA) and conscious sedation (CS), since they are often a contraindication to use of benzodiazepines, opioids, GA agents and other respiratory depressants.

Clinical features

Impaired gas exchange leads to laboured breathing and can cause significant incapacity. Features include cough, sputum production, wheeze, dyspnoea, chest pain, cyanosis, finger-clubbing (Fig. 15.1), use of accessory muscles of respiration with indrawing of the intercostal spaces (hyperinflation), and abnormalities in chest shape, movements, respiratory rate and breath sounds.

Cough may be a feature of any respiratory problem but, if chronic, may herald serious disease – for example, COPD, cancer or infection such as tuberculosis. Mucoïd or mucopurulent sputum is often a feature (Fig. 15.2); purulent sputum indicates acute bronchitis, bronchiectasis or lung abscess. Blood (haemoptysis) or blood-stained sputum, though common in acute infections (especially in pre-existing COPD), bronchiectasis and pulmonary embolism, may herald an even more serious condition – for example, possibly one due to carcinoma or tuberculosis. Wheezing is caused by airways obstruction and is a typical sign of asthma or COPD. Breathlessness (dyspnoea) is distressing, and may be caused by respiratory or cardiovascular disease, or by anaemia, and is particularly ominous if it persists at rest.



Fig. 15.1 Tobacco smoker with clubbing in lung cancer.



Fig. 15.2 Mucoid sputum from chronic obstructive pulmonary disease.

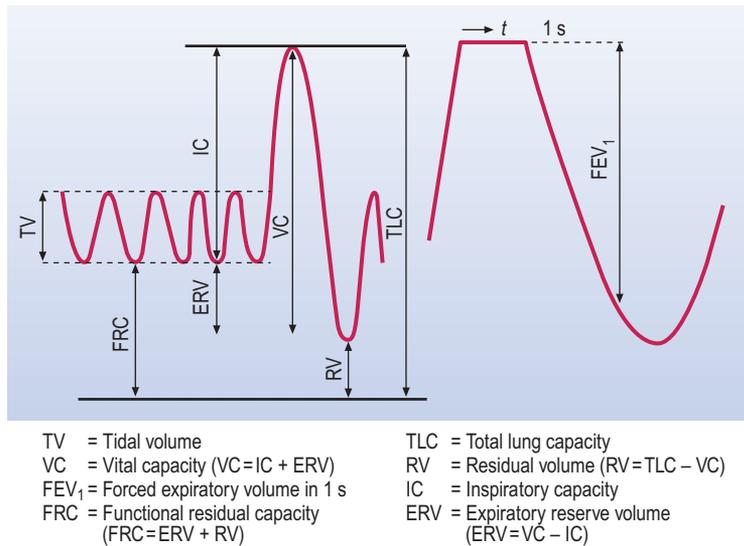


Fig. 15.3 Spirometry.

Excessive resistive load, such as in asthma, COPD and cystic fibrosis, impairs airflow. Elastic load increases because of, for example, interstitial fibrosis, muscle paralysis and obesity.

General management

Diagnosis of respiratory disorders is from the clinical features supported by imaging (especially chest radiography). Spiral computed tomography (CT) can now scan the lungs in a quick 20–30-second breath-hold and therefore, instead of producing a stack of individual CT slices, which may be misaligned due to patient movement or breathing in between slices, provides high-resolution three-dimensional images.

Respiratory function tests can measure individual components of the respiratory process. *Spirometry* is the basic screening test for assessing mechanical load problems, the quantification involving determination of the vital capacity (VC) – slow vital capacity (SVC) and/or forced vital capacity (FVC) – and the speed of maximal expiratory flow (MEF; Fig. 15.3). In health, about 75% of a normal-sized VC is expelled in 1 second (FEV₁). The peak flow meter, which measures the peak expiratory flow rate (PEFR; the earliest portion of forced

Table 15.1 Adult values for PaO₂ and oxygen saturation^a

	PaO ₂ (kPa)	SaO ₂ (%)
Normal (range)	13 (≥10.7)	97 (95–100)
Hypoxaemia	<10.7	<95
Mild hypoxaemia	8–10.5	90–94
Moderate hypoxaemia	5.3–7.9	75–89
Severe hypoxaemia	<5.3	<75

^aFrom Williams AJ. Assessing and interpreting arterial blood gases and acid-base balance. BMJ 1998; 317:1213. <http://www.bmj.com/cgi/content/full/317/7167/1213> (accessed 30 September 2013).

expiration), is a simple measure of airflow obstruction, when the FEV₁ is a much smaller fraction of the VC. In lung restriction, the diminished VC can be mostly expelled in about 1 second. Serial measurements (e.g. in asthma) provide valuable information about disease progress. The reversibility of airways obstruction is usually assessed by spirometry before and after use of a bronchodilator agent.

Arterial blood gas analysis yields considerable information about gas exchange efficiency. Arterial hypoxaemia in adults is defined as PaO₂ below 10.7 kPa breathing room air, although it is not usually treated as clinically important unless below 8 kPa, when oxygen saturation will be 90% or less (Table 15.1).

Arterial carbon dioxide tension (PaCO₂) is used as an inversely proportional index of 'effective' alveolar ventilation. Hence, a high PaCO₂ is taken to indicate poor alveolar ventilation. Alveolar hypoventilation (raised PaCO₂) with a normal pH probably represents a primary ventilatory change present long enough for renal mechanisms to compensate, as in chronic ventilatory failure. Ventilation/blood flow relationships are most simply assessed by considering the size of the difference between the amounts of oxygen and carbon dioxide in the blood and in the air; the differences are small if the lungs are working efficiently. Disparity between ventilation/blood flow ratios results in abnormally wide differences – and then alveolar–arterial PO₂ and arterial–alveolar PCO₂ gradients will be abnormal.

Alveolar capillary surface area is assessed by measuring the uptake of carbon monoxide – usually abnormal in diffuse interstitial inflammatory and fibrotic processes and in emphysema.

Assessing bronchial reactivity and the exercise response can help evaluate breathlessness. Simple exercise testing provides information about overall fitness and the appropriateness of cardiorespiratory responses. Radionuclide lung scanning, blood gas analysis and sputum cytology or culture are sometimes needed in addition.

Management can include oxygen administration by mask or nasal cannula (Figs 15.4 and 15.5).

Dental aspects

LRT disorders can cause significant incapacity and are often a contraindication to GA, and even to CS.

ASTHMA

General aspects

Asthma is common, affecting 2–5% of the overall population; it is on the increase, particularly in childhood, with a frequency of up to 20% in some high-income countries. Asthma usually begins in childhood or early adult life; about half the patients with asthma develop it before age 10 years.



Fig. 15.4 Oxygen by mask in a patient with severe bronchospasm.



Fig. 15.5 Nasal catheter.

Bronchial hyper-reactivity causes reversible airway obstruction from smooth muscle constriction (bronchospasm), mucosal oedema and mucus hypersecretion. There are two main types, extrinsic (allergic) and intrinsic asthma (Table 15.2).

Extrinsic (allergic) asthma, the main childhood type, may be precipitated by allergens in animal dander, feathers or hair, drugs (e.g. non-steroidal anti-inflammatory drugs [NSAIDs] and some antibiotics), food (e.g. eggs, fish, fruit, milk, nuts), house dust (mite allergens) or moulds. Patients frequently have or develop other allergic diseases, such as eczema, hay fever and drug sensitivities. Extrinsic asthma is associated with IgE overproduction on allergen exposure, and release of mast cell mediators (histamine, leukotrienes, prostaglandins, bradykinin and platelet activating factor), which cause bronchospasm and oedema. About 75% of asthmatic children lose their asthma or improve by adulthood.

Intrinsic asthma is usually of adult onset and not allergic, but appears rather to be related to mast cell instability and

Table 15.2 Types of asthma

	Extrinsic asthma	Intrinsic asthma
Frequency	Most common	Least common
Aetiopathogenesis	Allergens causing IgE-mediated mast cell degranulation	Mast cell instability and airway hyper-responsivity
Association with atopy	+	–
Typical age of onset	Child	Adult

airway hyper-responsivity. Triggers include emotional stress, gastro-oesophageal reflux or vagally mediated responses.

Either type of asthma can be triggered by: infections (especially viral, mycoplasmal or fungal); irritating fumes (e.g. traffic or cigarette smoke); exercise (possibly due to cold air); weather changes; emotional stress; foods (e.g. nuts, shellfish, strawberries or milk) or additives (such as tartrazine); and drugs (e.g. aspirin and other NSAIDs, beta-blockers and angiotensin-converting enzyme inhibitors [ACEIs]).

Clinical features

In well-controlled patients with asthma, clinical features may be absent. During an asthmatic episode, symptoms may include dyspnoea, cough and paroxysmal expiratory wheeziness with laboured expiration. The frequency and severity of attacks vary widely between individuals (Table 15.3). Patients may become distressed, anxious and tachycardic, have reduced chest expansion and be using accessory respiratory muscles to increase their ventilatory effort. Nasal polyps are common, especially in aspirin-sensitive asthmatics. Children with asthma initially suffer from repeated 'colds' with cough, malaise and fever, often at night.

Asthma is typically diagnosed when the patient has more than one of the following – wheeze, cough, difficulty breathing and chest tightness – particularly if these are frequent and recurrent; are worse at night and in the early morning; occur in response to, or are worse after, exercise or other triggers, such as exposure to pets, cold or damp air, or with emotions or laughter; or occur without an association with colds. There is often:

- a personal history of atopic disorder
- a family history of atopic disorder and/or asthma
- widespread wheeze, heard on chest auscultation
- a history of improvement in symptoms or lung function in response to adequate therapy.

A prolonged asthmatic attack, which is refractory to treatment, may lead to life-threatening *status asthmaticus* (persisting for more than 24 hours). Failure of the patient to complete a sentence, indrawing of the intercostal muscles, a rapid pulse, a silent chest and signs of exhaustion are suggestive of impending respiratory arrest.

General management

Diagnosis of asthma is from the clinical history and presentation, based on recognizing a characteristic pattern of episodic symptoms in the absence of an alternative explanation. Investigations include a chest radiograph (to exclude other diagnoses, such as a pneumothorax), spirometry (serial PEFr), skin tests and blood examination (usually eosinophilia, raised total IgE and specific IgE antibody concentrations, which may help identify allergens). Occasionally, a histamine or methacholine challenge is used if the diagnosis is unclear.

Table 15.3 Severity of asthma

Severity of asthma	Symptom duration	Attack frequency per week	Other comments	Typical therapy
Mild	<1 h	<2	Attacks follow exercise or exposure to trigger	Beta-agonist as required
Moderate	Days	>2	Activity restricted	Beta-agonist plus steroid
Severe	Persistent	Persistent	Audible wheezing. Tachypnoea. Activity and sleep severely restricted	Beta agonist plus steroid plus theophylline

Table 15.4 Medical management of asthma^a

Drug group	Examples	Comments
Beta-agonists	Selective β_2 -agonists or stimulants (e.g. salbutamol). Others include: Terbutaline, fenoterol, rimiterol Pirbuterol, reproterol, tulobuterol Bambuterol, salmeterol, formoterol	Safest and most effective bronchodilators for routine control of asthma Relax bronchial smooth muscle with little cardiac effect Act for 3–6 h Act for at least 12 h
Antimuscarinic bronchodilators	Ipratropium or oxitropium bromide	Useful particularly for those with asthma associated with bronchitis Act for up to 8 h Contraindicated in glaucoma and prostatic disease
Methylxanthines	Theophylline preparations (oral sustained release)	Prolonged action and useful for controlling nocturnal asthma
Corticosteroids	Corticosteroid (beclometasone, betametasone valerate, budesonide or fluticasone) aerosol inhalations	Effective inhaled along with a bronchodilator but must be taken regularly High-dose corticosteroid inhalants can cause some adrenal suppression
Mast cell stabilizers	Sodium cromoglicate or nedocromil	Occasionally used as inhalants for prophylaxis, mainly in children, but some fail to respond
Leukotriene receptor antagonists	Montelukast, zafirlukast	May impair liver function and increase INR
5-Lipoxygenase inhibitor (impairs leukotriene release)	Zileuton	Given orally Effective when used alone or with inhaled steroids but may precipitate, and should not be used in Churg–Strauss syndrome, where deterioration and cardiac complications may be seen
Recombinant humanized monoclonal anti-immunoglobulin E (IgE) antibody	Omalizumab	Safe, effective treatment for allergic asthma

^aIn addition to oxygen.

In children with an intermediate probability of asthma, who can perform spirometry and have evidence of airways obstruction, assess the change in FEV₁ or PEFR in response to an inhaled bronchodilator (reversibility) and/or the response to a trial of treatment for a specified period; if there is significant reversibility, or if a treatment trial is beneficial, a diagnosis of asthma is probable.

Management includes patient education, smoking cessation advice, avoidance of identifiable irritants and allergens, and use of drugs. Home use of peak flow meters allows patients to monitor progress and detect any deterioration that may require urgent modification of treatment. Treatment should be based on the amount by which peak flow is reduced (a PEFR diary should be kept).

Drugs used for asthma management (Table 15.4) include oxygen, short-acting β_2 agonists (SABAs; such as salbutamol), corticosteroids, leukotriene receptor antagonists and omalizumab (a recombinant humanized monoclonal anti-IgE antibody that reduces the antigen-specific IgE).

Inhaled long-acting β_2 agonists (LABAs) may be needed (Fig. 15.6). Deaths from asthma are usually a result of failure to recognize deterioration or reluctance to use corticosteroids.

Other factors that have been studied include:

- **air pollution** – There is an association between air pollution and aggravation of existing asthma
- **allergen avoidance** – There is no consistent evidence of benefit
- **breast-feeding** – There is evidence of a protective effect in relation to early asthma
- **electrolytes** – There is no consistent evidence of benefit
- **fish oils and fatty acid** – There is no consistent evidence of benefit
- **house dust mites** – Measures to reduce the numbers of house dust mites do not affect asthma severity
- **immunotherapy** – Allergen-specific immunotherapy is beneficial in allergic asthma
- **microbial exposure** – There is insufficient evidence to indicate that the use of probiotics in pregnancy reduces the incidence of childhood asthma
- **modified milk formulae** – There is no consistent evidence of benefit



Fig. 15.6 Inhaler.

- **nutritional supplementation** – There is limited, variable-quality evidence on the potential preventative effect of fish oil, selenium and vitamin E intake during pregnancy
- **pets** – There are no controlled trials on the benefits of removing pets from the home
- **tobacco** – Exposure to cigarette smoke adversely affects quality of life, lung function, need for rescue medications and long-term control with inhaled steroids. There is an association between maternal smoking and an increased risk of infant wheeze
- **weight reduction** – There is an association between increasing body mass index and symptoms of asthma.

Dental aspects

Elective dental care should be deferred in severe asthmatics until they are in a better phase; this can be advised by the patient's general practitioner.

Asthmatic patients should be asked to bring their usual medication with them when coming for dental treatment. Local anaesthesia (LA) is best used; occasional patients may react to the sulphites present as preservatives in vasoconstrictor-containing LA, so it may be better, where possible, to avoid solutions containing vasoconstrictor. Adrenaline (epinephrine) may theoretically enhance the risk of arrhythmias with beta-agonists and is contraindicated in patients using theophylline, as it may precipitate arrhythmias.

Relative analgesia with nitrous oxide and oxygen is preferable to intravenous sedation and gives more immediate control. Sedatives in general are better avoided as, in an acute asthmatic attack, even benzodiazepines can precipitate respiratory failure.

GA is best avoided, as it may be complicated by hypoxia and hypercapnia, which can cause pulmonary oedema even if cardiac function is normal, and cardiac failure if there is cardiac disease. The risk of post-operative lung collapse or pneumothorax is also increased. Halothane

Box 15.1 Agents that may precipitate asthmatic attack

- Acrylic monomer
- Aspirin and other NSAIDs
- Barbiturates
- Beta-blockers
- Colophony
- Cyanoacrylates
- Histamine-releasing agents
- Mefenamic acid
- Opioids
- Pancuronium
- Pentazocine
- Suxamethonium
- Tubocurarine

Table 15.5 Management complications from anti-asthmatic drugs

Anti-asthmatic drug	Possible complications
β_2 -agonists	Dry mouth
Corticosteroids	Steroid complications and adrenal crisis. Corticosteroid inhalers occasionally causes oral or pharyngeal thrush and, rarely, angina bullosa haemorrhagica
Ipratropium bromide	Dry mouth
Leukotriene antagonists	Bleeding tendency (and prolonged INR) because of impaired liver metabolism
Theophylline	Levels increased by epinephrine, erythromycin, clindamycin, azithromycin, clarithromycin or ciprofloxacin

or, better, enflurane, isoflurane, desflurane and sevoflurane are the preferred anaesthetics, but ketamine may be useful in children.

Allergy to penicillin may be more frequent in asthmatics. Drugs to be avoided, since they may precipitate an asthmatic attack (see later), include those listed in Box 15.1.

Acute asthmatic attacks may also occasionally be precipitated by anxiety; it is important to attempt to lessen fear of dental treatment by gentle handling and reassurance. Even routine dental treatment can trigger a clinically significant decline in lung function in approximately 15% of asthmatics. Acute asthmatic attacks are usually self-limiting or respond to the patient's usual medication, such as a beta-agonist inhaler, but status asthmaticus is a potentially fatal emergency (Ch. 1). There may be complications caused by the anti-asthmatic drugs (Table 15.5).

Gastro-oesophageal reflux is not uncommon, with occasional tooth erosion. Periodontal inflammation is greater in asthmatics than in those without respiratory disease. Persons using steroid inhalers may develop oropharyngeal candidosis or, occasionally, angina bullosa haemorrhagica.

Guidelines on the management of asthma may be found at: <http://www.sign.ac.uk/guidelines/fulltext/101/index.html>, <http://www.nice.org.uk/guidance/qualitystandards/indevelopment/Asthma.jsp> and <http://www.brit-thoracic.org.uk/Portals/0/Guidelines/AsthmaGuidelines/qrg101%202011.pdf> (all accessed 30 September 2013).

Box 15.2 Features of Churg–Strauss syndrome

- Asthma
- Eosinophilia >10%
- Extravascular eosinophils
- Mono- or polyneuropathy
- Pulmonary infiltrates (non-fixed)
- Paranasal sinus abnormality

CHURG–STRAUSS SYNDROME (ALLERGIC GRANULOMATOSIS OR ANGIITIS)**General aspects**

Churg–Strauss syndrome (CSS) is a rare, potentially fatal, systemic vasculitis similar to polyarteritis nodosa (PAN), characterized by severe asthma-like attacks with peripheral eosinophilia, and intravascular and extravascular granuloma formation with eosinophil infiltration and skin lesions in 70%. Cardiopulmonary involvement is the main cause of death.

Clinical features

CSS is diagnosed if at least 4 of the 6 criteria listed in [Box 15.2](#) are positive.

General management

The 5-year survival of untreated CSS is 25%. Combination treatment with cyclophosphamide and prednisolone (prednisone) provides a 5-year survival of 50%.

Dental aspects

Management problems relating to patients with CSS may include respiratory impairment and corticosteroid treatment (Ch. 6).

CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)**General aspects**

Chronic obstructive pulmonary disease (COPD; chronic obstructive airways disease, COAD) is a common, chronic, slowly progressive, irreversible disease (most frequently a combination of chronic bronchitis and emphysema), characterized by breathlessness and wheeze (airways obstruction), cough and sputum. *Chronic bronchitis* is defined as the excessive production of mucus and persistent cough with sputum production, daily for more than 3 months in a year over more than 2 consecutive years. It leads to production of excessive, viscous mucus, which is ineffectively cleared from the airway, obstructs and stagnates, and becomes infected, usually with *Streptococcus pneumoniae*, *Moraxella catarrhalis* and *Haemophilus influenzae*. Patchy areas of alveolar collapse can result. *Emphysema* is dilatation of air spaces distal to the terminal bronchioles with destruction of alveoli, reducing the alveolar surface area available for respiratory exchange. COPD is now the preferred term for conditions with airflow obstruction because of a combination of airway and parenchymal damage; patients were previously diagnosed as having chronic bronchitis or emphysema.

Table 15.6 Clinical features differentiating COPD and asthma

	COPD	Asthma
Smoker or ex-smoker	Nearly all	Possibly
Symptoms under age 35	Rare	Often
Chronic productive cough	Common	Uncommon
Breathlessness	Persistent and progressive	Variable
Night-time waking with breathlessness and/or wheeze	Uncommon	Common
Significant diurnal or day-to-day variability of symptoms	Uncommon	Common

Table 15.7 Additional investigations in suspected COPD

Investigation	Comments
Alpha ₁ -antitrypsin	If COPD has an early onset, or there is a minimal smoking history or positive family history
CT scan of thorax	To investigate symptoms that seem disproportionate to spirometric impairment To investigate chest radiograph abnormalities To assess suitability for GA and surgery
Echocardiogram	To assess cardiac status, if cor pulmonale is present
Electrocardiogram	To assess cardiac status, if cor pulmonale is present
Peak flow measurements (serial domiciliary)	To exclude asthma, if any diagnostic doubt
Pulse oximetry	To assess need for oxygen therapy, if cyanosis or cor pulmonale is present, or if FEV ₁ is <50% predicted
Sputum culture	To identify organisms, if sputum is persistently present and purulent
Transfer factor for carbon monoxide (T _L CO)	To investigate symptoms that seem disproportionate to spirometric impairment

COPD is characterized by airflow obstruction – defined as an FEV₁/FVC ratio reduced to less than 0.7. If FEV₁ is 80% or more, a diagnosis of COPD should only be made if there are respiratory symptoms (e.g. dyspnoea or cough). The airflow obstruction is not fully reversible, does not change significantly over months, and is usually progressive in the long term.

The most important causes of COPD include cigarette smoking, environmental pollution, dusts, chemicals or occupational exposures to various substances. Exposure to smoke from home cooking or heating fuels may contribute. Deficiency of the antiproteolytic enzyme alpha₁-antitrypsin is a rare cause of emphysema.

Clinical features

There is often significant airflow obstruction before the person is aware of it and so COPD typically remains undiagnosed until patients are in their fifties. Differentiation from asthma is important ([Table 15.6](#)).

A diagnosis of COPD should be considered in patients over the age of 35 who have a risk factor (e.g. smoking) and exertional breathlessness, chronic cough, regular sputum production, frequent winter ‘bronchitis’ or wheeze. Clinical judgment is based on history, physical examination, confirmation of airflow obstruction using spirometry (post-bronchodilator spirometry) and assessment of the severity of dyspnoea ([Tables 15.7 and 15.8](#)).

COPD is characterized by breathlessness and wheeze (airways obstruction), cough and an early morning mucoid sputum production.

Table 15.8 MRC dyspnoea scale

Grade	Degree of breathlessness related to activities
1	Not troubled by breathlessness except on strenuous exercise
2	Short of breath when hurrying or walking up a slight hill
3	Walks slower than contemporaries on level ground because of breathlessness, or has to stop for breath when walking at own pace
4	Stops for breath after walking about 100 metres or after a few minutes on level ground
5	Too breathless to leave the house, or breathless when dressing or undressing

Adapted from Fletcher CM, et al. *The significance of respiratory symptoms and the diagnosis of chronic bronchitis in a working population. Br Med J 1959; 2:257.*

Table 15.9 Comparison of chronic bronchitis and emphysema

	Chronic bronchitis	Emphysema
Cough	Chronic	Minimal
Sputum	Copious and mucoid	Minimal
Infections	Common	Uncommon
Dyspnoea	Mild	Severe
PO ₂	Low	Low
PCO ₂	Raised	Normal
Forced expiratory volume (FEV)	Low	Low
Clinical appearance	Blue bloater	Pink puffer

Progressive dyspnoea, low oxygen saturation, carbon dioxide accumulation (hypercapnia) and metabolic acidosis mean that patients may ultimately become dyspnoeic at rest ('respiratory cripples'), especially when recumbent (orthopnoea), and eventually develop respiratory failure, pulmonary hypertension, right ventricular hypertrophy and right-sided heart failure (cor pulmonale).

Two clinical patterns of COPD are recognized:

- 'Pink puffers' – patients with emphysema who manage to maintain normal blood gases by hyperventilation, and are always breathless but not cyanosed; rather they are pink from vasodilatation
- 'Blue bloaters' – patients with chronic bronchitis who lose their CO₂ drive, fail to maintain adequate ventilation and become both hypercapnic and hypoxic with central cyanosis, cor pulmonale and oedema (for these patients, the respiratory drive is from the low PO₂ and thus oxygen administration is contraindicated) (Table 15.9).

General management

The diagnosis of COPD is based upon clinical history and presentation. Investigations include a chest radiograph (which may show hyperinflated lung fields with loss of vascular markings); arterial blood gases (which should be measured if pulse oximetry shows oxygen saturation less than 92%); spirometry; and lung function tests. FEV₁ is reduced in all cases (FEV₁ of less than 40% signifies severe COPD) and the flow–volume curve shows a typical pattern, with reduced flow rates at mid- and lower-lung volumes. A ratio of FEV₁:FVC of less than 70% confirms airways obstruction.

Patients with COPD and their family should be educated about the disease, and about required lifestyle changes and medication.

Non-drug therapy includes: stopping smoking (nicotine replacement therapy or bupropion may help); exercise by pulmonary rehabilitation – of proven benefit; weight loss (improves exercise tolerance); and vaccination (pneumococcal and influenza vaccines). Drug therapy includes short-acting bronchodilators (anticholinergic drugs [ipratropium bromide]) and β₂ agonists (salbutamol) to treat the reversible component of airway disease; corticosteroids (inhaled or systemic); and antibiotics (amoxicillin, trimethoprim or tetracycline). Mucolytics, such as carbocisteine, reduce acute exacerbations by almost one-third. Long-term oxygen therapy (LTOT) reduces mortality.

People with stable COPD who remain breathless or have exacerbations, despite using short-acting bronchodilators, should be offered the following as maintenance therapy:

- If FEV₁ is 50% of predicted or more: use either a long-acting β₂ agonist (LABA) or long-acting muscarinic antagonist (LAMA).
- If FEV₁ is less than 50% predicted: either a LABA with an inhaled corticosteroid (ICS) in a combination inhaler, or a LAMA.

Offer a LAMA in addition to a LABA plus ICS to people with COPD who remain breathless or have exacerbations, despite taking LABA plus ICS, irrespective of their FEV₁.

Provide pulmonary rehabilitation for all who need it; non-invasive ventilation (NIV) is the treatment of choice for persistent hypercapnic ventilatory failure during exacerbations not responding to medical therapy. The frequency of exacerbations should be reduced by appropriate use of inhaled corticosteroids and bronchodilators, and vaccinations.

Inhaled therapy

Bronchodilators (short-acting β₂ agonists [SABA] and short-acting muscarinic antagonists [SAMA]) should be the initial empirical treatment for the relief of breathlessness and exercise limitation. ICS have potential adverse effects (including non-fatal pneumonia) in people with COPD. Offer a once-daily LAMA in preference to four-times-daily SAMA to people with stable COPD who remain breathless or have exacerbations, despite using short-acting bronchodilators as required, and in whom a decision has been made to commence regular maintenance bronchodilator therapy with a muscarinic antagonist (see above).

Most patients – whatever their age – are able to acquire and maintain an adequate inhaler technique. Bronchodilators are usually best administered using a hand-held inhaler device (including a spacer device if appropriate).

Patients with distressing or disabling dyspnoea, despite maximal therapy using inhalers, should be considered for nebulizer therapy. They should be offered a choice between a face mask and a mouthpiece to administer their nebulized therapy, unless the drug specifically requires a mouthpiece (for example, anticholinergic drugs).

Oral therapy

Some patients with advanced COPD may require maintenance oral corticosteroids when these cannot be withdrawn following an exacerbation. These individuals should be monitored for the development of osteoporosis and given appropriate prophylaxis.

Theophylline should only be used after a trial of SABA and LABA, and only to those who are unable to use inhaled therapy, as there is a need to monitor plasma levels and interactions. The dose of theophylline prescribed should be reduced at the time of an exacerbation if macrolide or fluoroquinolone antibiotics (or other drugs known to interact) are given. There is insufficient evidence to recommend

prophylactic antibiotic therapy in the management of stable COPD. Mucolytic drug therapy should be considered in patients with a chronic cough productive of sputum.

Combined inhaled and oral therapy

If patients remain symptomatic on monotherapy, their treatment should be intensified by combining therapies from different drug classes, such as:

- β_2 agonist and theophylline
- anticholinergic and theophylline.

Oxygen

Long-term oxygen therapy (LTOT). Inappropriate oxygen therapy in people with COPD may depress respiration. LTOT is indicated in patients with COPD who have a PaO_2 of less than 7.3 kPa when stable, or a PaO_2 greater than 7.3 kPa and less than 8 kPa when stable, and one of: secondary polycythaemia, nocturnal hypoxaemia (oxygen saturation of arterial blood [SpO_2] of less than 90% for more than 30% of the time), peripheral oedema or pulmonary hypertension.

To reap the benefits of LTOT, patients should breathe supplemental oxygen for at least 15 hours per day. To ensure that all those eligible for LTOT are identified, pulse oximetry should be available in all health-care settings. The assessment of patients for LTOT should comprise the measurement of arterial blood gases on two occasions at least 3 weeks apart in patients who have a confident diagnosis of COPD, who are receiving optimum medical management and whose COPD is stable.

Patients should be warned about the risks of fire and explosion and told not to smoke when using oxygen.

Ambulatory oxygen therapy. Ambulatory oxygen therapy should be considered in patients on LTOT who wish to continue oxygen therapy outside the home, and who have exercise desaturation, are shown to have an improvement in exercise capacity and/or dyspnoea with oxygen, and are motivated to use oxygen.

Non-invasive ventilation (NIV). Adequately treated patients with chronic hypercapnic respiratory failure who have required assisted ventilation during an exacerbation, or who are hypercapnic or acidotic on LTOT, should be referred to a specialist centre for consideration of long-term NIV. Advanced emphysema is occasionally treated with surgery – excision of large acquired bullae or, rarely, lung transplantation.

Dental aspects

Patients with COPD who need dental care can be classified as follows:

- Patients at low risk – experience dyspnoea on effort but have normal blood gas levels. These patients can receive all dental treatment with minor modifications.
- Patients at moderate risk – experience dyspnoea on effort, are chronically treated with bronchodilators or recently with corticosteroids, and PaO_2 lowered. A medical consultation is advised to determine the level of control of the disease before any dental treatment.
- Patients at high risk – have symptomatic COPD that may be end-stage and poorly responsive to treatment. With these patients, a medical consultation is essential before any dental treatment is carried out.

Patients with COPD are best treated in an upright position at mid-morning or early afternoon, since they may become increasingly

dyspnoeic if laid supine. It may be difficult to use a rubber dam, as some patients are mouth-breathers and not able to tolerate the additional obstruction. LA is preferred for dental treatment, but bilateral mandibular or palatal injections should be avoided. Patients with COPD should be given relative analgesia only if absolutely necessary, and only in hospital after full preoperative assessment. CS with diazepam and midazolam should not be used, as benzodiazepines are respiratory depressants. Patients should be given GA only if absolutely necessary, and intravenous barbiturates are contraindicated. Secretions reduce airway patency and, if lightly anaesthetized, the patient may cough and contaminate other areas of the lung.

Postoperative respiratory complications are more prevalent in patients with pre-existing lung diseases, especially after prolonged operations and if there has been no preoperative preparation. The most important single factor in preoperative care is cessation of smoking for at least 1 week preoperatively. Respiratory infections must also be eradicated; sputum should first be sent for culture and sensitivity, but antimicrobials such as amoxicillin should be started without awaiting results.

The medical management of COPD should be optimized prior to surgery. The ultimate clinical decision about whether or not to proceed with surgery should rest with a consultant anaesthetist and consultant surgeon, taking account of co-morbidities, functional status of the patient and necessity for the surgery.

Composite assessment tools, such as the American Society of Anesthesiologists (ASA) scoring system, and not just lung function, are the best criteria for the assessment of patients with COPD before surgery. Those taking corticosteroids should be treated with appropriate precautions (Ch. 6). Interactions of theophylline with other drugs, such as adrenaline (epinephrine), erythromycin, clindamycin, azithromycin, clarithromycin or ciprofloxacin, may result in dangerously high levels of theophylline. Ipratropium can cause dry mouth.

Guidelines for the management of COPD may be found at: <http://publications.nice.org.uk/chronic-obstructive-pulmonary-disease-cg101> (accessed 30 September 2013).

INFECTIONS

General aspects

Respiratory viruses usually spread by touch or airborne transmission and the very small particles (2–0.2 micrometres) can avoid the upper respiratory tract defences and the mucociliary elevator to reach the lung alveoli. A range of viruses can cause lower respiratory tract infections (LRTIs; Table 15.10). Some viruses (e.g. influenza and respiratory syncytial) can spread from the upper to the lower respiratory tract via infection of the respiratory epithelium and can lead to bacterial superinfection and pneumonitis (pneumonia). Mycoplasmal (atypical) pneumonia and tuberculosis (TB) may be direct infections. Epidemics of a potentially fatal severe acute respiratory syndrome (SARS) have been caused by a coronavirus that originated in China and spread worldwide; H5N1 bird influenza also arose as an epidemic; and a similar epidemic, but of swine influenza (H1N1), emanated from Mexico (see later).

Bacterial infections, such as pneumonia or lung abscess, can also result from material aspirated into the lungs, and are usually unilateral. Those who aspirate more than others have, as a result, more frequent LRTI and this is seen in alcohol and other drug abusers, as well as comatose patients. Exogenous penetration and contamination

Table 15.10 Lower respiratory tract infections and their main causes^a

Condition	Microorganisms
Laryngo-tracheo-bronchitis (croup)	Influenza viruses <i>Mycoplasma pneumonia</i> Para-influenza viruses Respiratory syncytial virus
Acute bronchiolitis	Human metapneumovirus (HMPV) Influenza viruses Respiratory syncytial virus
Acute bronchitis	Adenovirus <i>Bordetella pertussis</i> <i>Chlamydia pneumoniae</i> (Taiwan acute respiratory [TWAR] agent) Coronaviruses Coxsackie virus <i>Haemophilus influenzae</i> (non-typeable) Herpes simplex virus Influenza viruses <i>Moraxella catarrhalis</i> <i>Mycoplasma pneumonia</i> Para-influenza virus Respiratory syncytial virus Rhinovirus
Acute pneumonitis (pneumonia)	<i>Escherichia coli</i> <i>Haemophilus influenza</i> <i>Klebsiella</i> species <i>Pseudomonas aeruginosa</i> Severe acute respiratory syndrome-associated coronavirus (SARS-CoV) <i>Streptococcus pneumoniae</i> (pneumococcus)

^aThe most frequent are shown in bold.

of the lung can result from trauma (e.g. a stab wound or road traffic accident) or surgery. *Entamoeba histolytica* can occasionally cause pneumonia – by direct extension from an amoebic liver abscess (Table 15.11). Patients with endocarditis, or septic pelvic or jugular thrombophlebitis, may experience LRTI acquired haematogenously and then it is often bilateral.

Immunocompromised persons (e.g. those with human immunodeficiency virus/acquired immune deficiency syndrome [HIV/AIDS] and transplant recipients) and people with bronchiectasis or cystic fibrosis are also susceptible to respiratory infections by a range of opportunistic microbes. *Pneumocystis jiroveci* (*P. carinii*), for example, is a common cause of potentially fatal pneumonia in immunocompromised patients – especially those with HIV/AIDS (Chs 20 and 21).

Clinical features

Clinical features of LRTI vary according to the part of the respiratory tract mainly affected:

- *Bronchiolitis* causes rapid respiration, wheezing, fever and dyspnoea – but is restricted mainly to infants.
- *Bronchitis* causes cough, wheezing and sometimes dyspnoea.
- *Pneumonia* causes cough, fever, rapid respiration, breathlessness, chest pain, dyspnoea and shivering.

Table 15.11 Causes of pneumonia

Infective route	Microorganisms
Inhalation	<i>Streptococcus pneumoniae</i> , <i>Streptococcus pyogenes</i> Mycobacteria, <i>Legionella</i> , <i>Coxiella burnetii</i> (Q fever) Influenza, measles virus, adenovirus <i>Coccidioides</i> , <i>Histoplasma</i> , <i>Cryptococcus</i>
Aspiration	Anaerobes, <i>Streptococcus pneumoniae</i> , <i>Staphylococcus aureus</i> , <i>Haemophilus influenzae</i> , Gram-negative bacilli
Haematogenous spread	<i>Staphylococcus aureus</i> , Gram-negative bacilli (<i>Pseudomonas aeruginosa</i>) <i>Candida</i> <i>Strongyloides</i> , <i>Ascaris</i>
Contiguous spread	Anaerobes, Gram-negative bacilli <i>Entamoeba histolytica</i>
Reactivation	Mycobacteria Cytomegalovirus <i>Coccidioides</i> , <i>Histoplasma</i> , <i>Blastomyces</i> <i>Toxoplasma</i> , <i>Strongyloides</i> , <i>Pneumocystis jiroveci</i> (<i>P. carinii</i>)

General management

Antimicrobial therapy is indicated, particularly for pneumonia. Antivirals have not been highly effective. Oxygen may be needed. Pneumococcal vaccine is indicated for older people.

Dental aspects

The majority of LRTIs are severe illnesses, and are contraindications to all but emergency dental treatment. GA is hazardous and absolutely contraindicated. Dental treatment should be deferred until recovery, or be limited to pain relief.

INFLUENZA ('FLU)

Influenza is mainly a community-based infection transmitted in households and communities. Health-care-associated influenza infections can arise in any health-care setting, most commonly when influenza is also circulating in the community.

General aspects

Influenza is a contagious disease caused by influenza virus types A, B or C. Type A has two main subtypes (H1N1 and H3N2); it causes most of the widespread influenza epidemics and can occasionally be fatal. Type B viruses generally cause regional outbreaks of moderate severity, and type C viruses are of minor significance.

A person can spread influenza starting 1 day before they feel sick and for another 3–7 days after symptoms start. Influenza can be prevented or ameliorated by vaccination each autumn; this is especially indicated for older people and those with cardiorespiratory disease.

Clinical features

Influenza attacks virtually the whole respiratory tract; symptoms appear suddenly after 1–4 days and include fever, sore throat, nasal congestion, headache, tiredness, dry cough and muscle pains (myalgia).

Most people recover in 1–2 weeks but infection can be life-threatening, mainly because primary influenzal viral pneumonia can lead to secondary bacterial pneumonia or can exacerbate underlying conditions (e.g. pulmonary or cardiac disease). The old and very young, and those with chronic disorders, are more likely to suffer complications, such as pneumonia, bronchitis, sinusitis or otitis media. Influenza has also been followed by depression, encephalopathy, myocarditis, myositis, pericarditis, Reye syndrome and transverse myelitis.

General management

Rest, maintenance of fluid intake, analgesics, antipyretics, and avoidance of alcohol and tobacco help relieve symptoms. Aspirin must *never* be given to children under the age of 16 years who have 'flu-like symptoms, and particularly fever, as this can cause Reye syndrome.

Zanamivir (an antiviral that works against influenza types A and B) can shorten the symptoms by approximately 1 day, if treatment is started during the first 2 days of illness. Other antiviral drugs include amantadine, oseltamivir and rimantadine; they may be helpful but their use is restricted mainly to immunocompromised persons, since they can cause adverse effects.

Dental aspects

Influenza can be a severe contagious illness so all but emergency dental treatment should be deferred until recovery. GA is hazardous and absolutely contraindicated.

Bird 'flu

Influenza type A subtype H5N1 can cause an illness known as 'avian influenza' or 'bird 'flu' in birds, humans and many other animal species. HPAI A(H5N1) – 'highly pathogenic avian influenza virus of type A of subtype H5N1' – is the causative agent and is enzootic in many bird populations, especially in South-East Asia. It has spread globally and resulted in the deaths of over 100 people and the slaughter of millions of chickens. A vaccine that could provide protection (Prepandrix) has been cleared for use in the European Union. H5N7 is a more recent emergent infection, similar in many respects.

Swine 'flu

Swine influenza is common in pigs in the midwestern United States, Mexico, Canada, South America, Europe (including the UK, Sweden and Italy), Kenya, China, Taiwan, Japan and other parts of eastern Asia. Transmission of swine influenza virus from pigs to humans is not common, but can produce symptoms similar to those of influenza. A 2009 outbreak in humans ('swine 'flu') was due to an apparently new strain of H1N1 arising from a reassortment produced from strains of human, avian and swine viruses. It can pass from human to human. Antiviral agents such as oseltamivir may help. Vaccines are now available.

SEVERE ACUTE RESPIRATORY SYNDROME (SARS)

General aspects

An outbreak of a life-threatening febrile respiratory infection appeared in 2003, originating from Guangdong, China, and was named severe acute respiratory syndrome (SARS). Caused by a newly recognized coronavirus (SARS-associated coronavirus, SARS-CoV), SARS spread via close contact to many countries across the world. According to the

World Health Organization, 8437 people worldwide became sick with SARS during the course of the first recognized outbreak and 813 died.

Clinical features

The incubation period of 2–7 days is followed by a high fever (above 38.0°C), malaise, headache and myalgia. Some people also experience mild upper respiratory symptoms and, after 2–7 days, lower respiratory signs – a dry cough and dyspnoea, potentially progressing to hypoxaemia. SARS can cause a pneumonia with a mortality approaching 10%, particularly in older or immunocompromised people.

General management

Artificial ventilation has been needed in 10–20% of cases. Antiviral agents, such as oseltamivir or ribavirin, may help. Inactivated vaccines, virally and bacterially vectored vaccines, recombinant protein and DNA vaccines, as well as attenuated vaccines, are under development.

Dental aspects

SARS is a severe illness, and all but emergency dental treatment should be deferred until recovery. GA is hazardous and absolutely contraindicated. For all contact with suspect SARS patients, careful hand hygiene is important, including hand-washing with soap and water; if hands are not visibly soiled, alcohol-based handrubs may be used as an alternative to hand-washing. If a suspected SARS patient is admitted to hospital, infection control personnel should be notified immediately. Infection control measures (www.cdc.gov/ncidod/hip/iso-lat/isolat.htm; accessed 30 September 2013) should include standard precautions (e.g. hand hygiene): health-care personnel should wear eye protection for all patient contact; contact precautions (e.g. gown and gloves for contact with the patient or their environment); and airborne precautions (e.g. an isolation room with negative pressure relative to the surrounding area and use of an N-95 filtering disposable respirator for persons entering the room).

BACTERIAL PNEUMONIA

General aspects

Pneumonia is classed as 'primary' if it occurs in a previously healthy individual, and is usually lobar; it is called 'secondary' if it follows some other disorder, such as previous viral respiratory infections, aspiration of foreign material, lung disease (bronchiectasis or carcinoma), depressed immunity (e.g. alcoholism or immunosuppression), or aspiration of oral bacteria (Table 15.12). It is usually bronchopneumonia.

Community-acquired pneumonia is often associated with *Streptococcus pneumoniae* or *Haemophilus influenzae* but Enterobacteriaceae, such as *Klebsiella* species, *Escherichia coli* and *Pseudomonas aeruginosa*, are especially likely in the very old and infirm (Table 15.13). Poor oral hygiene and periodontal disease may promote oropharyngeal bacterial colonization. Early on, hospital-acquired pneumonia is often associated with *Strep. pneumoniae* or *H. influenzae*. In late hospital-acquired pneumonia, polymicrobial infections or meticillin-resistant *Staphylococcus aureus* (MRSA) are particular hazards.

Clinical features

Pneumonia causes cough, fever, rapid respiration, breathlessness, chest pain, dyspnoea and shivering. Complications can include lung abscess or empyema (pus in pleural cavity).

Table 15.12 Factors predisposing to pneumonia

Exogenous	Endogenous
Viral respiratory infections, particularly influenza	Old age
Suppression of the cough reflex	Immobility
Aspiration of foreign material	Respiratory depression or chest injury
Mortality in patients in intensive care units (ventilator-associated pneumonia; VAP) – can range from 20% to 50%	Neurological disorders permitting aspiration of foreign material
Prolonged endotracheal intubation (increases risk by up to 20-fold)	Underlying pulmonary disease, such as carcinoma or emphysema
	Alcoholism
	Immunodeficiency (especially HIV/AIDS)
	<i>Pneumocystis jiroveci</i> (<i>carinii</i>) pneumonia – Chs 20 and 21

Table 15.13 Main causes of bacterial pneumonia

Pathogen	Comments
<i>Chlamydia pneumoniae</i>	Seen in persons in institutions
<i>Chlamydia psittaci</i>	Seen after contact with psittacine birds (parrots, etc.)
<i>Coxiella burnetii</i>	Seen after contact with farm animals
Gram-negative anaerobes	Seen after aspiration
<i>Haemophilus influenzae</i>	Seen at extremes of life
<i>Klebsiella pneumoniae</i>	Seen in the elderly and debilitated, and in nursing homes
<i>Legionella pneumoniae</i>	Seen after exposure to water aerosols
<i>Mycoplasma pneumoniae</i>	Epidemics every 4 years
<i>Staphylococcus aureus</i>	Follows influenza
<i>Streptococcus pneumoniae</i>	Most common pathogen

General management

It is important to avoid alcohol and tobacco, but use analgesics and antipyretics to relieve the symptoms. Broad-spectrum antimicrobials given promptly and empirically usually include a macrolide (azithromycin, clarithromycin or erythromycin), quinolone (moxifloxacin, gatifloxacin or levofloxacin), or doxycycline for outpatients. For inpatients, cefuroxime or ceftriaxone plus a macrolide is used.

Prophylaxis includes immunization against influenza and pneumococci.

Dental aspects

Pneumonia is a severe illness and all but emergency dental treatment should be deferred until recovery. GA is hazardous and absolutely contraindicated.

Ventilator-associated pneumonia (VAP) is discussed later.

LEGIONELLOSIS

General aspects

Legionellosis is a bacterial respiratory infection caused by one of the family Legionellaceae, Gram-negative aerobic bacilli, ubiquitous in water and soil but particularly preferring warm aquatic environments. The term Legionnaire’s disease was coined as a result of an outbreak of the previously unrecognized respiratory disease in an American Legion meeting in Philadelphia in 1976, but it is now recognized

Table 15.14 Differentiation of Legionnaire’s disease from Pontiac fever

	Legionnaire’s disease	Pontiac fever
Isolation of bacterium	+	–
Incubation period	2–14 days	24–48 h
Percentage of persons who, when exposed to the source of an outbreak, become ill	<5%	>90%
Clinical features	Pneumonia: cough, fever, chest pain	‘Flu-like illness (fever, chills, malaise) without pneumonia
Radiographic pneumonia	+	–
Case-fatality rate (%)	5–80	~0

worldwide, many infections being contracted during travel abroad, particularly to Spain, Turkey and some other Mediterranean areas.

Legionella bacteria can be found in natural freshwater environments, usually in insufficient numbers to cause disease. *Legionella* grow best in warm water, as in hot tubs, cooling towers, hot water tanks, large plumbing systems, or the air-conditioning systems of large buildings. Though there are over 30 Legionellaceae, most infections are caused by *Legionella pneumophila*. Disease is contracted by inhalation of contaminated mist or vapour, mainly (approximately 46%) through aerosolization of infected water in air-conditioning systems, hot-water systems, humidifiers, nebulizers, showers and spa pools. Outbreaks have mostly been linked to aerosol sources in the community, cruise ships and hotels, with the most likely sources being whirlpool spas, air-conditioning units in large buildings, potable (drinking) water systems, and water used for bathing. Risk factors include:

- exposure to:
 - recent travel with an overnight stay outside of the home (outbreaks of travel-associated legionellosis are infrequently identified but more than 20% of cases are thought to be associated with recent travel)
 - whirlpool spas
 - recent repairs or maintenance work on domestic plumbing
- systemic ill-health:
 - alcohol use
 - chronic kidney disease
 - diabetes
 - immune defects
 - liver disease
 - malignancy
 - smoking.

Illness mainly affects males over 45, smokers, heavy drinkers, older people and the immunocompromised. Also vulnerable are travellers, especially middle-aged and older tourists, and conference or business groups, possibly because of tiredness or age. Many young people have been exposed to infection and become seropositive, but remained healthy.

There is no evidence of person-to-person transmission of legionellosis.

Clinical features

Legionellosis manifests as one of two clinical syndromes (Table 15.14). *Legionnaire’s disease* is typically a lobular type of pneumonia, which

Table 15.15 Sensitivity and specificity of *Legionella* diagnostic tests

Test	Sensitivity (%)	Specificity (%)
Culture	80	100
Urine antigen	70	100
Paired serology ^a	70–80	>90
Direct fluorescent antibody stain	25–75	95

^aA single antibody titre of any level is not diagnostic of legionellosis.

can be fatal but is fortunately rare; infection can range from discrete patches of inflammation and consolidation to involvement of whole lobes. *Pontiac fever* is milder and usually subsides rapidly, often without treatment.

People who should be tested for Legionnaire's disease include those with pneumonia in the following groups:

- Hospitalized patients with enigmatic pneumonia
- Patients who require care in an intensive care unit
- Compromised hosts
- Individuals who contract disease in the setting of a legionellosis outbreak
- Those who fail to respond to a beta-lactam or cephalosporin
- Patients who have travelled away from home within the preceding 2 weeks.

Because *Legionella* is commonly found in the environment, clinical isolates are necessary to interpret the findings of an environmental investigation. Diagnosis can be by rapid urine molecular testing for *L. pneumophila* antigen, and culture of respiratory secretions on selective media. Sensitivity and specificity of the diagnostic tests are shown in Table 15.15.

General management

Pontiac fever is a self-limited illness; most cases recover within 1 week and few benefit from antibiotic treatment. Overall mortality in Legionnaire's disease may be as high as 10%, and over 25% in older people and up to 80% in the immunocompromised. Erythromycin is standard treatment; cephalosporin is an alternative.

Dental aspects

Legionella species are present in roughly two-thirds of potable water samples collected from domestic and institutional taps and drinking fountains, and from a similar percentage of dental units, but water from these dental units often has higher bacterial concentrations (Ch. 31). There are reports of *Legionella* infections in dental unit water lines, and antibodies and occasionally frank infection demonstrated in dental staff; at least one patient appears to have contracted and died from infection emanating from a dental practice.

Prevention is crucial, involving (Ch. 31):

- continuous circulation water systems
- independent water reservoirs
- flushing lines
- regular disinfection of waterlines, handpieces and power scalers
- waterline filters
- regular water quality testing.

Further information on infection control measures is available at: <http://www.legionellacontrol.com/legionella-control-association.htm> (accessed 30 September 2013).

TUBERCULOSIS (TB)

General aspects

Tuberculosis (TB), an infection caused by mycobacteria, affects approximately one-third of the world's population (1.5 billion people); it is a major global health problem, some 2 million people dying from it annually. TB disproportionately affects the poorest persons in both high-income and developing countries. In high-income countries, most human TB arises from *Mycobacterium tuberculosis*, transmitted from person to person through the air. TB usually affects the lungs initially (pulmonary TB) but can also involve brain, kidneys, spine and other parts. From Victorian times to about the Second World War, *Mycobacterium bovis* infection from infected cows' milk (bovine or bTB) was a major cause of morbidity and mortality; it was clinically and pathologically indistinguishable from infection caused by *M. tuberculosis*. Cattle-testing and a slaughter programme became compulsory in 1950 and, by the 1980s, the incidence of TB in cattle had been substantially reduced. Tuberculosis from *M. bovis* in cows' milk was virtually eliminated in high-income countries by the tuberculin testing of cattle and pasteurization of milk. In the developing world, many cattle still have TB, and bTB is still seen. bTB has also increased in high-income countries over the last two decades and an infection rate of up to 38% in badgers – and transmission to cattle – may explain this.

TB is not spread by touch or by drinking glasses, dishes, sheets or clothing. It is usually transmitted by infected sputum, typically from close contacts such as family members, but is unlikely to be transmitted between normal social contacts. TB can present an occupational risk to health-care professionals, including dental staff. One outbreak of drug-resistant TB in New York involved at least 357 patients, most of whom contracted TB in one of 11 hospitals; nearly 90% of the patients were also HIV-positive, and most were young males of Hispanic or African heritage. TB has been transmitted between passengers during long-haul airline flights. The risk of transmitting TB though air circulation is now low because the high-efficiency particulate air (HEPA) filters on newer commercial aircraft are of the same type as those used in hospital respiratory isolation rooms; indeed, the number of times air is cleaned each hour exceeds the recommendation for hospital isolation rooms.

Sub-Saharan Africa has the highest rates of active TB per capita, driven primarily by the HIV epidemic. The absolute number of cases is highest in Asia, with India and China having the greatest burden of disease globally. In the USA and most Western European countries, the majority of cases occur in foreign-born residents and recent immigrants from countries in which tuberculosis is endemic. Immunocompromised people – such as diabetics and severely immunodeficient patients, like those with HIV/AIDS (about 30% of South Africans with HIV/AIDS also have TB) – and patients in prisons or institutions are at risk. TB also mainly affects medically neglected persons, such as vagrants, alcoholics, intravenous drug abusers or older homeless people. The main groups at increased risk for infection therefore include people who are resource-poor or immunoincompetent, especially:

- alcoholics
- older people
- people with cancer, diabetes mellitus, HIV/AIDS or liver disease
- people taking immunosuppressive or biological agents
- young children.

TB in developing countries is particularly widespread and is increasing, the highest rises in incidence being in South-East Asia, sub-Saharan Africa and Eastern Europe. In high-income countries,

Table 15.16 Tuberculosis: differentiation of latent and active infections

	Latent	Active
Mycobacteria present	+	+
Mycobacteria active	–	+
Contagious	–	+
Symptoms	–	+
Mantoux test	+	+
Chest radiograph	Normal	Abnormal
Sputum culture	–	+

the incidence is also rising, probably because of worsening social deprivation, homelessness, immigration, HIV infection and intravenous drug abuse. It is now as common in London as in the developing world, and is seen especially in immigrants, such as those from the Indian subcontinent, Africa and South Asia. This increase appears to be a result of the development of TB disease in individuals who may have been infected for some time and of new infections acquired in the UK, or as a result of travel to other countries where TB is common. London accounted for the highest proportion of cases in the UK in 2011 (39%), followed by the West Midlands region (11%); 74% of these were born outside the UK and mainly originated from South Asia and sub-Saharan Africa. In 2011, there was a rise in the number of TB cases compared to 2010, as well as an increase in drug resistance.

More information on TB, including statistics, can be found at: <http://www.hpa.org.uk/Publications/InfectiousDiseases/Tuberculosis/> and <http://www.tbfacts.org/tb-statistics.html> (both accessed 30 September 2013).

Clinical features

Initial infection with TB is usually subclinical. About 10% of those infected develop overt disease; of these, half will manifest within 5 years (primary TB), while the remainder will develop post-primary disease. Inhaled mycobacteria may cause subpleural lesions (primary lesion) and lesions in the regional lymph nodes (primary complex). Body defences usually localize the mycobacteria, though these remain viable; infected persons are not obviously ill and are unlikely to know they are infected (latent; Table 15.16). Latent TB infection (LTBI) usually becomes active only after many years, if body defences become weakened (Box 15.3). However, active TB can develop shortly after mycobacteria enter the body, if body defences are impaired such as in ageing, drug or alcohol abuse, or HIV/AIDS. Also, in massive infections, acute active TB can result, typically causing a chronic productive cough, haemoptysis, weight loss, night sweats and fever. Erythema nodosum may be associated. Extrapulmonary TB is less common; it may appear as glandular involvement in the neck or elsewhere, and is less infectious than pulmonary TB. Lymph node TB may lead to lymphadenopathy, caseation of the nodes and pressure symptoms – for example, on the bronchi.

Post-primary TB follows reactivation of an old primary pulmonary lesion and results in features ranging from a chronic fibrotic lesion to fulminating tuberculous pneumonia. The pulmonary lesions may extend and lead to a pleural effusion. Reactivation or progression of primary TB may also result in widespread haematogenous dissemination of mycobacteria – ‘miliary TB’. Multiple lesions may involve the central nervous system, bones, joints, and cardiovascular, gastrointestinal and genitourinary systems.

Box 15.3 Conditions in which tuberculosis may become activated

- Alcohol abuse
- Cancer
- Chronic kidney disease
- Diabetes
- Drug abuse
- Gastric bypass/gastrectomy
- HIV
- Immunosuppression
- Leukaemia
- Recent infection
- Silicosis
- Young age at infection

Clinical presentation in TB is thus variable, depending on the extent of spread and the organs involved. As it frequently passes unrecognized for so long, the mortality is high.

Similar illnesses to TB may also be caused by atypical (non-tuberculous) mycobacteria, such as *M. avium* complex (MAC; see below).

General management

The diagnosis of TB is suggested by the history and confirmed by physical examination, a massively raised erythrocyte sedimentation rate (ESR), positive tuberculin skin tests (TSTs; Mantoux or Heaf test for a delayed hypersensitivity reaction to protein from *M. tuberculosis* [purified protein derivative; PPD]) and chest imaging. Hypersensitivity develops with 2–8 weeks of infection and can be detected by conversion of the TST from negative to positive, but TSTs are neither 100% sensitive nor specific. A positive Mantoux reaction indicates previous immunization (BCG; bacille Calmette–Guérin – live attenuated *M. bovis*) or current infection – not necessarily disease. Chest radiography may show scarring and hilar lymphadenopathy. Computed tomography (CT) may show areas of calcification or highlight a tuberculous abscess. Smears and culture of sputum, blood, laryngeal swabs, bronchoalveolar lavage, gastric aspirates or pleural fluid may be tested for mycobacteria.

Polymerase chain reaction (PCR) techniques have greatly accelerated the diagnosis and speciation, though Ziehl–Neelsen, auramine or rhodamine microbial stains are still used. The mycobacteria growth indicator tube (MGIT) system gives results as early as 3–14 days. Blood assay for *M. tuberculosis* (BAMT) may be positive by interferon-gamma release assay (IGRA). Some 15% of people over 65 years have a positive IGRA. The IGRA can be used in place of (but not in addition to) TST. IGRAs measure the immune reactivity to *M. tuberculosis*. White blood cells from most persons that have been infected with *M. tuberculosis* will release interferon-gamma (IFN- γ) when mixed with *M. tuberculosis* antigens. A positive test result suggests that *M. tuberculosis* infection is likely; a negative result suggests that infection is unlikely.

Latent infection (LTBI) can be diagnosed with either a tuberculin skin test or an IGRA (more specific). IGRA gives a result within 24 hours and should be used biological therapy is given, such as for rheumatoid arthritis or inflammatory bowel disease. Prior BCG vaccination does not cause a false-positive IGRA test result. More information on the IGRA is available at: <http://www.cdc.gov/tb/publications/factsheets/testing/igra.htm> (accessed 30 September 2013).

Active TB is diagnosed by sputum microscopy and culture in liquid medium with subsequent drug-susceptibility testing. Nucleic acid

Table 15.17 Antitubercular therapy

Drug	Use	Main adverse effects
Ethambutol ^a	Initial therapy ^b	Ocular damage
Isoniazid	Initial therapy ^b	Peripheral neuropathy
	Continuation therapy ^c	Hepatotoxicity
Pyrazinamide	Initial therapy ^b	Hepatotoxicity
Rifampicin	Initial therapy ^b	Enhanced liver P450 drug-metabolizing enzymes
	Continuation therapy ^c	Red urine and saliva
		Bullous lesions
		Hepatotoxicity
		Nephrotoxicity
Streptomycin ^a	Initial therapy ^b	Vestibular nerve damage
		Circumoral paraesthesiae

^aIncreasing resistance.

^bInitial therapy, usually = isoniazid + rifampicin + pyrazinamide or ethambutol for 2 months.

^cContinuation therapy = isoniazid + rifampicin for 4 months.

amplification tests, imaging, and histopathological examination of biopsy samples help. IGRA and TSTs have no role in the diagnosis of active disease. A molecular diagnostic test now available in some high-income countries (Xpert MTB/RIF assay) detects *M. tuberculosis* complex within 2 hours, with a higher assay sensitivity than that of smear microscopy.

People who should be tested for TB include those who have symptoms, those who have had close day-to-day contact with active TB disease (family member, friend or co-worker), those who have HIV infection or AIDs, those with lowered immunity, those who are required to for employment or school, and those about to be treated with biological agents.

The top priority of TB control programmes is to identify and give complete treatment to all patients with active disease. TB is a notifiable disease and contact tracing is an important aspect of limiting spread. Treatment with antibiotics is indicated for people who are sick with TB, those infected but not sick, and those who are close contacts of infectious TB cases. Treatment for 'symptomatic sputum-positive' patients, which should be instituted as soon as possible, is combination chemotherapy, usually isoniazid plus rifampicin plus pyrazinamide or ethambutol for 2 months, with continuation of daily isoniazid and rifampicin for a further 4 months. Treatment for 'asymptomatic' patients who are believed to have been infected by contacts, but are not unwell, includes isoniazid for 6 months or isoniazid and rifampicin for 3 months. Rifapentine is a long-acting rifampicin used once weekly. Fluoroquinolones (moxifloxacin) may also act against TB. There may be resistance to one or more than one antibiotic.

Currently, given the potential risk of drug-resistant TB being present, treatment is usually started with isoniazid, rifampicin, pyrazinamide and ethambutol (or a quinolone such as gatifloxacin or moxifloxacin) for 2 months, then isoniazid and rifampicin for 4 months.

All antituberculous drugs (Table 15.17) have potentially serious adverse effects and require careful monitoring. If patient compliance is considered to be poor, directly observed therapy (DOT), where drugs are dispensed by and taken in the presence of a health-care professional, may be indicated. New drugs are on the horizon.

Immunization using BCG is advocated for schoolchildren, high-risk individuals and health-care professionals – although its efficacy has been questioned. New vaccines are in development.

Chemoprophylaxis with isoniazid and rifampicin is indicated in a number of situations (Box 15.4).

Box 15.4 Indications for tuberculosis (TB) chemoprophylaxis

- Previous inadequate treatment of TB
- Close contact with persons actively infected with TB
- Conversion of the tuberculin test within the past 2 years
- Biological therapy being considered
- A positive tuberculin test in the following groups:
 - Immunocompromised persons (diabetes, renal failure, cancer, HIV infection)
 - Persons under 35 years, or intravenous drug users
 - A foreign-born person who has migrated from a region of high prevalence within the previous 2 years

Drug-resistant TB (DR-TB)

TB can become resistant to the drugs used to treat it particularly when the drugs are misused or mismanaged. This may occur, for example, when:

- drugs are unavailable or of poor quality
- patients fail to complete the full treatment course
- health-care providers prescribe the wrong drugs, doses or length of treatment.

DR-TB is more common in people who:

- fail to take their TB drugs regularly or fail to take a complete course
- have recurrence of TB disease
- come from areas where DR-TB is common
- have spent time with someone who has DR-TB
- work in hospitals or health-care settings where DR-TB patients are seen.

More than 60% of DR-TB patients are in China, India, the Russian Federation, Pakistan and South Africa.

Multidrug-resistant TB (MDR-TB)

In some developing countries, approximately 10% of cases are multiple antibiotic-resistant; this is termed multidrug-resistant tuberculosis (MDR-TB); in the UK, only a small minority currently fall into this category but the number of cases is increasing. MDR-TB is defined as resistance to rifampicin and isoniazid; it may be atypical in presentation and the infection disseminates. More than 4% of people with TB worldwide have MDR-TB, and Eastern Europe has a high prevalence. MDR-TB is seen mainly in people with HIV/AIDS and in HIV/AIDS and in Africans. Bedaquiline, is a new anti-tubercular agent - the first active agent against tuberculosis to be registered since 1963.

Extensively drug-resistant TB (XDR-TB)

Extensively drug-resistant tuberculosis (XDR-TB) is a rare type of MDR-TB, not only resistant to isoniazid and rifampin, but also to any fluoroquinolone and at least one of three injectable second-line drugs (i.e. amikacin, kanamycin, or capreomycin). XDR-TB is of special concern for immunocompromised people (e.g. with HIV/AIDS), who are more likely to develop TB, and have a higher risk of death if they do develop it. XDR-TB is most often encountered in people from Eastern Europe, Russia and Africa. It has been transmitted in health-care facilities and is now seen worldwide. It is essentially untreatable, though capreomycin has been used effectively to treat MDR-TB in HIV-positive individuals.

Totally drug-resistant TB (TDR-TB or XXDR-TB)

Totally drug-resistant TB was reported initially in 2007–2009 in India, Iran and Italy; it is spreading, despite denials, and is most disquieting.



Fig. 15.7 Neck scarring from tuberculous lymphadenitis.

Dental aspects

Chronic ulcers, usually on the tongue dorsum, are the main oral manifestation of TB. They result from coughing of infected sputum from pulmonary TB, including in HIV-infected persons with TB, but are rare and such cases (usually middle-aged males) may result from neglect of symptoms or default from treatment. Occasionally, the diagnosis is made from biopsy of an ulcer after granulomas are seen microscopically. Acid-fast bacilli are rarely seen in oral biopsies, even with the help of special stains, so unfixed material should also be sent for culture if possible. Tuberculous cervical lymphadenopathy is the next most common form of the infection and is particularly common among those from South Asia. Most TB lymphadenitis is painless, with several enlarged, matted nodes, but systemic symptoms are present only in a minority and only about 15% have pulmonary manifestations on radiography (Fig. 15.7). Diagnosis relies on tuberculin testing, which can be positive in both tuberculous and non-tuberculous mycobacterial cervical lymphadenitis. Any person with lymphadenopathy and recent conversion from a negative to positive tuberculin test should be suspected of having mycobacterial infection, and this should prompt biopsy (e.g. fine-needle aspiration biopsy) for culture or histological confirmation. PCR will improve diagnosis, as culture must wait 4–8 weeks for a result. Oral complications of antitubercular therapy are rare, but rifabutin and rifampicin can cause red saliva.

Pulmonary TB is of high infectivity, as shown by cases of tuberculous infection of extraction sockets and cervical lymphadenitis in 15 patients treated by an infected member of staff at a dental clinic. Dental staff who themselves were HIV-positive, working in a dental clinic for HIV-infected persons in New York, have died from TB contracted occupationally. Transmission of MDR-TB between two dental workers may have occurred in an HIV dental clinic. Infection control is thus important, so staff with TB are usually precluded from their occupation until treated.

Management of a patient with TB depends upon the level of potential infectivity (Table 15.18). Patients with open pulmonary TB are contagious, and dental treatment is thus best deferred until the infection has been treated. Treatment with appropriate drugs for 2 weeks drastically reduces the infectivity of patients with pulmonary TB. If patients with open pulmonary TB must be given dental treatment, special precautions should be used to prevent the release of mycobacteria into the air, to remove any that are present and to stop their inhalation by other persons. Reduction of splatter and aerosols, by minimizing coughing and avoiding ultrasonic instruments, and use of a rubber dam, are important. Improved ventilation, ultraviolet germicidal light, new masks and personal respirators, and other personal protective devices,

Table 15.18 Dental management of patients with known or suspected tuberculosis (TB)

History of TB	Potential infectivity	Comment
Active sputum-positive TB	High	Urgent dental treatment only; use special infection control precautions.
Recent history of TB and sputum known to be positive for TB	High	Defer elective dental care until TB treatment complete
Past history of TB	Refer to physician; needs confirmation	Use special infection control precautions for emergency dental care Defer elective dental care until medical advice received
No history of TB but signs or symptoms suggestive		
No history of TB but positive tuberculin test		



Fig. 15.8 Respirator.

such as HEPA filters, are indicated (Fig. 15.8). Mycobacteria are very resistant to disinfectants, so that heat sterilization must be used.

LA is safe and satisfactory. Relative analgesia is contraindicated because of the risk of contamination of the apparatus. GA is also contraindicated for dental treatment because of the risk of contamination of the anaesthetic apparatus and because of impaired pulmonary function. Aminoglycosides, such as streptomycin, enhance the activity of some neuromuscular blocking drugs and in large doses may alone cause a myasthenic syndrome. Possible drug interactions are shown in Table 15.19.

Other factors, such as alcoholism or intravenous drug use (Ch. 34), hepatitis (Ch. 9) or HIV disease (Ch. 20), may also influence dental management.

ATYPICAL MYCOBACTERIA (NON-TUBERCULOUS MYCOBACTERIA, NTM; MYCOBACTERIA OTHER THAN TUBERCULOSIS; MOTT)

General aspects

Mycobacteria other than tuberculosis (MOTT) are widely distributed in water, soil, animals and humans, and rarely cause disease. Severe MOTT infections have been seen, however, in individuals predisposed because of defects in the interleukin-12 (IL-12) and interferon-gamma (IFN-gamma) pathways.

Mycobacterium abscessus, a bacterium found in water, soil and dust, has been known to contaminate medications and products, including

Table 15.19 Possible drug interactions in tuberculosis (TB)

Drug	May cause interactions with
Paracetamol (acetaminophen)	Isoniazid
Azole antifungals	Rifampicin
Benzodiazepines	
Clarithromycin	
Diazepam	
Paracetamol (acetaminophen)	
Aspirin	Amikacin, capreomycin, kanamycin or streptomycin

Box 15.5 Mycobacteria other than tuberculosis

- *Mycobacterium abscessus*
- *M. avium*
- *M. chelonae*
- *M. fortuitum*
- *M. intracellulare* (*M. avium*–*intracellulare* complex; MAC)
- *M. kansasii*
- *M. marinum*
- *M. scrofulaceum*
- *M. ulcerans*
- *M. xenopi*

medical devices. Health-care-associated *M. abscessus* can cause a variety of infections, usually of the skin, but it can also cause lung infections in persons with various chronic lung diseases and is increasingly recognized as an opportunistic pathogen in *cystic fibrosis* (CF) patients.

Person-to-person transmission of atypical mycobacteria is *not* important in acquisition of infection, except for skin infections. On rare occasions, MOTT skin infections have followed tattooing with contaminated tattoo inks. Many people become infected with and harbour MOTT in their respiratory secretions without any symptoms or evidence of disease. Individuals with respiratory disease from MOTT do *not* readily infect others and, therefore, do not need to be isolated. MOTT are generally not infectious to others.

Infection with *M. abscessus* is usually caused by injections of contaminated substances or by invasive medical procedures employing contaminated equipment or material. Infection can also occur after accidental injury where the wound is contaminated by soil. There is very little risk of transmission from person to person.

Clinical features

Atypical mycobacteria include *M. avium*, *M. intracellulare* (MAC) species and others (Box 15.5). *Mycobacterium avium* complex (comprising *M. avium* and *M. intracellulare*; MAC) can cause several different syndromes:

- In children, MAC most commonly cause cervical lymphadenitis.
- In non-immunocompromised adults, pulmonary disease is a result of infection with MAC.
- In immunocompromised adults, disseminated MAC infections may arise. An immune defect, underlying illness or tissue damage may result in disseminated MAC infection.

MAC complex, *M. scrofulaceum* and *M. kansasii* are possible causes of tuberculous cervical lymphadenitis. MAC may also infect the lungs (similar to TB), skin or lymph nodes. Lung disease is also caused occasionally by *M. kansasii*, mainly in middle-aged and older persons

with underlying chronic lung conditions. *M. fortuitum* and *M. chelonae* may cause skin and wound infections and abscesses, frequently associated with trauma or surgery. *M. marinum* may cause ‘swimming pool granuloma’, a nodular lesion that may ulcerate, usually on an extremity. *M. ulcerans* may produce chronic ulcerative skin lesions, usually of an extremity. *M. abscessus* skin infections present with swollen and/or painful areas that are usually red, warm and tender to the touch, and which can also develop into boils or pustules. Other features of *M. abscessus* infection are fever, chills, muscle aches and malaise.

General management and dental aspects

Cervical lymphadenitis due to MAC, *M. scrofulaceum* and *M. kansasii* may affect otherwise healthy young children, most commonly preschool females who have unilateral cervical lymphadenopathy, typically in the submandibular or jugulodigastric nodes, and they may form a ‘cold abscess’. MOTT is the usual cause in children under 12 years but TB is more common in older patients. Absence of fever or tuberculosis, a positive tuberculin test and failed response to conventional antimicrobials are highly suggestive of MOTT, but definitive diagnosis is by smear, culture or PCR of biopsy material obtained by fine-needle aspiration or removal of nodes.

Treatment is based on results of laboratory testing, which should identify the appropriate antibiotic. Preventive treatment of close contacts of persons with disease caused by MOTT is *not* needed. Most MOTT are resistant to standard antitubercular medication and, though it is possible that clarithromycin or clofazimine may have some effect, excision of affected nodes is the usual recommended therapy.

Water from dental units may contain MOTT species; mycobacterial proliferation in biofilms may explain the extent of this contamination (Ch. 31).

ASPIRATION SYNDROMES

Aspiration syndromes are conditions in which foreign substances are inhaled into the lungs and which can have consequences ranging from asphyxia to infection and lung abscess. Dental restorations or fragments of teeth, plaque, gastric contents and other materials may be aspirated, especially if material enters the pharynx, and particularly if the cough reflex is impaired for any reason.

Most commonly, aspiration syndromes involve oral or gastric contents associated with gastro-oesophageal reflux disease (GORD), swallowing dysfunction (Ch. 7), neurological disorders and structural abnormalities, such as a pharyngeal pouch. Cricopharyngeal dysfunction involves cricopharyngeal muscle spasm or achalasia of the superior oesophageal sphincter, and can be seen in infants who have a normal sucking reflex but have incoordination during swallowing, possibly secondary to delayed development or cerebral palsy. Anatomical disorders, such as cleft palate, pharyngeal pouch, oesophageal atresia, tracheo-oesophageal fistula, duodenal obstruction or malrotation, and motility disorders, such as achalasia, may have an aspiration risk. Infirm older patients are also at risk of aspiration, especially if they are bed-bound or have neurological disorders. Isolated superior laryngeal nerve damage, vocal cord paralysis, cerebral palsy, muscular dystrophy and Riley–Day syndrome (familial dysautonomia) are all associated with increased risk of aspiration.

VENTILATOR-ASSOCIATED PNEUMONIA (VAP)

Ventilator-associated pneumonia (VAP), as defined by the Centers for Disease Control and Prevention (CDC), is present when the

chest radiograph shows new or progressive infiltrate, consolidation, cavitation or pleural effusion in conjunction with either new onset of purulent sputum or change in character of sputum, and an organism isolated from blood, or the isolation of an aetiological agent from a specimen obtained via suction aspiration through an endotracheal or tracheostomy tube.

The major route for acquiring endemic VAP is oropharyngeal colonization by endogenous flora or by exogenously acquired pathogens from intensive care units. VAP is the most commonly reported health-care-acquired infection in patients receiving mechanical ventilation, with prevalence rates consistently in the 10–20% range. Mortality rates in VAP are at least double those in patients without VAP, ranging from 24% to 85% when the infection is caused by a multidrug-resistant Gram-negative pathogen.

The Healthcare Infection Control Practices Advisory Committee of the CDC has developed guidelines for the prevention of VAP. These include strategies aimed at preventing aspiration of contaminated oral or gastric material (e.g. raising the head of the bed and draining subglottic secretions), and interventions to alter bacterial colonization of stomach (e.g. stress ulcer prophylaxis and selective digestive decontamination) and mouth. Oral hygiene, suctioning and the provision of moisture to lips and oral mucosa, plus tooth-brushing, may be important in prevention of VAP. There are also strategies for managing ventilator circuits (e.g. replacement of ventilator circuits, use of closed rather than open suction, and use of heat moisture exchange as opposed to heated circuit technology).

LUNG ABSCESS

General aspects

Lung abscess is a localized infection leading to cavitation and necrosis. While some cases result from aspiration of foreign material, most develop from pneumonia caused by infection with *Staph. aureus* or *Klebsiella pneumoniae*. Bronchial obstruction by carcinoma is another important cause.

Clinical features

Symptoms resemble those of suppurative pneumonia. There is a risk of infection spreading locally or leading, via septicaemia, to a brain abscess.

General management

Diagnosis rests mainly on the chest radiograph, which may sometimes show cavitation or a fluid level. Antimicrobial chemotherapy, postural drainage and relief by bronchoscopy of any obstruction are indicated.

Dental aspects

A well-recognized cause of lung abscess is inhalation of a tooth or fragment, a restoration or rarely, an endodontic instrument. When undertaking endodontics or cementing restorations, such as inlays or crowns, a rubber dam or other protective device should always be used to avoid the danger of inhalation.

Lung abscesses may also result from aspiration of oral bacteria, particularly anaerobes, especially in infirm older patients or those who are intubated.

The other main dangers in dentistry are with GA, particularly if an inadequate throat pack has been used. Patients who inhale tooth fragments or dental instruments must have chest radiographs (lateral and postero-anterior) and, if necessary, bronchoscopy.

Table 15.20 Sarcoidosis: possible clinical findings

Type	Finding
Dermatological	Erythema nodosum, infiltrates around eyes and nose (lupus pernio)
Hepatic	Asymptomatic hepatomegaly, sarcoid liver disease
Lymph nodes	Lymphadenopathy (rarely lymphoma)
Musculoskeletal	Arthralgia, effusions, cyst-like radiolucent areas
Neurological	Cranial or peripheral neuropathies
Oral/para-oral	Salivary gland or gingival swelling
Ocular	Acute uveitis, cataracts, glaucoma
Pulmonary	Hilar lymphadenopathy; widespread infiltration
Renal	Nephrocalcinosis, renal calculi
Spleen	Splenomegaly
Systemic symptoms	Fever, weight loss, fatigue

LOEFFLER SYNDROME

Loeffler syndrome appears to be an allergic reaction, usually to the parasitic worm *Ascaris lumbricoides*, or drugs such as sulphonamides. It manifests with pulmonary infiltrates (and abnormal chest radiograph) and eosinophilia (eosinophilic pneumonia). The disease usually clears spontaneously.

SARCOIDOSIS

General aspects

Sarcoidosis, so named because skin lesions resembled a sarcoma, is a multisystem granulomatous disorder, seen most commonly in young adult females in northern Europe, especially in people of African heritage. The aetiology is unclear but *Propionibacterium acnes* and *P. granulorum* have been implicated and associations have been reported with exposure to inorganic particles, insecticides, moulds and occupations such as firefighting and metal-working. Serum samples contain antibodies directed against *Mycobacterium tuberculosis* antigens. Sarcoidosis is associated with HLA-DRB1 and DQB1, and a butyrophilin-like 2 (*BTNL2*) gene on chromosome 6. T-helper 1 (Th1) cells release IL-2 and IFN- γ , and augment macrophage tumour necrosis factor alpha (TNF- α) release. CD25 regulatory T cells cause a limited impairment of cell-mediated immune responses (partial anergy) but no obvious special susceptibility to infection.

Clinical features

Sarcoidosis affects the thorax in 90%, but has protean manifestations and can involve virtually any tissue (Table 15.20). Sarcoid most typically causes Löfgren syndrome (fever, bilateral hilar lymphadenopathy, arthralgia and erythema nodosum, especially around the ankles; Figs 15.9 and 15.10).

Other common presentations may include pulmonary infiltration and impaired respiratory efficiency, with cough and dyspnoea in severe cases, or acute uveitis, which can progress to blindness. Susceptibility to lymphomas has been suggested but not confirmed.

General management

Because of its vague and protean manifestations, sarcoidosis is underdiagnosed. In the presence of suggestive clinical features, helpful



Fig. 15.9 Sarcoid causing ankle swelling in Löfgren syndrome.



Fig. 15.10 Sarcoid lung image showing hilar adenopathy.

investigations include: chest radiography (enlarged hilar lymph nodes); raised serum angiotensin-converting enzyme (SACE; Table 15.21) in acute disease (this is insensitive, non-specific and a poor guide to therapy); positive gallium-67 citrate or gadolinium or positron emission tomography (PET) scans; labial salivary gland or transbronchial biopsy (for histological evidence of non-caseating epithelioid cell granulomas) – except in Löfgren syndrome, which is a classical clinical diagnosis. ^{18}F -deoxyglucose PET is helpful in identifying sites for biopsy.

Non-specific findings may include mild anaemia, leukopenia, eosinophilia, hypergammaglobulinaemia, raised ESR and low serum albumin. Hypercalcaemia is common because of extrarenal production of active vitamin D and can result in renal damage. Alkaline phosphatase, 5'-nucleotidase, lysozyme and adenosine deaminase levels are raised in hepatic sarcoidosis. Evidence of impaired delayed hypersensitivity reactions to some antigens may be useful. Kveim skin tests are not now used.

Table 15.21 Sarcoidosis: laboratory findings

Type	Finding
Histological	Non-caseating tubercle-like granulomas
Immunological	Anergy (partial) Negative response to tuberculin and some other common antigens on skin testing Lymphopenia; low numbers of T cells
Biochemical	Raised serum levels of immunoglobulins Hypercalcaemia Raised serum levels of lysozyme, serum angiotensin-converting enzyme (SACE) and adenosine deaminase

Half the patients with sarcoidosis remit within 3 years and about 66% remit by 10 years. Patients with only minor symptoms usually need no treatment but corticosteroids, sometimes with azathioprine, methotrexate, tetracyclines, hydroxychloroquine, infliximab or etanercept, are given if there is active organ disease (ocular disease, progressive lung disease, hypercalcaemia or cerebral involvement).

Dental aspects

Biopsy of the minor salivary glands frequently shows non-caseating granulomas and association with other features of sarcoidosis, particularly hilar lymphadenopathy. This is an important diagnostic finding that may obviate more invasive procedures. Sarcoidosis can involve any of the oral tissues but has a predilection for salivary glands. Asymptomatic swelling of the parotid glands or cervical nodes, and less frequently the lips, may accompany systemic disease. Superficial or deep-seated red submucosal nodules may develop intraorally and on the lips. Non-tender, well-circumscribed, brownish-red or violaceous nodules with superficial ulceration have also been reported. The oral and lip lesions may occasionally precede systemic involvement.

There is enlargement of the major salivary glands in about 6% of cases; some have xerostomia, and the association of salivary and lacrimal gland enlargement with fever and uveitis is known as uveoparotid fever (Heerfordt syndrome). Salivary gland swellings usually resolve on treatment of sarcoidosis but this may take up to 3 years.

Facial palsy and other cranial neuropathies may be seen. There is also an association with Sjögren syndrome, when SS-A and SS-B serum autoantibodies are found. Rarely there is an association of thyroiditis with Addison disease, Sjögren syndrome and sarcoidosis (TASS syndrome). There is a group of patients who have histological features of sarcoid in one or more sites in the mouth, such as the gingivae, but no systemic manifestations. A few of these patients may ultimately develop other more or less systematized disease but the majority probably have isolated lesions. Such cases, where no exogenous cause for the granulomatous reaction can be found, are regarded as having 'sarcoid-like' reactions (orofacial granulomatosis) and treatment is unnecessary. However, patients should be kept under observation for as long as possible.

Management of patients with systemic sarcoidosis may include consideration of respiratory impairment, uveitis and visual impairment, renal disease, jaundice or corticosteroid treatment.

LA is safe and satisfactory. CS is contraindicated if there is any respiratory impairment. GA should only be given in hospital.

LUNG CANCER

General aspects

Lung cancer is the most common cancer in high-income countries in males and most frequently affects adult urban cigarette-smokers. Bronchogenic carcinoma accounts for 95% of all primary lung cancer and has also become increasingly common in women (because of increased tobacco use), to the extent that the mortality rate for the two sexes has become almost equal. Metastases from cancers elsewhere are also frequently found in the lungs.

Clinical features

Recurrent cough, haemoptysis, dyspnoea, chest pain and recurrent chest infections are the predominant features. Local infiltration may cause pleural effusion, lesions of the cervical sympathetic chain (Horner syndrome), brachial neuritis, recurrent laryngeal nerve palsy or obstruction of the superior vena cava with facial cyanosis and oedema (superior vena cava syndrome).

There are many non-metastatic extrapulmonary effects of bronchogenic (or other) carcinomas – for example, weight loss, anorexia, finger-clubbing, neuromyopathies, thromboses (thrombophlebitis migrans), muscle weakness, various skin manifestations and ectopic hormone production (of antidiuretic hormone, adrenocorticotrophic hormone, parathyroid hormone and thyroid-stimulating hormone).

Metastases from bronchogenic cancer are common and typically form in the brain (which may manifest with headache, epilepsy, hemiplegia or visual disturbances), liver (hepatomegaly, jaundice or ascites) or bone (pain, swelling or pathological fracture).

General management

The diagnosis is based on history and physical examination, supported by radiography, CT and magnetic resonance imaging (MRI), sputum cytology, bronchoscopy and biopsy. Spiral CT appears to detect tumours at an early stage.

The overall 5-year survival rate is only 8%. Radiotherapy is the most common treatment. Only some 25% of patients are suitable for surgery but, even then, the 5-year survival is only about 25%. Chemotherapy has been disappointing, except in small-cell carcinomas.

Dental aspects

Dental treatment under LA should be uncomplicated. CS should preferably be avoided. GA is a matter for specialist management in hospital, as patients often have impaired respiratory function, especially after lobectomy or pneumonectomy. This, along with any muscle weakness (myasthenic syndrome, Eaton–Lambert syndrome) that can make the patient unduly sensitive to the action of muscle relaxants, makes GA hazardous.

Oral cancer may be associated with lung cancer, and *vice versa*, or develop at a later stage (Ch. 22). Such synchronous or metachronous primary tumours must always be ruled out.

Metastases can occasionally affect the orofacial region and cause enlargement of the lower cervical lymph nodes, epulis-like soft-tissue swellings or labial hypoaesthesia or paraesthesia in the jaw. Soft palate pigmentation is a rare early oral manifestation.

Lung cancer is a fairly common cause of death in dental technicians, but it is unknown whether this is due to smoking alone or to dust inhalation.

CYSTIC FIBROSIS (CF; FIBROCYSTIC DISEASE; MUCOVISCIDOSIS)

General aspects

Cystic fibrosis (CF) is one of the most common fatal hereditary disorders. Inherited as an autosomal recessive trait, with an incidence of about 1 in 2000 births, it is the most common inherited error of metabolism and is seen mainly in people of European descent. The gene responsible is on chromosome 7q. CF is caused by defects in the cystic fibrosis transmembrane conductance regulator (CFTR), a protein that appears to be part of a cyclic adenosine monophosphate (cAMP)-regulated chloride channel, regulating Cl^- and Na^+ transport across epithelial membranes, and ion channels and intracellular fluid flow in sweat, digestive and mucus glands.

The basic defect in CF is abnormal chloride ion transport across the cell membrane of nearly all exocrine glands. The blockage of salt and water movement into and out of cells results in the cells that line the lungs, pancreas and other organs producing abnormally thick, sticky mucus that can obstruct the airways and various glands, especially in the respiratory tract and pancreas. Involved glands (lungs, pancreas, intestinal glands, intrahepatic bile ducts, gallbladder, submaxillary and sweat glands) may become obstructed by this viscid or solid eosinophilic material.

Clinical features

Recurrent respiratory infections result in a persistent productive cough and bronchiectasis, with the lungs becoming infected with a variety of organisms including *Staph. aureus*, *Haemophilus influenzae*, *Pseudomonas aeruginosa*, *Strep. pneumoniae*, *Burkholderia cepacia*, and sometimes mycoses or mycobacteria. *Mycobacterium abscessus* is a non-tuberculous mycobacterium increasingly recognized as an opportunistic pathogen in CF patients. Viral infections, such as measles, can have severe sequelae.

Pancreatic duct obstruction leads to pancreatic insufficiency, with malabsorption and bulky, frequent, foul-smelling, fatty stools. Gallstones, diabetes, cirrhosis and pancreatitis may result. Sinusitis is very common.

Growth is frequently stunted. The mutations can also cause congenital bilateral absence of the vas deferens, so fertility is impaired in most males with CF. In women, fertility may be impaired by viscid cervical secretions, but many women have carried pregnancies to term.

General management

Most patients have a high concentration of sodium in their sweat (also reflected in the saliva); a sweat test showing sodium and chloride values of more than 60 mmol/L is considered positive, between 40 and 60 mmol/L equivocal, and less than 40 mmol/L negative.

Physiotherapy and postural drainage are crucially important. Clearance of sputum is helped by water aerosols and bronchodilators (terbutaline or salbutamol), but mucolytics such as carbocysteine, methyl cysteine and dornase alfa are of questionable effectiveness. Treatment with ivacaftor, a CFTR potentiator, improves chloride transport through the ion channel.

Amoxicillin and flucloxacillin are effective prophylactic antimicrobials and may be given by aerosol. Vaccination against measles, whooping cough and influenza is important. A low fat intake, adequate vitamins and oral pancreatic enzyme replacement (pancreatin) are also necessary.

Double-lung or heart–lung transplantation may eventually become necessary.

Dental aspects

Sinusitis is very common; most CF patients have recurrent sinusitis and nasal polyps. The major salivary glands may enlarge and hyposalivation sometimes occurs. The low-fat, high-carbohydrate diet and dry mouth may predispose to caries. Enamel hypoplasia and black stain may be seen, and both dental development and eruption are delayed. Tetracycline staining of the teeth was common but should rarely be seen now. Pancreatin may cause oral ulceration if held in the mouth.

LA is satisfactory but CS is usually contraindicated because of poor respiratory function. GA is contraindicated if respiratory function is poor. Lung disease, such as bronchiectasis, liver disease and diabetes, may complicate treatment.

BRONCHIECTASIS

General aspects

Bronchiectasis is dilatation and distortion of the bronchi. Causes include:

- Congenital defects, which should be considered in all patients include cystic fibrosis, Kartagener syndrome, alpha-1-antitrypsin deficiency, collagen defects (e.g. Marfan syndrome)
- Immunodeficiencies
- Postinfection
- Gastric aspiration
- Bronchial obstruction
- Autoimmune diseases, e.g. Sjögren's syndrome
- Asthma
- Inflammatory bowel disease

There is no identifiable underlying cause in about 50% of adults and 25% of children.

The damaged and dilated bronchi lose their ciliated epithelium and therefore mucus tends to pool, causing recurrent LRTIs, typically with *Strep. pneumoniae*, *Haemophilus influenzae* or *Pseudomonas aeruginosa*.

Clinical features

Overproduction of sputum, which is purulent during exacerbations, a cough (especially during exercise or when lying down) and finger-clubbing are typical features, with recurrent episodes of bronchitis, pneumonia and pleurisy. Haemoptysis is not uncommon. In advanced bronchiectasis, chest pain, dyspnoea, cyanosis and respiratory failure may develop. Complications may include cerebral abscess and amyloid disease.

General management

Chest radiography and pulmonary function tests are required. High-resolution CT (HRCT) is useful. Postural drainage is important. Antimicrobials, such as amoxicillin, cephalosporins or ciprofloxacin, are given for acute exacerbations and for long-term maintenance treatment.

Dental aspects

GA should be avoided where possible and is contraindicated in acute phases.

OCCUPATIONAL LUNG DISEASE (PNEUMOCONIOSES)

General aspects

Workers exposed to airborne particles may develop pulmonary disease (pneumoconiosis), which ranges from benign (e.g. siderosis) to malignant, as in mesothelioma from asbestosis (see Appendix 15.1), but any pneumoconiosis can cause significant incapacity.

Dental aspects

GA may be contraindicated; the physician should be contacted before treatment.

Berylliosis may be a hazard in some dental technical laboratories, when lung cancer is more frequent.

POSTOPERATIVE RESPIRATORY COMPLICATIONS

Respiratory complications following surgical operations under GA include segmental or lobar pulmonary collapse and infection. They are more common after abdominal surgery or if there is pre-existent respiratory disease or smoking (see also Ch. 3), and can be significantly reduced by smoking cessation, preoperative physiotherapy and bronchodilators, such as salbutamol.

If postoperative pulmonary infection develops, sputum should be sent for culture, and physiotherapy and antibiotics should be given. The common microbial causes are *Strep. pneumoniae* and *Haemophilus influenzae*; in this case, suitable antibiotics include amoxicillin and erythromycin. Hospital infections may include other microorganisms, such as MRSA, *Klebsiella*, *Pseudomonas* and other Gram-negative bacteria.

Inhalation (aspiration) of gastric contents can cause pulmonary oedema and may be fatal (Mendelson syndrome); it is most likely if a GA is given to a patient who has a stomach that is not empty, has a hiatus hernia or is in the last trimester of pregnancy. Prevention is by ensuring the stomach is empty preoperatively; if it is not, an anaesthetist should pass an endotracheal tube. Antacids or an H₂-receptor blocker, such as cimetidine or ranitidine, may be given by mouth preoperatively to lower gastric acidity.

If gastric contents are aspirated, the pharynx and larynx must be carefully sucked out. Systemic corticosteroids have been recommended but probably do not reduce the mortality.

RESPIRATORY DISTRESS SYNDROMES

Respiratory distress in premature infants may be caused by immaturity of surfactant-producing cells, when the alveoli fail to expand fully; this necessitates endotracheal intubation for many weeks. It may, in turn, result in midface hypoplasia, palatal grooving or clefting, or defects in the primary dentition. The same oral effects may be seen with prolonged use of orogastric feeding tubes. The degree to which subsequent growth corrects these deformations is currently unknown, though the palatal grooves typically regress by the age of 2 years. Using soft endotracheal tubes does not obviate this problem and, at present, the best means of avoiding palatal grooving appears to be the use of an intraoral acrylic plate to stabilize the tube and protect the palate.

Acute respiratory distress syndrome (ARDS) is a sequel to several types of pulmonary injury and some infections, including those with oral viridans streptococci.

LUNG TRANSPLANTATION

General aspects

Patients with end-stage pulmonary disease are considered for potential transplantation, usually using a lung from a brain-dead organ donor. A combination of ciclosporin, azathioprine and glucocorticoids is usually given for lifelong immunosuppression to prevent a T-cell, alloimmune rejection response.

Inhaled nitric oxide modulates pulmonary vascular tone via smooth muscle relaxation and can improve ventilation/perfusion matching and oxygenation in diseased lungs. Early graft failure following lung transplantation has been described by various investigators as reimplantation oedema, reperfusion oedema, primary graft failure or allograft dysfunction. Pathologically, this entity is diffuse alveolar damage.

Dental aspects

See also Chapter 35.

A meticulous pre-surgery oral assessment is required and dental treatment must be undertaken with particular attention to establishing optimal oral hygiene and eradicating sources of potential infection. Dental treatment should be completed before surgery. For 6 months after surgery, elective dental care is best deferred. If surgical treatment is needed during that period, antibiotic prophylaxis is probably warranted.

HEART AND LUNG TRANSPLANTATION

General aspects

Cardiopulmonary transplantation (heart and lung transplantation) is the simultaneous surgical replacement of the heart and lungs in patients with end-stage cardiac and pulmonary disease, with organs from a cadaveric donor.

General management

All transplant recipients require lifelong immunosuppression to prevent a T-cell, alloimmune rejection response.

Dental aspects

See also Chapter 35.

A meticulous pre-surgery oral assessment is required and dental treatment must be undertaken with particular attention to establishing optimal oral hygiene and eradicating sources of potential infection. Dental treatment should be completed before surgery. For 6 months after surgery, elective dental care is best deferred. If surgical treatment is needed during that period, antibiotic prophylaxis is probably warranted.

KEY WEBSITES

(Accessed 27 May 2013)
BMJ. <<http://www.bmj.com/specialties/respiratory-medicine>>

Centers for Disease Control and Prevention. <<http://www.cdc.gov/ncird/overview/websites.html>>
National Institutes of Health. <<http://health.nih.gov/topic/RespiratoryDiseasesGeneral>>

USEFUL WEBSITES

(Accessed 27 May 2013)
American Academy of Allergy, Asthma & Immunology. <<http://www.aaaai.org/home.aspx>>.
ERS e-Learning Resources. <<http://www.ers-education.org/pages/default.aspx>>.
Medic8.com. <<http://www.medic8.com/lung-disorders>>.
National Institutes of Health: National Institute of Allergy and Infectious Diseases. <<http://www.niaid.nih.gov/topics/Pages/default.aspx>>.

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APPENDIX 15.1 OCCUPATIONAL LUNG DISEASES

Disorder	Source of causal agent	Group at risk	Clinical significance of pneumoconiosis
Anthracosis	Soot, carbon smoke	Urban dwellers	Benign
Asbestosis	Asbestos, insulation, fertilizers, explosives	Asbestos workers	Pulmonary fibrosis (crocidolite) predisposes to cor pulmonale or amosite (bronchial carcinoma, mesothelioma)
Bagassosis	Mouldy sugar cane	Farmers	Acute pneumonia or fibre bronchiolitis
Barilosis	Barium	Barium miners	Benign
Berylliosis	Beryllium	Those using fluorescent lamps, various alloys	Chronic respiratory disease leading to cor pulmonale
Byssinosis	Cotton, flax or hemp	Cotton workers	Periodic bronchospasm leading to obstructive airways disease
Coal miner's lung	Coal dust	Coal miners	Largely asymptomatic but may cause fibrosis and emphysema
Kaolin	China clay	China-clay workers	Resembles silicosis (see below)
Siderosis	Iron dust	Welders, grinders	Benign
Silicosis	Silica (quartz) dust	Miners, sandblasters, potters	Pulmonary fibrosis leading to cor pulmonale, tuberculosis
Stannosis	Tin dust	Tin refiners	Benign