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Definition and symptoms of chronic rhinosinusitis

Definition and symptoms of chronic rhinosinusitis

Rhinosinusitis refers to concurrent inflammation of the mucosal lining of the nose (rhinitis) and the paranasal sinuses (sinusitis). Rhinitis that occurs in isolation is usually caused by an allergy; see Allergic rhinitis.

Rhinosinusitis is classified as acute (symptoms lasting less than 4 weeks) or chronic (symptoms lasting longer than 12 weeks). Acute rhinosinusitis is most commonly caused by a viral infection—for information on acute viral rhinosinusitis (the common cold), see here.

Chronic rhinosinusitis is characterised by the presence of two or more of the following symptoms for more than 12 weeks:

- nasal blockage (obstruction or congestion)
- mucopurulent nasal discharge (anterior or posterior drip)
- facial pain or pressure
- reduction of loss of sense of smell.

Some patients can also experience cough or nausea. Patients with coexisting allergic rhinitis may also have symptoms such as sneezing, rhinorrhoea, nasal itching and itchy watery eyes.

Chronic rhinosinusitis is usually related to multiple contributing factors, which can include:

- bacterial infection
- allergy
- cystic fibrosis
- physical obstruction (including nasal polyps or anatomical variation)
- swelling of the mucosa
- mucociliary impairment
- immune deficiency
- prolonged use of intranasal decongestants (rhinitis medicamentosa).

Chronic rhinosinusitis is uncommon in children younger than 12 years. If chronic rhinosinusitis is suspected in a child, consider referral to a paediatrician or an ear, nose and throat surgeon.

Initial management of chronic rhinosinusitis

Initial management of chronic rhinosinusitis

Treatment for chronic rhinosinusitis can be started at presentation using the same therapies as for allergic rhinitis. Additional therapies include isotonic or hypertonic saline (sodium chloride solution) nasal irrigation.

If symptoms respond well to drug therapy, specialist referral is not usually needed.

If symptoms do not respond after at least 1 month of therapy, refer the patient to a specialist for further management. Assessment for possible allergic triggers via serum-specific immunoglobulin E (IgE) tests ('RAST' testing) and a computed tomography (CT) scan may help to guide the appropriate referral. A CT scan of a patient with chronic rhinosinusitis will show mucosal changes in the osteomeatal complex or sinuses. Sinus X-rays are rarely helpful and are not routinely recommended.

Further management depends on whether nasal polyps are identified on investigation or examination; see Chronic rhinosinusitis without nasal polyps and Chronic rhinosinusitis with nasal polyps. Polyps are grape-like structure that are pearly or greyish-yellow (a markedly different colour from the nasal mucosa); they may be easily visible inside the nasal cavity. About two-thirds of patients with chronic rhinosinusitis do not have polyps.

Chronic rhinosinusitis with or without nasal polyps can be caused by fungal conditions such as allergic fungal sinusitis and invasive fungal sinusitis. If a fungal aetiology is suspected, refer the patient to an ear, nose and throat surgeon. Topical or systemic antifungal therapy may be used by a specialist for invasive fungal disease. Surgical management may also be required.

Chronic rhinosinusitis without nasal polyps

Chronic rhinosinusitis without nasal polyps

For patients with chronic rhinosinusitis and no evidence of nasal polyps on investigation or examination, if symptoms do not respond after at least 1 month of initial therapy, refer to a specialist for further management.

Refer to a clinician with expertise in allergy if an allergic cause is suspected after assessment.

Refer to an ear, nose and throat surgeon if allergy can be excluded or CT scan identifies evidence of physical obstruction or sinus abnormalities.

Studies to support oral corticosteroids for chronic rhinosinusitis without nasal polyps are limited. A short course of oral corticosteroids can be used in adults with uncontrolled symptoms while awaiting specialist management. If suitable, use:

prednis(ol)one 25 mg orally, once daily for 5 to 10 days. *rhinosinusitis, chronic (without nasal polyps)*

Evidence to support the use of antibiotics (including long-term, low-dose macrolide therapy) for chronic rhinosinusitis is limited; they should only be prescribed in select patients by a specialist.

Chronic rhinosinusitis with nasal polyps

Chronic rhinosinusitis with nasal polyps

For patients with chronic rhinosinusitis with evidence of nasal polyps on investigation or examination, if symptoms do not respond after at least 1 month of initial therapy, refer to an ear, nose and throat surgeon for further investigation (including a nasal endoscopy) and management. Nasal endoscopy of a patient with chronic rhinosinusitis will have at least one objective finding, such as polyps, oedema, obstruction at the middle meatus, or mucopurulent discharge from the middle meatus.

The presence of nasal polyps should always prompt testing for cystic fibrosis in children, and for coexisting asthma and aspirin sensitivity (aspirin-exacerbated respiratory disease) in adults. Some adults with chronic rhinosinusitis and aspirin sensitivity may benefit from aspirin desensitisation under specialist supervision.

If symptoms do not respond after at least 1 month of initial therapy, or if the nose is too blocked to be able to use a nasal spray effectively, use a course of oral corticosteroid to reduce the size of polyps ('medical polypectomy'). Medical polypectomy can be trialled while awaiting specialist referral. Use:

prednis(ol)one 25 mg orally, once daily for 1 week, then 12.5 mg once daily for 1 week, then 12.5 mg on alternate days for 1 week. *rhinosinusitis, chronic (with nasal polyps)*

If medical polypectomy is ineffective or if symptoms recur, surgical polypectomy may be required.

Recurrence of nasal polyps after surgery is common so intranasal corticosteroid therapy must be continued long term after surgery to prevent or delay recurrence.

Some biological drugs (eg dupilumab, omalizumab, mepolizumab) are used by specialists for the treatment of chronic rhinosinusitis with nasal polyps.

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Key references: Definition and symptoms of chronic rhinosinusitis

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Key references: Chronic rhinosinusitis with nasal polyps

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Approach to diagnosis of asthma

Approach to diagnosis of asthma

This topic addresses asthma diagnosis in children 6 years and older as well as adolescents and adults. For assessment of children aged 1 to 5 years with respiratory symptoms suggestive of asthma, see Assessment of wheeze and asthma in children 5 years and younger. Wheezing in infants younger than 12 months is most commonly a symptom of acute viral bronchiolitis rather than asthma. For information about wheeze in infants younger than 12 months, see here.

Asthma is characterised by a variety of respiratory symptoms including wheeze, shortness of breath, cough, chest discomfort or tightness, and, in children, increased respiratory rate and work of breathing. The symptoms vary in intensity and over time. Patients who present with these symptoms should be investigated for asthma. Asthma frequently presents in childhood, but can occur for the first time at any age.

The diagnosis of asthma is based on clinical assessment supported by lung function tests (primarily spirometry) that demonstrate airflow limitation or airway inflammation. Lung function tests have significant false positive and negative results. No single test or symptom can be used to diagnose asthma, and isolated signs or symptoms have poor predictive value. Always record the basis of the diagnosis of asthma.

No single test or symptom can be used to diagnose asthma.

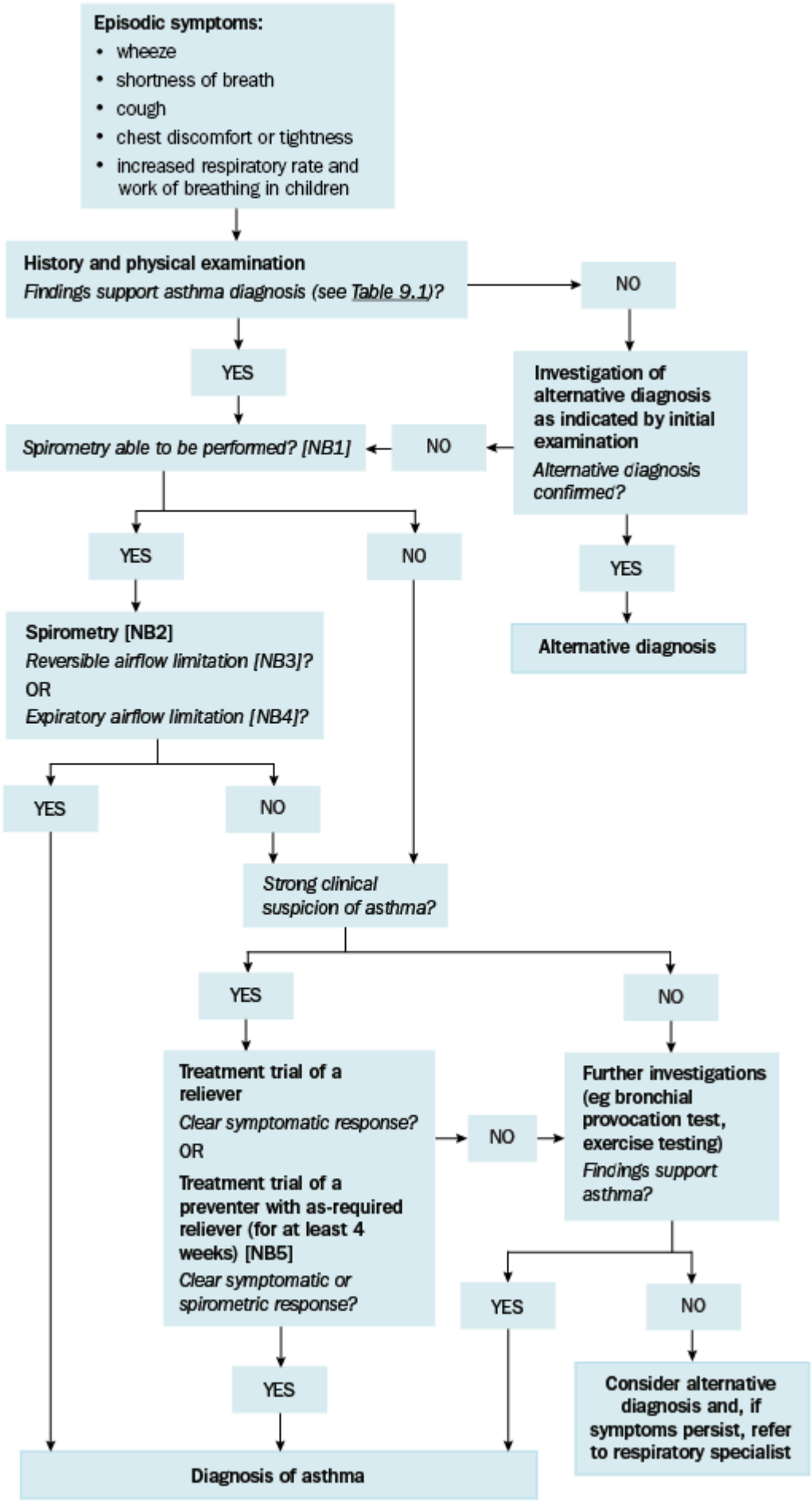
A diagnosis of asthma should preferably be confirmed before starting regular preventer treatment, as it is harder to confirm the diagnosis once treatment is started. Empirical treatment with an inhaled corticosteroid can be started in patients with significant symptoms or exacerbations, but testing should be done as soon as possible.

Perform or arrange spirometry for every patient with suspected asthma.

If the diagnosis remains uncertain and symptoms persist, refer the patient to a specialist for further investigation.

Figure 9.1 outlines the steps involved in making a diagnosis of asthma.

Figure 9.1 Assessment of suspected asthma in children 6 years and older, adolescents and adults



NB1: Spirometry is not always reliable in children, so a treatment trial may be preferred.

NB2: Normal spirometry when the patient is not symptomatic does not exclude the diagnosis of asthma; ideally, repeat spirometry when the patient is symptomatic. If spirometry is normal when the patient is symptomatic, consider an alternative diagnosis. Repeated measurements of lung function are often more informative than a single assessment.

NB3: Reversible airflow limitation is defined as an increase in forced expiratory volume in 1 second (FEV_1) of at least 200 mL and at least 12% from baseline 10 to 15 minutes after administration of a short-acting $beta_2$ agonist.

NB4: Expiratory airflow limitation is defined as reduced FEV_1 to forced vital capacity (FVC) ratio (FEV_1/FVC ratio).

NB5: A preventer can be used in combination with a reliever for a treatment trial.

Adapted from the *Australian Asthma Handbook* © 2020 National Asthma Council Australia. Accessed 31 August 2020.

Clinical diagnosis of asthma

Clinical diagnosis of asthma

For assessment of children aged 1 to 5 years with respiratory symptoms suggestive of asthma, see Assessment of wheeze and asthma in children 5 years and younger.

The first step in assessing a child older than 6 years, an adolescent or an adult with suspected asthma is to take a detailed history and perform a physical examination to identify the pattern of symptoms and exclude other causes. The predictive value of a single sign or symptom is poor, but combinations of signs and symptoms can provide a clearer clinical picture to support a diagnosis of asthma.

Patient history should include:

- current symptoms (wheeze, cough, shortness of breath, chest discomfort or tightness)
- pattern of symptoms (frequency, time of day or night)
- severity of symptoms (impact on work, school or lifestyle)
- allergies (eg atopic dermatitis, allergic rhinitis)
- aggravating or precipitating factors (eg exercise, viral infections)
- smoking history (including exposure to second-hand smoke in the home) and exposure to biomass smoke (eg indoor fires for heating or cooking)
- relieving factors (including medication trials)
- presence of sinonasal disease
- family history of allergies or asthma.

The physical examination should include:

- chest auscultation
- height and weight (for children)
- inspection for chest deformity (for children)
- assessment of respiratory rate and work of breathing (for children).

If atopy is suspected, inspect the upper respiratory tract for signs of allergic rhinitis (eg inflammation in the nasal passages) and the skin for signs of atopic dermatitis.

A chest X-ray is not necessary for diagnosis of asthma—it can be considered for unusual symptoms, or as required for suspected alternative diagnoses (eg lung cancer, pneumonia).

A summary of the key symptom patterns and features consistent with asthma, and those less consistent with asthma, are provided in Table 9.1.

Alternative diagnoses to consider according to the predominant symptom are suggested in Table 9.2.

Table 9.1 Clinical features that increase and decrease the probability of asthma in children 6 years and older, adolescents and adults

CLINICAL FEATURES THAT INCREASE THE PROBABILITY OF ASTHMA

more than one of the following symptoms: wheeze, breathlessness, chest tightness or discomfort, cough—particularly if symptoms:

- are worse at night and in the early morning
- occur in response to exercise, allergen exposure or cold air
- occur after taking aspirin or beta blockers
- are recurrent

history of atopic disorder (eg allergic rhinitis, atopic dermatitis)

family history of asthma or atopic disorder

widespread wheeze heard on auscultation of the chest

improvement in symptoms or lung function in response to standard asthma therapy

otherwise unexplained low FEV_1 or PEF (historical or serial readings)

otherwise unexplained peripheral blood eosinophilia

in children, presence of conditions associated with asthma (eg bronchopulmonary dysplasia, obstructive sleep apnoea, recurrent bronchiolitis)

CLINICAL FEATURES THAT LOWER THE PROBABILITY OF ASTHMA

chronic productive cough in the absence of wheeze or breathlessness

normal FEV_1 when symptomatic [NB1]

repeatedly normal auscultation of chest when symptomatic

voice disturbance or throat tightness

symptoms that worsen with talking or laughing

prominent dizziness, light-headedness, peripheral tingling

symptoms that only occur with viral respiratory infections, with few or no symptoms in between

no response to a trial of asthma therapy

significant smoking history (more than 20 pack years [NB2])

clinical features supporting an alternative diagnosis

FEV_1 = forced expiratory volume in 1 second; PEF = peak expiratory flow

NB1: Normal spirometry when the patient is not symptomatic does not exclude the diagnosis of asthma; ideally, repeat spirometry when the patient is symptomatic. If spirometry is normal when the patient is symptomatic, consider an alternative diagnosis. Repeated measurements of lung function are often more informative than a single assessment.

NB2: Pack years is calculated using the formula (years of smoking × cigarettes per day) / 20; see here for an online calculator. A significant smoking history could indicate that the patient has chronic obstructive pulmonary disease (COPD). Asthma and COPD can coexist; see Overlap of asthma and COPD.

Table 9.2 Alternative diagnoses that can be confused with asthma

Predominant symptom	Possible alternative diagnoses in adults and adolescents [NB1]	Possible alternative diagnoses in children
breathlessness	lack of fitness	inducible laryngeal obstruction (vocal cord dysfunction)
	obesity	anxiety
	COPD	inhaled foreign body
	hyperventilation or dysfunctional breathing	congenital heart disease
	anxiety	tracheobronchomalacia
	inducible laryngeal obstruction (vocal cord dysfunction)	interstitial lung disease
	heart failure	cystic fibrosis
	pleural effusion	
	pulmonary fibrosis	
	lung cancer	
	large airway stenosis	
	congenital heart disease	
	pulmonary hypertension	
	inhaled foreign body	
	pulmonary embolism	
	tachyarrhythmias	
	tracheobronchomalacia	
	interstitial lung disease	
	cystic fibrosis	
wheeze	COPD	wheeze associated with viral respiratory infection
	bronchiectasis	transient infant wheeze
	inducible laryngeal obstruction (vocal cord dysfunction)	tracheobronchomalacia
	large airway stenosis	airway lesion
	tracheobronchomalacia	inhaled foreign body (unilateral wheeze)
	inhaled foreign body	congenital heart disease
	heart failure	
chest tightness	ischaemic heart disease	anxiety
	hyperventilation or dysfunctional breathing	hyperventilation or dysfunctional breathing

Predominant symptom	Possible alternative diagnoses in adults and adolescents [NB1]	Possible alternative diagnoses in children
dry cough	oesophageal disorders (eg gastro-oesophageal reflux)	postinfective cough (respiratory viruses, *Bordetella pertussis* or *Mycoplasma pneumoniae*)
	anxiety	habit cough, particularly if it resolves during sleep
	postinfective cough	inhaled foreign body
	upper airway cough syndrome (postnasal drip)	
	inducible laryngeal obstruction (vocal cord dysfunction)	
wet cough or sputum production	oesophageal disorders (eg gastro-oesophageal reflux)	protracted bacterial bronchitis
	drug-induced (eg ACEI)	chronic suppurative lung disease (including bronchiectasis)
	COPD	cystic fibrosis
	chronic rhinosinusitis	inhaled foreign body
	lung cancer	
	inhaled foreign body	
	pulmonary fibrosis	
	COPD	
	chronic bronchitis	
	bronchiectasis	
	rhinitis	
	lung cancer	
	cystic fibrosis	
	allergic bronchopulmonary aspergillosis	

ACEI = angiotensin converting enzyme inhibitor; COPD = chronic obstructive pulmonary disease

NB1: Likelihood of alternative diagnoses depends on other patient-specific factors such as age, comorbid conditions, smoking history and other findings.

Lung function testing in the diagnosis of asthma

Lung function testing in the diagnosis of asthma

Overview

Overview

Lung function tests commonly used in the diagnosis of asthma in children 6 years and older, adolescents and adults include spirometry, peak expiratory flow monitoring and fractional exhaled nitric oxide (FeNO)

measurements. Total immunoglobulin E (IgE), specific IgE to perennial allergens and blood eosinophils may be measured by specialists in patients with severe asthma in whom treatment with monoclonal antibodies is considered. Lung function testing cannot be used for the assessment of respiratory symptoms suggestive of asthma in children aged 5 years and younger; see Assessment of wheeze and asthma in children 5 years and younger.

Repeated measurements of lung function are more informative than a single measure. All people have some day-to-day variation in lung function, but patients with asthma have more pronounced variation than is seen in a healthy person. In a patient with a symptom pattern consistent with asthma (see Table 9.1), frequent and significant variation in lung function supports the diagnosis of asthma.

For further information on lung function tests, including tests that may require specialist referral, see Pulmonary function tests.

Spirometry

Spirometry

In children older than 6 years, adolescents and adults with suspected asthma, perform spirometry to identify airflow limitation.

Spirometry should preferably be done before starting regular preventer treatment, as it is harder to confirm the diagnosis of asthma in patients receiving treatment. In patients with significant symptoms, empirical treatment with an inhaled corticosteroid can be started, but spirometry should be done as soon as possible.

Normal spirometry when the patient is asymptomatic does not exclude asthma. Ideally, repeat spirometry when the patient is symptomatic. If spirometry is normal when the patient is symptomatic (especially if short of breath), consider another diagnosis.

Consider an alternative diagnosis if spirometry is normal when the patient is symptomatic.

Some patients only have reduced lung function seasonally (eg patients with allergic asthma related to grass pollen allergy). In these patients, performing spirometry in the pollen season can confirm the diagnosis. It is also important to consider whether such a patient may be susceptible to thunderstorm asthma.

Spirometry findings that support a diagnosis of asthma include:

- reversible airflow limitation—an increase in forced expiratory volume in 1 second (FEV_1) of at least 200 mL and 12% from baseline 10 to 15 minutes after giving a short-acting $beta_2$ agonist (SABA) (200 to 400 micrograms inhaled salbutamol or equivalent). A larger increase in FEV_1 (eg more than 400 mL) in response to a SABA is strongly supportive of asthma
- expiratory airflow limitation—reduced FEV_1 to forced vital capacity (FVC) ratio (FEV_1/FVC ratio).

Spirometry testing requires staff training and reliable equipment to ensure good quality testing, particularly in young children. For further information on performing spirometry; see here.

Peak expiratory flow monitoring

Peak expiratory flow monitoring

If airflow reversibility is not shown on spirometry but the suspicion of asthma remains high, peak expiratory flow (PEF) monitoring can help to identify variable airflow obstruction. However, peak flow meters should not be used in the place of spirometry for diagnosing asthma, because they cannot measure reversible airflow limitation or expiratory airflow limitation.

PEF measurements are particularly useful if taken over a 14-day period when the patient is both asymptomatic and symptomatic. Variation of greater than 20% between the two highest measurements and

the two lowest measurements taken during this period supports the diagnosis of asthma. Always use the same peak flow meter for each measurement.

Fractional exhaled nitric oxide (FeNO) measurements

Fractional exhaled nitric oxide (FeNO) measurements

Fractional exhaled nitric oxide (FeNO) is a measure of airway inflammation. It can be used as part of asthma diagnosis, and to give an indication of how well a person is likely to respond to inhaled corticosteroid therapy. FeNO is commonly measured in specialist clinics; it is not readily available in primary care at the time of writing.

Ongoing lung function testing

Ongoing lung function testing

Lung function tests should be repeated at regular intervals in patients with asthma. Findings that support the continued diagnosis of asthma include:

- an increase in FEV_1 of at least 200 mL and 12% from baseline after a trial of inhaled corticosteroids for 4 weeks
- clinically important variation in lung function between repeat measurements (a change of 20% or more in FEV_1 or peak expiratory flow)
- diurnal variation in PEF readings of greater than 10% [Note 1]
- positive bronchial provocation challenge or exercise challenge in a respiratory function laboratory (only required if the diagnosis is uncertain).

Note 1: Diurnal variability is calculated each day from twice-daily PEF readings using the formula: (the day's highest PEF minus the day's lowest PEF) divided by the mean of the day's PEF. This is then averaged over 1 to 2 weeks.

Treatment trial in the diagnosis of asthma

Treatment trial in the diagnosis of asthma

A treatment trial of a short-acting $beta_2$ agonist (SABA) reliever (eg salbutamol, terbutaline) alone or in combination with a regular low-dose inhaled corticosteroid (ICS) preventer can be a useful aid for diagnosis in children 6 years and older, adolescents and adults. Consider a treatment trial in:

- patients who cannot perform spirometry
- patients in whom the clinical assessment strongly suggests asthma, but initial spirometry does not show airflow limitation.

For information on treatment trials in children aged 1 to 5 years with recurrent bothersome wheeze associated with increased work of breathing, see Treatment trial for wheeze and asthma in children 1 to 5 years.

Instruct patients to use the SABA when they experience acute symptoms. For dosages, see here for adults and adolescents, and here for children 6 years and older. Immediate symptomatic relief of acute asthma symptoms strongly suggests asthma.

A treatment trial with regular low-dose ICS and an as-required SABA can be started in:

- patients with significant symptoms or exacerbations who are awaiting spirometry (but spirometry should be done as soon as possible after starting ICS)
- patients with significant symptoms or exacerbations who cannot perform spirometry

- patients with a strong clinical suspicion of asthma but initial spirometry does not show airflow limitation.

For dosages of regular low-dose ICS, see here for adults and adolescents, and here for children 6 years and older. A clear response (eg improvements in symptoms or lung function) to a trial of ICS therapy of at least 4 weeks supports a diagnosis of asthma.
Consider an alternative diagnosis if symptoms or lung function do not improve with a trial of low-dose ICS for at least 4 weeks.

If treatment trial supports a diagnosis of asthma, start maintenance management of asthma; see here for adults and adolescents, and here for children 6 years and older.

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Definition of thunderstorm asthma

Definition of thunderstorm asthma

Asthma triggered by thunderstorms has been recognised since the 1980s. Following a major thunderstorm asthma event in Melbourne in 2016, in which hospitals and emergency services were overwhelmed by asthma-related presentations and ten people died, thunderstorm asthma became more widely recognised.

Thunderstorm asthma events can occur when a high concentration of aeroallergen is present. In Australia, thunderstorm asthma is more prevalent in spring or early summer in regions with high levels of rye grass pollen, particularly New South Wales, South Australia and Victoria.

In a thunderstorm asthma event, the following storm sequence occurs:

- pollen grains are swept up into clouds as a storm develops
- moisture in the clouds ruptures the pollen grains into smaller granules that are respirable into the lower airways and cause acute onset of asthma symptoms (in contrast to the larger pollen grains, which lodge in the upper airways and cause allergic rhinitis)
- as the thunderstorm 'breaks', it brings the pollen granules to ground level (usually as a result of a rapid drop in temperature).

Although this mechanism of thunderstorm asthma is understood, events are difficult to predict.

Identifying people at risk of thunderstorm asthma

Identifying people at risk of thunderstorm asthma

Identifying people at risk of thunderstorm asthma is difficult, both because it can affect people with no apparent prior symptoms, and because of the limited data to inform risk factors.

Seasonal allergic rhinitis is commonly caused by rye grass allergy. Ask all patients who experience allergic rhinitis during the pollen season (spring to early summer) and who live in an area with high rye grass pollen levels (eg south-eastern Australia) if they have experienced wheeze, shortness of breath, chest tightness or cough during the pollen season; this can give a good indication of risk of thunderstorm asthma.

Ask all patients who experience allergic rhinitis during the pollen season and who live in an area with high rye grass pollen levels (eg south-eastern Australia) if they have experienced wheeze, shortness of breath, chest tightness or cough during the pollen season.

For patients who were in Melbourne during the 2016 thunderstorm asthma event, ask if they experienced any asthma symptoms on the night of the thunderstorm event and how this was managed.

If a patient with allergic rhinitis has experienced asthma symptoms during the pollen season, test for rye grass sensitisation with skin-prick testing or serum-specific immunoglobulin E (IgE) testing ('RAST' testing) to confirm the risk, ideally with interpretation by a clinician with expertise in allergy.

Patients with coexisting asthma (even mild or seasonal asthma) and seasonal allergic rhinitis with rye grass sensitisation are at increased risk of thunderstorm asthma. Many patients who presented in the 2016 Melbourne thunderstorm asthma event only had mild or seasonal asthma previously. Poor adherence to inhaled corticosteroid (ICS) therapy was a risk factor for presentation, and poorly controlled asthma increased the risk of poor outcomes; there were low rates of inhaled preventer use with only 25% of the patients being adherent to their preventer medication.

Poorly controlled asthma and poor adherence to inhaled corticosteroid therapy increases the risk of the patient experiencing asthma symptoms during a thunderstorm asthma event.

People with undiagnosed asthma or no known history of asthma can also experience thunderstorm asthma. At least half of the presentations in the 2016 Melbourne thunderstorm asthma event had no known history of asthma.

Data from the 2016 Melbourne thunderstorm asthma event showed that young adults, people of Asian or Indian background and people born overseas, were disproportionately affected by thunderstorm asthma.

A follow-up study found that many patients who experienced asthma for the first time during the 2016 Melbourne thunderstorm asthma event have had persistent asthma symptoms since that time. It also showed that some patients with pre-existing asthma who presented to hospital with symptoms during the event had a worse asthma trajectory after that event [Note 1].

Note 1: Foo CT, Yee EL, Young A, Denton E, Hew M, O'Hehir RE, et al. Continued loss of asthma control following epidemic thunderstorm asthma. Asia Pac Allergy 2019;9(4):e35. [URL]

Prevention of thunderstorm asthma

Prevention of thunderstorm asthma

General measures

General measures

Educate people at risk of thunderstorm asthma about how to prevent and manage symptoms. Advise them to check daily pollen counts and weather forecasts during the pollen season (spring to early summer). The Auspollen application (app) and website can be used to obtain accurate information about daily pollen counts in Canberra, Sydney, Brisbane, Tasmania and Victoria. If a high pollen count and a thunderstorm are forecast, people at risk should stay indoors as much as possible, particularly as the storm is beginning (just before the rain starts). Recommend that any air conditioners be switched to recirculation mode, including those in cars.

All people at risk of thunderstorm asthma should have a written asthma action plan (see here for children and adolescents and here for adults) and be advised to carry a reliever during the pollen season.

For patients with asthma, adherence to preventer therapy reduces the patient's vulnerability to acute triggers. For strategies to improve adherence, see here.

Allergen immunotherapy and drug therapy

Allergen immunotherapy and drug therapy

Preventive therapy for thunderstorm asthma includes rye grass immunotherapy, and management of asthma symptoms and allergic rhinitis.

Rye grass immunotherapy has been shown to have a preventive role in thunderstorm asthma, but data are limited. Consider referring all patients who have experienced asthma symptoms during a thunderstorm asthma event, particularly if the symptoms were severe, to an allergy specialist.

Referral to an allergy specialist should be considered for all patients who have experienced thunderstorm asthma symptoms.

For patient who experienced asthma symptoms during a thunderstorm asthma event, a risk assessment should be performed taking into consideration the severity of the symptoms and previous history of asthma symptoms, as well as factors such as occupation (indoor or outdoor), and accessibility of health care.

For all patients who presented to hospital or who had a severe asthma exacerbation requiring oral steroids during a thunderstorm event, start regular preventer therapy. For patients who experienced mild asthma symptoms but who only have symptoms during the pollen season, consider regular preventer therapy for the pollen season.
All people at risk of thunderstorm asthma should be advised to carry a reliever during the pollen season.

For patients with year-round symptoms of asthma, treat as for any patient with asthma. For patients with seasonal asthma symptoms occurring more than twice per month during the pollen season, or people who previously experienced symptoms during a thunderstorm asthma event, start low-dose preventer therapy; start 2 weeks before the rye grass season begins (late August) and continue until the end of rye grass season (late January).

For information on preventer therapy; see Asthma maintenance management in adults and adolescents and Asthma maintenance management in children.

For patients with allergic rhinitis, treat as per allergic rhinitis. Good control of allergic rhinitis reduces the risk of acute events, including thunderstorm asthma.

Key references: Thunderstorm asthma

Key references: Thunderstorm asthma

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Published December 2020

[X] Close

Introduction to COPD

Introduction to COPD

Chronic obstructive pulmonary disease (COPD) is characterised by persistent airflow limitation resulting from a combination of small airways disease and alveolar destruction (emphysema). It is caused by an abnormal inflammatory response in the lungs to noxious particles or gases, most commonly tobacco smoke. COPD is a progressive disease; however, smoking cessation can slow progression, and treatment can improve the patient's quality of life.

Diagnosis of COPD

Diagnosis of COPD

Clinical history and symptoms

Clinical history and symptoms

Chronic obstructive pulmonary disease (COPD) typically presents in middle-aged and older people, usually with a history of exposure to noxious particles or gases. Tobacco smoking is the most important risk factor for COPD—approximately half of all smokers develop some degree of airflow limitation, and 15 to 20% develop clinically significant disability. Figure 9.13 illustrates the accelerated decline in lung function seen in smokers compared with nonsmokers.

Not all patients with COPD have a history of smoking. Other risk factors include prenatal parental smoking, premature birth, respiratory illnesses in childhood, asthma, exposure to second-hand smoke, occupational exposure to dusts and fumes, and genetic susceptibility. In low- and middle-income countries, exposure to biomass smoke for heating and cooking is common.

Consider the possibility of COPD in all patients older than 35 years who are smokers or ex-smokers, or have other relevant risk factors, and present with symptoms suggestive of COPD, including:

- breathlessness
- cough
- recurrent respiratory tract infection
- sputum production
- wheezing.

Breathlessness may be the patient's only symptom; it typically occurs only on exertion initially, but worsens insidiously over several years.

Some inherited conditions, most notably alpha$_1$-antitrypsin deficiency, make patients more susceptible to the damaging effects of tobacco smoke, and lead to earlier development and more rapid progression of COPD. Alpha$_1$-antitrypsin deficiency should be suspected if COPD develops at a young age (eg before 40 years), particularly if the patient has a family history of COPD. Refer young patients with COPD to a respiratory physician for assessment.

Although a medical history and symptoms can suggest COPD, a formal diagnosis cannot be made without spirometry; see Lung function measurement for more information.

Lung function measurement

Lung function measurement

In a patient with a clinical history and symptoms suggestive of COPD, measure lung function with spirometry to confirm the diagnosis. COPD cannot be diagnosed without spirometry.

A postbronchodilator forced expiratory volume in 1 second to forced vital capacity ratio (FEV_1/FVC ratio) less than 0.7 is diagnostic of COPD. This is a widely accepted practical definition.

An FEV_1/FVC ratio less than 0.7 is diagnostic of COPD.

A chest X-ray can be useful to exclude other causes of breathlessness. A computed tomography (CT) scan is not required for diagnosis of COPD.

More extensive lung function testing (eg plethysmographic lung volumes) will often also show gas trapping (increased residual volume) and a diffusion defect (decreased diffusing capacity for carbon monoxide [DLCO]). However, these tests are not routinely required as part of the diagnosis of COPD.

See Pulmonary function testing for detail on the measurement and interpretation of pulmonary function tests.

Assessing the severity of stable COPD

Assessing the severity of stable COPD

Assess the severity of chronic obstructive pulmonary disease (COPD) both at diagnosis and as part of ongoing monitoring and review. COPD severity assessment guides management of COPD, which follows a stepwise escalation of nondrug and drug interventions.

The severity of COPD is determined by:

- symptoms—consider breathlessness, limitation on daily activities, cough and sputum production
- exacerbation history—consider frequency and severity (exacerbations occur more frequently as COPD progresses)
- typical lung function (spirometry findings)—however, spirometric thresholds are somewhat arbitrary and may not correlate with other criteria for severity.

Assess the severity of COPD when the patient is stable (preferably not within 4 weeks of an exacerbation). See Table 9.14 for classifications of COPD severity.

Table 9.14 Classification of stable COPD severity

	Mild	Moderate	Severe
Symptoms and exacerbation history	few symptoms breathless on moderate exertion daily activities minimally limited or unaffected cough and sputum production	breathless walking on level ground daily activities increasingly limited recurrent chest infections exacerbations requiring oral corticosteroids or antibiotics	breathless on minimal exertion daily activities severely limited exacerbations of increasing frequency and severity
Typical lung function [NB1]	FEV_1 60 to 80% predicted	FEV_1 40 to 59% predicted	FEV_1 less than 40% predicted

COPD = chronic obstructive pulmonary disease; FEV_1 = forced expiratory volume in 1 second

	Mild	Moderate	Severe

NB1: Spirometric thresholds are somewhat arbitrary, and may not correlate with other criteria for severity; however, they can be useful to give an indication of severity.

Adapted with permission from: Yang I, Dabscheck E, George J, Jenkins S, McDonald C, McDonald V, et al. The COPD-X Plan: Australian and New Zealand Guidelines for the management of Chronic Obstructive Pulmonary Disease 2020, Version 2.61. Milton, QLD: Lung Foundation Australia; February 2020. [URL]

The COPD Assessment Test (CAT) is a validated questionnaire that can be useful as part of a comprehensive assessment of symptoms. The modified Medical Research Council (mMRC) dyspnoea scale is useful to assess breathlessness.

Also assess for comorbidities (eg ischaemic heart disease, depression, anxiety) and sequelae of COPD (eg hypoxaemia), which may require additional treatment.

Stepwise management of stable COPD

Stepwise management of stable COPD

Management of stable chronic obstructive pulmonary disease (COPD) follows a stepwise escalation of nondrug and drug interventions, introduced according to disease severity, as outlined in Figure 9.11.

Discuss the following short- and long-term goals of managing stable COPD with patients:

- reducing symptoms
- reducing frequency and severity of exacerbations
- improving exercise tolerance
- improving health-related quality of life
- slowing disease progression.

All patients with COPD can benefit from general measures, including:

- smoking cessation—this is the single most important intervention to prevent or limit lung damage in COPD
- physical activity
- pulmonary rehabilitation (for symptomatic patients)
- maintenance of up-to-date vaccination
- good nutrition.

Smoking cessation is the single most important intervention to prevent or limit lung damage and reduce mortality in a patient with COPD.

For patients with few symptoms and a COPD Assessment Test (CAT) score less than 10, these general measures may be adequate initially.

As the disease progresses, drug therapy can be introduced. Drug therapy relieves symptoms, improves quality of life and reduces the frequency of exacerbations. The effect of drug treatment on mortality remains unclear. Drug therapy is typically introduced sequentially as follows:

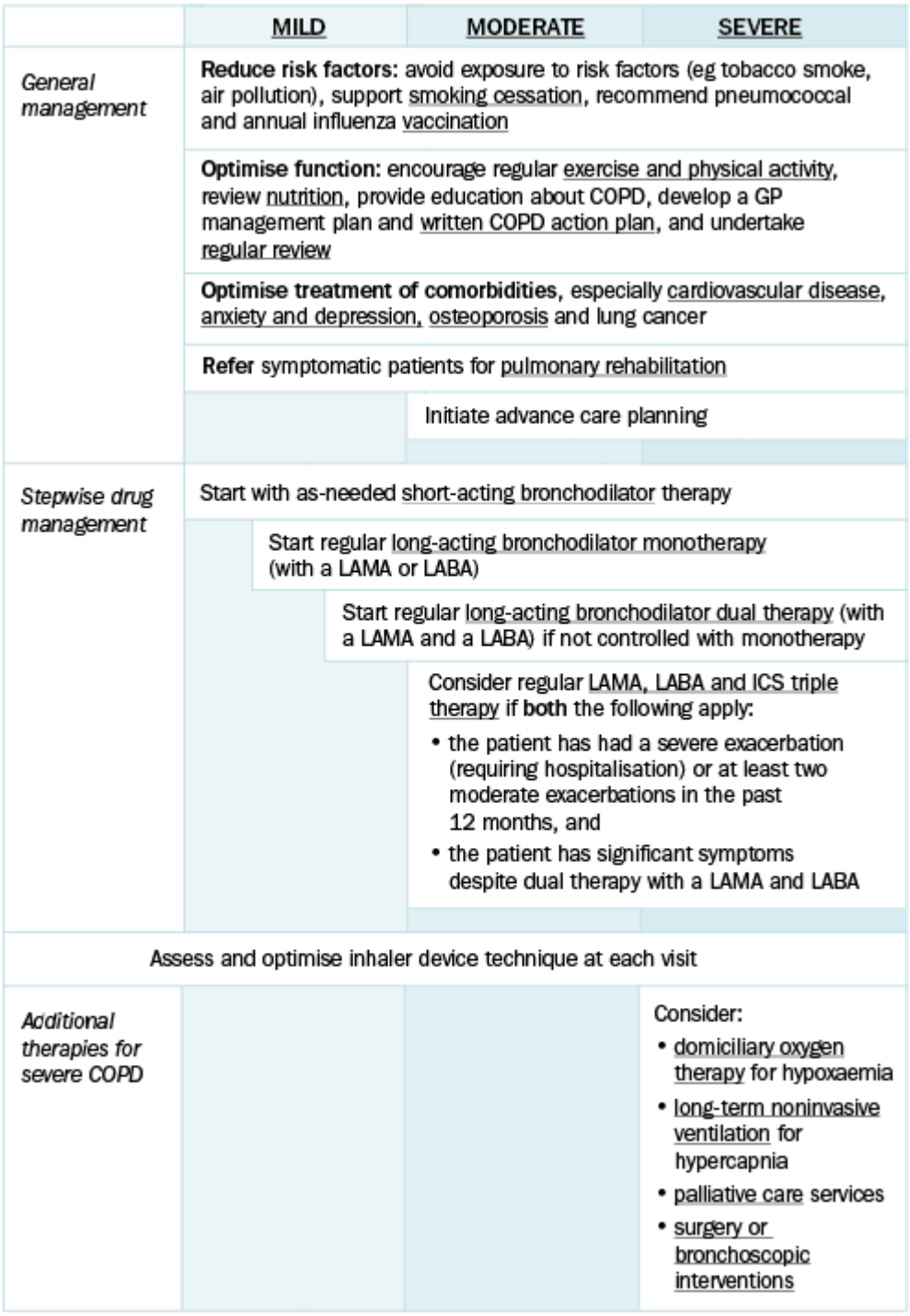
- short-acting bronchodilator therapy—usually a short-acting $beta_2$ agonist (SABA)
- long-acting bronchodilator monotherapy—a long-acting $beta_2$ agonist (LABA) or long-acting muscarinic antagonist (LAMA)
- long-acting bronchodilator dual therapy—LABA plus LAMA combination therapy
- LABA, LAMA plus inhaled corticosteroid triple therapy.

Other treatments used infrequently include mucolytics, antibiotics and theophylline. Oxygen, noninvasive ventilation and surgical or interventional procedures can be considered for severe disease.

Review drug therapy 3 to 6 months after starting or adjusting therapy and regularly thereafter to assess response and tolerability. Check inhaler technique and adherence at each visit, and before considering stepping up therapy; up to 90% of patients use their devices incorrectly.

Nondrug measures that can provide symptomatic relief of dyspnoea include handheld fans, pursed-lip breathing, and breathlessness recovery positions (eg leaning forward).

Figure 9.11 Management pathway for stable COPD



COPD = chronic obstructive pulmonary disease; GP = general practitioner; ICS = inhaled corticosteroids; LABA = long-acting beta$_2$ agonist; LAMA = long-acting muscarinic antagonist

Adapted with permission from Yang I, Brown JL, George J, Jenkins S, McDonald C, McDonald CF, McDonald V, et al. The COPD-X Plan: Australian and New Zealand Guidelines for the management of chronic obstructive pulmonary disease 2020, version 2.61. Brisbane, QLD: Lung Foundation Australia; February 2020. [URL]

Printable figure available from the Lung Foundation Australia website.

Effective management of COPD should involve a multidisciplinary team including nursing and allied health professionals. The general practitioner is usually best suited to coordinate management. Figure 9.12 outlines the common professions included in a multidisciplinary team for COPD.

Figure 9.12 Multidisciplinary care for COPD[NB1]

A multidisciplinary team to manage COPD can include:

- GP to manage drug therapy and regular reviews, to develop a management plan [NB1] and to coordinate overall care
- respiratory physician to manage advanced COPD, confirm the diagnosis, exclude complicating factors and help develop a self-management plan in complex patients
- practice nurse or respiratory educator to perform spirometry testing, assess and educate patients on inhaler technique and adherence, and provide training in self-management
- respiratory nurse to assess the need for and arrange specialist treatments such as domiciliary oxygen therapy and noninvasive ventilation
- pulmonary rehabilitation clinic
- physiotherapist to provide exercise training and pulmonary rehabilitation, including teaching airway clearance techniques
- occupational therapist to assess ability to perform daily tasks of living, and arrange home modifications and adaptive equipment
- speech therapist to provide swallowing training to avoid aspiration
- psychologist or psychiatrist to manage psychiatric disorders (eg anxiety, depression), which are common comorbidities of COPD
- pharmacist to provide medication advice, opportunistic assessment, home medication review and education on inhaler technique and adherence
- dietician to provide advice about nutrition
- council- or government-supported programs to assist with daily tasks of living (eg home visits to assist with showering or cleaning)
- other services including hospital-in-the-home, early discharge schemes and palliative care services.

COPD = chronic obstructive pulmonary disease; GP = general practitioner

NB1: Subsidised allied health services may be available through a pulmonary rehabilitation program or a GP management plan.

General management of stable COPD

General management of stable COPD

Smoking cessation for COPD

Smoking cessation for COPD

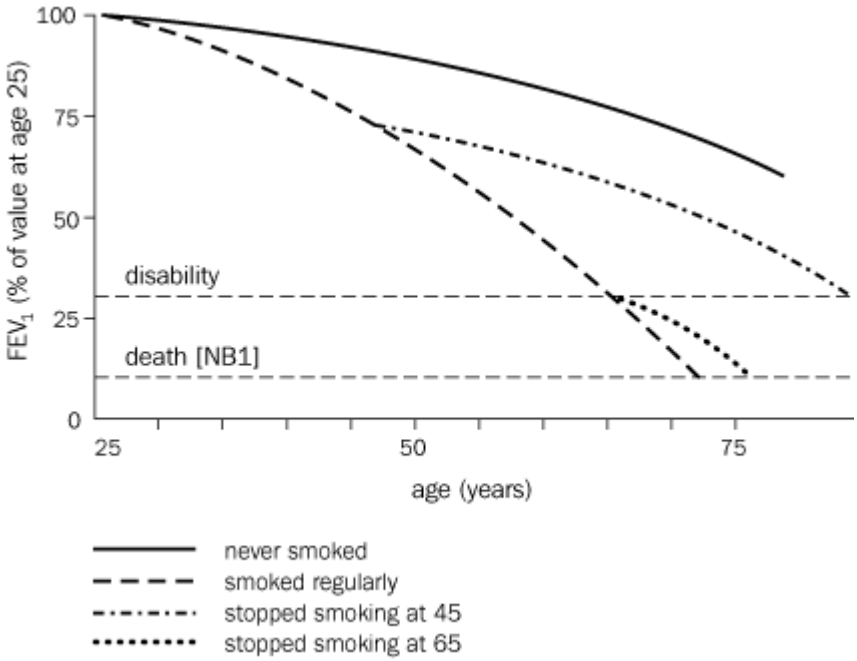
Smoking cessation is the single most important intervention to prevent or limit lung damage in a patient with chronic obstructive pulmonary disease (COPD). For detailed information about smoking cessation, see here.

Smoking cessation is the only intervention shown to improve the natural history of COPD.

Tobacco smoking is the most common cause of COPD, and smoking cessation is the only intervention that has been shown to slow the progression of COPD (other than oxygen therapy in patients with severe hypoxaemia).

Figure 9.13 illustrates the effect of smoking on lung function, and the benefit of stopping smoking.

Figure 9.13 Smoking and loss of forced expiratory volume in 1 second (FEV1) with age



NB1: Death in this figure refers to death with an underlying cause of irreversible chronic obstructive pulmonary disease, whether the immediate cause of death is respiratory failure, pneumonia, cor pulmonale or aggravation of other heart disease by respiratory insufficiency.

Adapted by permission from BMJ Publishing Group Limited. Fletcher C, Peto R. The natural history of chronic airflow obstruction. Br Med J 1977;1(6077):1645-8. [URL]

Physical activity and COPD

Physical activity and COPD

Many patients with COPD have a sedentary lifestyle. It is important to encourage an increase in regular physical activity. Performing some form of regular activity may lower the risk of hospitalisation for patients with COPD. See also advice about Pulmonary rehabilitation.

Pulmonary rehabilitation for COPD

Pulmonary rehabilitation for COPD

Pulmonary rehabilitation is an extremely effective intervention; it improves quality of life and exercise capacity in all patients with COPD, regardless of severity. It may also reduce the frequency of hospitalisations for COPD exacerbations.

Pulmonary rehabilitation should be made available to all patients with symptomatic COPD, provided they are sufficiently motivated and do not have severe comorbidities that preclude participation. Programs typically run for at least 8 weeks, with sessions on 2 or 3 days per week, each running for 2 to 3 hours.

Pulmonary rehabilitation programs typically contain four elements:

- exercise training
- education
- behaviour modification
- outcome assessment (eg with the 6-minute walk test).

The key components of exercise training are aerobic and strength training of the upper and lower limbs. Flexibility exercises are often included. Breathing techniques and positioning that assist patients to recover from episodes of breathlessness are also taught. Targeted inspiratory muscle training is included for some patients.

Supervision by a trained health professional is recommended to help build patient confidence, optimise training intensity and outcomes, and encourage exercise maintenance.

After a pulmonary rehabilitation program, patients are encouraged to continue regular exercise at home—30 minutes per day is suggested. Although benefit wanes after a rehabilitation program ends, if exercise training is maintained at home the patient's health status remains above pre-rehabilitation levels.

Patient support organisations can help maintain the benefits of rehabilitation by providing educational material for patients with COPD. Support organisations also provide an important social contact for patients. Links to patient support resources are available from the Lung Foundation Australia website. Other patient resources available through the Lung Foundation website can be found here.

The Lung Foundation Australia Pulmonary Rehabilitation Toolkit is an online resource for health professionals working in pulmonary rehabilitation. It can also assist patients who do not have access to a pulmonary rehabilitation program.

Vaccinations and COPD

Vaccinations and COPD

Ensure all patients with COPD are up to date with their pneumococcal vaccination, and receive an annual influenza vaccination (ideally before the influenza season begins). Pneumococcal and influenza vaccinations reduce exacerbation frequency in COPD.

For more information, see the *Australian Immunisation Handbook* .

Nutrition and COPD

Nutrition and COPD

Patients with COPD and a body mass index (BMI) outside the healthy range should be referred to a dietician for advice about nutrition.

Although the evidence for the benefits of nutritional supplements in underweight patients with COPD is limited, consider high-calorie supplements in malnourished patients.

Patients with COPD and coexisting obesity have impaired health-related quality of life, including increased dyspnoea and fatigue. However, overweight people with COPD have a reduced mortality risk (the 'obesity paradox'), possibly because of decreased static lung volume or increased free fat mass. Weight loss strategies must be tailored to each patient and followed cautiously.

Short-acting bronchodilator therapy for COPD

Short-acting bronchodilator therapy for COPD

Short-acting bronchodilator therapy is used as required to provide short-term symptom relief for patients with COPD. There is no evidence that short-acting bronchodilator therapy reduces the rate of decline in lung function or has any effect on survival. For patients with mild and infrequent symptoms, a combination of general measures and short-acting $beta_2$ agonist (SABA) bronchodilator therapy may be adequate.

For as-required therapy, use:

1 salbutamol 100 to 200 micrograms by inhalation via pMDI with spacer, as required (see Table 9.15 for regimen expressed as number of inhalations) *chronic obstructive pulmonary disease, maintenance* _

OR

1 terbutaline 500 micrograms by inhalation via DPI, as required (see Table 9.15 for regimen expressed as number of inhalations). *chronic obstructive pulmonary disease, maintenance*

A nebuliser is only necessary for patients who are unable to use a pMDI or a DPI.

Ipratropium is not usually used for symptom relief in COPD—it is contraindicated in patients taking a long-acting muscarinic antagonist (LAMA), is more expensive than a SABA, and may increase the risk of cardiovascular events.

Assess response 3 months after starting treatment. In patients who remain symptomatic, check inhaler technique before considering stepping up to long-acting bronchodilator (LABA or LAMA) monotherapy.

Long-acting bronchodilator (LABA or LAMA) monotherapy for COPD

Long-acting bronchodilator (LABA or LAMA) monotherapy for COPD

Long-acting bronchodilator monotherapy (plus as-required short-acting bronchodilator used as 'rescue medication') is indicated for patients who remain symptomatic despite general measures and short-acting bronchodilator therapy.

Long-acting bronchodilators include:

- long-acting muscarinic antagonists (LAMAs): aclidinium, glycopyrronium, tiotropium, umeclidinium
- long-acting beta$_2$ agonists (LABAs) [Note 1]: indacaterol, formoterol, olodaterol, salmeterol, vilanterol.

Long-acting bronchodilators improve lung function (as measured by forced expiratory volume in 1 second [FEV_1]). They also provide symptomatic relief of breathlessness, improve exercise capacity, reduce the frequency and severity of exacerbations, reduce hospitalisations and improve quality of life. Symptomatic and functional benefits should be seen within 6 to 12 weeks, and can occur even in the absence of any change in FEV_1.

In a meta-analysis of randomised controlled trials, LAMAs were more effective at reducing exacerbations than LABAs [Note 2]. However, individual response to long-acting bronchodilators varies; some patients may respond better to a LABA than a LAMA.

The choice of long-acting bronchodilator therapy should also consider patient preference of dosage regimen and device—see Table 9.15 for details of inhaled drug formulations for COPD, and Table 9.31 for information about devices.

For treatment with a LAMA, use:

1 aclidinium 322 micrograms by inhalation via DPI, twice daily (see Table 9.15 for regimen expressed as number of inhalations) *chronic obstructive pulmonary disease, maintenance*

OR

1 glycopyrronium 50 micrograms by inhalation via DPI, daily (see Table 9.15 for regimen expressed as number of inhalations) *chronic obstructive pulmonary disease, maintenance*

OR

1 tiotropium 13 or 18 micrograms [Note 3] by inhalation via DPI, daily (see Table 9.15 for regimen expressed as number of inhalations) *chronic obstructive pulmonary disease, maintenance*

OR

1 tiotropium 5 micrograms by inhalation via mist inhaler, daily (see Table 9.15 for regimen expressed as number of inhalations)

OR

1 umeclidinium 62.5 micrograms by inhalation via DPI, daily (see Table 9.15 for regimen expressed as number of inhalations). *chronic obstructive pulmonary disease, maintenance*

For treatment with a LABA, use:

indacaterol 150 micrograms by inhalation via DPI, daily [Note 4], increasing to 300 micrograms daily if required (see Table 9.15 for regimen expressed as number of inhalations). *chronic obstructive pulmonary disease, maintenance*

Assess response 3 to 6 months after starting treatment. In patients who remain symptomatic or have continued exacerbations, check inhaler technique and adherence. Before stepping up to long-acting bronchodilator dual therapy, also consider other causes of breathlessness, particularly in patients who show no response to a long-acting bronchodilator.

Note 1: At the time of writing, indacaterol is the only LABA available on the Pharmaceutical Benefits Scheme (PBS) as monotherapy for COPD. See the PBS website for current information.

Note 2: Chen WC, Huang CH, Sheu CC, Chong IW, Chu KA, Chen YC, et al. Long-acting beta2-agonists versus long-acting muscarinic antagonists in patients with stable COPD: A systematic review and meta-analysis of randomized controlled trials. Respirology 2017;22(7):1313-9. [URL]

Note 3: Tiotropium dry powder inhaler is available as a 13 microgram inhaler and an 18 microgram formulation. These formulations are bioequivalent, both delivering 10 micrograms per dose, and can be used interchangeably.

Note 4: Indacaterol is the only LABA available on the Pharmaceutical Benefits Scheme (PBS) as monotherapy for COPD. See the PBS website for current information.

Long-acting bronchodilator (LABA plus LAMA) dual therapy for COPD

Long-acting bronchodilator (LABA plus LAMA) dual therapy for COPD

In patients who remain symptomatic or have continued exacerbations despite monotherapy with a long-acting $beta_2$ agonist (LABA) or a long-acting muscarinic antagonist (LAMA), start combination LABA and LAMA therapy (long-acting bronchodilator dual therapy).

Long-acting bronchodilator dual therapy:

- improves lung function and quality of life compared with LAMA or LABA monotherapy
- reduces exacerbations compared with LABA monotherapy, and may reduce exacerbations compared with LAMA monotherapy
- appears to reduce the frequency of exacerbations compared to combination therapy with an inhaled corticosteroid (ICS) and a LABA.

Long-acting bronchodilator dual therapy can be given as two single-drug inhalers using the doses outlined in Long-acting bronchodilator monotherapy.

Alternatively, a fixed-dose combination inhaler can be used. See Table 9.15 for details of inhaled drug formulations for COPD, and Table 9.31 for information about devices.

For a fixed-dose combination inhaler containing a LABA and a LAMA, use:

1 formoterol+aclidinium 12+340 micrograms by inhalation via DPI, twice daily (see Table 9.15 for regimen expressed as number of inhalations) *chronic obstructive pulmonary disease, maintenance*

OR

1 indacaterol+glycopyrronium 110+50 micrograms by inhalation via DPI, daily (see Table 9.15 for regimen expressed as number of inhalations) *chronic obstructive pulmonary disease, maintenance*

OR

1 olodaterol+tiotropium 5+5 micrograms by inhalation via mist inhaler, daily (see Table 9.15 for regimen expressed as number of inhalations) *chronic obstructive pulmonary disease, maintenance*

OR

1 vilanterol+umeclidinium 25+62.5 micrograms by inhalation via DPI, daily (see Table 9.15 for regimen expressed as number of inhalations). *chronic obstructive pulmonary disease, maintenance*

Assess response 3 to 6 months after starting treatment. In patients who remain symptomatic or have continued exacerbations, check inhaler technique and adherence. Before stepping up to LABA, LAMA and inhaled corticosteroid triple therapy, also consider other causes of breathlessness.

LABA, LAMA and inhaled corticosteroid triple therapy for COPD

LABA, LAMA and inhaled corticosteroid triple therapy for COPD

Consider adding an inhaled corticosteroid (ICS) to long-acting bronchodilator dual therapy if both of the following apply:

- the patient has had a severe exacerbation (requiring hospitalisation) or at least two moderate exacerbations in the previous 12 months, and
- the patient has significant symptoms despite dual therapy with a LAMA and LABA.

Triple therapy is only required in patients with continued symptoms and exacerbations despite dual therapy with a LABA and LAMA.

In a meta-analysis comparing triple therapy, LAMA monotherapy, LAMA plus LABA dual therapy, and ICS+LABA dual therapy, triple therapy improved lung function and quality of life, and reduced exacerbations, compared with other treatments. However, ICS are associated with an increased risk of pneumonia in patients with COPD. The benefits of adding ICS must be balanced against the increased risk of pneumonia and local adverse effects (dysphonia, upper airway candidiasis).

Response to oral corticosteroids does not predict response to ICS; do not use oral corticosteroids to identify which patients may benefit from ICS.

Triple therapy can be given as an ICS+LABA fixed-dose combination inhaler plus a separate LAMA inhaler, or as a single fixed-dose combination inhaler containing all three drug classes [Note 5]. There is no evidence that a single inhaler improves outcomes compared to separate inhalers. See Table 9.15 for details of inhaled drug formulations for COPD, and Table 9.31 for information about devices.

For triple therapy with two separate inhalers [Note 6], use:

a LAMA (see Long-acting bronchodilator monotherapy for doses)

PLUS ONE OF THE FOLLOWING ICS+LABA FIXED-DOSE COMBINATIONS

1 budesonide+formoterol 400+12 micrograms by inhalation via pMDI with spacer or via DPI, twice daily (see Table 9.15 for regimen expressed as number of inhalations) *chronic obstructive pulmonary disease, maintenance*

OR

1 fluticasone furoate+vilanterol 100+25 micrograms by inhalation via DPI, daily (see Table 9.15 for regimen expressed as number of inhalations) *chronic obstructive pulmonary disease, maintenance*

OR

1 fluticasone propionate+salmeterol 500+50 micrograms by inhalation via pMDI with spacer or via DPI, twice daily (see Table 9.15 for regimen expressed as number of inhalations). *chronic obstructive pulmonary disease, maintenance*

For triple therapy with a single inhaler, use:

1beclometasone+glycopyrronium+formoterol 200+20+12 micrograms by inhalation via pMDI with spacer, twice daily (see Table 9.15 for regimen expressed as number of inhalations)

OR

1budesonide+glycopyrronium+formoterol 320+14.4+10 micrograms by inhalation via pMDI with spacer, twice daily (see Table 9.15 for regimen expressed as number of inhalations)

OR

1 fluticasone furoate+umeclidinium+vilanterol 100+62.5+25 micrograms by inhalation via DPI, daily (see Table 9.15 for regimen expressed as number of inhalations). *chronic obstructive pulmonary disease, maintenance*

Assess response 3 to 6 months after starting treatment. Refer patients to a respiratory physician if they remain symptomatic or have continued exacerbations despite triple therapy.

Note 5: Single-drug inhalers of ICS are not approved on the Pharmaceutical Benefits Scheme (PBS) for COPD, so three separate inhalers, or a LAMA+LABA fixed-dose combination with a separate ICS, are not typically used.

Note 6: Formulations not available on the Pharmaceutical Benefits Scheme (PBS) are not listed. See the PBS website for current information.

Inhaled drugs for COPD: formulation and device summary

Inhaled drugs for COPD: formulation and device summary

A summary of inhaled drugs available in Australia for COPD at the time of writing is provided in Table 9.15. For detailed information about delivery devices, including links to videos and patient handouts, see Inhalational drug delivery devices.

Table 9.15 Inhalers available in Australia for COPD

Drug or drug combination (brand examples)	Delivery device [NB1] (brand examples)	Dose per inhalation	Usual regimen for COPD
SABA inhalers			

Drug or drug combination (brand examples)	Delivery device [NB1] (brand examples)	Dose per inhalation	Usual regimen for COPD
salbutamol (Ventolin, Asmol, Airomir)	pMDI or breath-activated pMDI (Autohaler)	100 micrograms	1 to 2 inhalations as required
terbutaline (Bricanyl)	multiple-dose DPI (Turbuhaler)	500 micrograms	1 inhalation as required
SAMA inhaler [NB2]			
ipratropium (Atrovent)	pMDI	21 micrograms	2 inhalations as required
LAMA inhalers			
aclidinium (Bretaris)	multiple-dose DPI (Genuair)	322 micrograms	1 inhalation twice daily
glycopyrronium (Seebri)	single-dose DPI (Breezehaler)	50 micrograms	1 inhalation daily
tiotropium (Spiriva, Braltus)	single-dose DPI (Handihaler)	18 micrograms [NB3]	1 inhalation daily
	single-dose DPI (Zonda device)	13 micrograms [NB3]	1 inhalation daily
	mist inhaler (Respimat)	2.5 micrograms	2 inhalations daily
umeclidinium (Incruse)	multiple-dose DPI (Ellipta)	62.5 micrograms	1 inhalation daily
LABA inhalers [NB4]			
indacaterol (Onbrez)	single-dose DPI (Breezehaler)	150 micrograms	1 to 2 inhalations daily
	single-dose DPI (Breezehaler)	300 micrograms	1 inhalation daily
LABA+LAMA fixed-dose combination inhalers			
formoterol+aclidinium (Brimica)	multiple-dose DPI (Genuair)	12+340 micrograms	1 inhalation twice daily
indacaterol+glycopyrronium (Ultibro)	single-dose DPI (Breezehaler)	110+50 micrograms	1 inhalation once daily
olodaterol+tiotropium (Spiolto)	mist inhaler (Respimat)	2.5+2.5 micrograms	2 inhalations once daily
vilanterol+umeclidinium (Anoro)	multiple-dose DPI (Ellipta)	25+62.5 micrograms	1 inhalation once daily
ICS+LABA fixed-dose combination inhalers			
budesonide+formoterol (Symbicort, DuoResp)	pMDI (Rapihaler)	200+6 micrograms	2 inhalations twice daily
	multiple-dose DPI (Turbuhaler, Spiromax)	400+12 micrograms	1 inhalation twice daily

Drug or drug combination (brand examples)	Delivery device [NB1] (brand examples)	Dose per inhalation	Usual regimen for COPD
fluticasone furoate+vilanterol (Breo)	multiple-dose DPI (Ellipta)	100+25 micrograms [NB5]	1 inhalation once daily
fluticasone propionate+salmeterol (Seretide, SalplusF, Cipla, Pavtide)	pMDI	250+25 micrograms	2 inhalations twice daily
	multiple-dose DPI (Accuhaler)	500+50 micrograms	1 inhalation twice daily
ICS+LAMA+LABA fixed-dose combination inhaler			
beclometasone+glycopyrronium+formoterol (Trimbow)	pMDI	100+10+6 micrograms	2 inahalations twice daily
budesonide+ glycopyrronium+formoterol (Breztri)	pMDI	160+7.2+5 micrograms	2 inhalations twice daily
fluticasone furoate+umeclidinium+vilanterol (Trelegy)	multiple-dose DPI (Ellipta)	100+62.5+25 micrograms	1 inhalation once daily

COPD = chronic obstructive pulmonary disease; DPI = dry powder inhaler; ICS = inhaled corticosteroid; LABA = long-acting beta$_2$ agonist; LAMA = long-acting muscarinic antagonist; SABA = short-acting beta$_2$ agonist; SAMA = short-acting muscarinic antagonist; PBS = Pharmaceutical Benefits Scheme; pMDI = pressurised metered dose inhaler

NB1: For detailed information about delivery devices, including links to videos and patient handouts, see Inhalational drug delivery devices.

NB2: Ipratropium is not usually used for symptom relief in COPD—it is contraindicated in patients taking a LAMA, is more expensive than a SABA, and may increase the risk of cardiovascular events.

NB3: Tiotropium dry powder inhaler is available as a 13 microgram inhaler and an 18 microgram inhaler. These inhalers are bioequivalent, both delivering 10 micrograms per dose, and can be used interchangeably.

NB4: Indacaterol is the only LABA available on the PBS as monotherapy for COPD. See the PBS website for current information.

NB5: Fluticasone furoate+vilanterol is also available in a 200+25 microgram formulation, but this higher dose increases the risk of adverse effects (including pneumonia), and does not improve COPD outcomes.

Additional therapy for severe COPD

Additional therapy for severe COPD

Domiciliary oxygen therapy

Domiciliary oxygen therapy

Patients with advanced COPD can develop significant hypoxaemia, and can benefit from treatment with long-term continuous domiciliary oxygen therapy (usually delivered by a concentrator).

In patients with advanced COPD and an arterial oxygen saturation measured by pulse oximetry (SpO_2) of 90% or less, assessment for domiciliary oxygen therapy may appropriate. Arterial blood gas analysis on room air is required to determine eligibility for domiciliary oxygen therapy; see Long-term continuous oxygen

therapy for indications for domiciliary oxygen therapy based on arterial blood gas results. Assess patients while COPD is stable, and not within 4 weeks of an exacerbation (when gas exchange may deteriorate).

For general information about domiciliary oxygen therapy, including delivery, monitoring, precautions and access, see Domiciliary oxygen therapy.

Home noninvasive ventilation

Home noninvasive ventilation

Home noninvasive ventilation can be considered for patients with stable COPD and persistent hypercapnia. A large meta-analysis demonstrated improved outcomes (reduced mortality, hospital admissions and intubations) in patients with stable COPD and persistent hypercapnia treated with home noninvasive ventilation [Note 7]. The study did not find significant difference in quality of life. Consider referring patients with severe COPD, recurrent exacerbations and persistent hypercapnia and hypoxia to a centre with expertise in home noninvasive ventilation for assessment of suitability.

Note 7: Wilson ME, Dobler CC, Morrow AS, Beuschel B, Alsawas M, Benkhadra R, et al. Association of Home Noninvasive Positive Pressure Ventilation With Clinical Outcomes in Chronic Obstructive Pulmonary Disease: A Systematic Review and Meta-analysis. JAMA 2020;323(5):455-65. [URL]

Oral mucolytics

Oral mucolytics

Over-the-counter oral mucolytics (usually bromhexine) are widely used by patients with COPD. They have not been studied for efficacy in COPD, but appear to be safe.

Other oral mucolytics, such as N-acetylcysteine, erdosteine, carbocysteine and ambroxol, can reduce exacerbations in moderate to severe COPD, although trials did not show an improvement in quality of life. Access to these drugs in Australia is limited.

Long-term macrolide antibiotics

Long-term macrolide antibiotics

For information on the harms and benefits of long-term macrolide antibiotics as anti-inflammatory therapy for patients with severe COPD and frequent exacerbations, see here.

Theophylline

Theophylline

Theophylline is not recommended to treat COPD in Australia. Previous recommendations to use theophylline were based on a study that showed a reduced number of exacerbations in patients treated with theophylline compared to placebo [Note 8]. However, patients in this study were not treated with current standard therapy for COPD (eg long-acting bronchodilators, inhaled corticosteroids [ICS]). In a 2018 study of patients with a recent history of COPD exacerbations, theophylline did not reduce the number of exacerbations in 1 year [Note 9].

Note 8: Zhou Y, Wang X, Zeng X, Qiu R, Xie J, Liu S, et al. Positive benefits of theophylline in a randomized, double-blind, parallel-group, placebo-controlle study of low-dose, slow-release theophylline in the treatment of COPD for 1 year. Respirology 2006;11(5):603-10. [URL]

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Surgical and interventional procedures

Surgical and interventional procedures

For patients with very severe COPD who remain incapacitated by dyspnoea despite optimised therapy (including pulmonary rehabilitation), surgical or interventional procedures can be considered. Refer patients to a specialist centre for considerations of these highly specialised palliative approaches.

Lung transplantation can be considered for selected patients with end-stage COPD. It can improve survival, but is limited by donor availability, need for lifelong immunosuppression, and the development of chronic allograft dysfunction. Young patients with few comorbidities may be suitable for consideration of lung transplantation.

Lung volume reduction surgery or bronchoscopic lung volume reduction employing endobronchial valves are suitable for only a small group of highly selected patients. Although they can improve lung function, quality of life and exercise tolerance, they are also associated with significant morbidity and mortality.

Indications for referral for COPD

Indications for referral for COPD

Assessment by a respiratory physician can be useful to verify the diagnosis of COPD, to identify patients with asthma or overlap of asthma and COPD and to differentiate COPD from other airway diseases or occupational exposures that can cause respiratory disease.

Figure 9.14 lists indications for which consultation with a respiratory specialist may be considered.

For patients with end-stage COPD, consider referral to a palliative care service. See also Prognosis, palliative care and advance care planning.

Figure 9.14 Indications for referral to a respiratory physician for COPD

- diagnostic uncertainty
- frequent exacerbations or persistent symptoms despite optimal drug and nondrug therapy (including pulmonary rehabilitation)
- unusual symptoms (eg haemoptysis)
- rapid decline in FEV_1
- COPD in a patient younger than 40 years (to investigate for $alpha_1$-antitrypsin deficiency)

COPD = chronic obstructive pulmonary disease; FEV_1 = forced expiratory volume in 1 second

Ongoing monitoring and review of stable COPD

Ongoing monitoring and review of stable COPD

Review patients with chronic obstructive pulmonary disease (COPD) regularly; the frequency of review depends on the disease severity (symptoms and exacerbation history).

Suggested review intervals and assessments according to severity are outlined in Table 9.16.

At each review, consider whether any change (step up or step down) of therapy is required.

The COPD Assessment Test (CAT) and the modified Medical Research Council (mMRC) dyspnoea scale are useful to assess changes in quality of life, breathlessness and functional limitation, and can help to quantify the patient's perception of treatment adequacy.

Table 9.16 Review intervals and suggested assessment of patients with COPD according to severity

Mild to moderate COPD [NB1]

Review at least annually [NB2]

Assess:

- need for referral to specialist physician or other services (see Figure 9.12)
- smoking status and motivation to quit
- adequacy of symptom control, including breathlessness and exercise tolerance
- exacerbation frequency
- need for pulmonary rehabilitation
- presence of sequelae of COPD (eg hypoxaemia)
- benefits and adverse effects of each drug treatment
- inhaler technique
- adherence
- written COPD action plan
- presence of psychiatric comorbidities (eg depression, anxiety)

Measure:

- FEV_1 and FVC [NB3]
- CAT score [NB4]
- mMRC breathlessness score [NB5]
- BMI

Severe COPD [NB1]

Review at least twice per year [NB2]

Assess as for mild to moderate COPD, plus:

- presence of cor pulmonale
- presence of coexisting cardiovascular disease (including heart failure, atrial fibrillation, ischaemic heart disease), particularly if there is evidence of recent COPD deterioration
- need for long-term oxygen therapy
- nutritional state
- need for social services and occupational therapy input
- need for referral for specialist surgical procedures
- need for end-of-life discussion and advance care planning

Measure as for mild to moderate COPD, plus:

- arterial blood gases if SpO_2 is less than 90%

BMI = body mass index; CAT = COPD Assessment Test; COPD = chronic obstructive pulmonary disease; FEV_1 = forced expiratory volume in 1 second; FVC = forced vital capacity; mMRC = modified Medical Research Council; SpO_2 = oxygen saturation measured by pulse oximetry

NB1: See Table 9.14 for classification of COPD severity.

NB2: More frequent opportunistic assessment of factors such as inhaler technique, smoking status, symptom control and adverse effects of treatment is encouraged.

NB3: Perform spirometry annually in all patients with COPD.

NB4: The CAT is available here.

NB5: The mMRC dyspnoea scale is available here.

Self-management programs and action plans for COPD

Self-management programs and action plans for COPD

Self-management programs aim to teach patients with chronic disease the skills needed to carry out medical regimens specific to their condition. They also aim to guide behaviour change to help patients control their condition and improve their wellbeing.

Self-management programs for COPD involve a range of strategies, including written action plans to manage symptoms, avoiding risk factors (eg smoking), maintaining adequate nutrition and physical activity, and adhering to drug regimens.

Consider introducing a COPD self-management program for patients likely to be able to self-manage and follow an action plan. Written COPD action plans are an important component of self-management; they must be accompanied by comprehensive patient education to be effective.

A written COPD action plan outlines the initial measures that the patient should take in response to an increase in symptoms. This can include:

- adjusting bronchodilator therapy to control symptoms
- starting oral corticosteroid therapy if breathlessness increases and interferes with activities of daily living
- considering starting antibiotics if the exacerbation is suspected to be caused by bacterial infection (see Is the COPD exacerbation caused by infection?).

Patients should keep a course of corticosteroid and antibiotic tablets at home for use as part of self-management. See Exacerbations of COPD for information about clinical management of an exacerbation.

The written COPD action plan must be developed, updated and reviewed in partnership with the healthcare team and the patient. A COPD action plan template is available from the Lung Foundation Australia website.

Comorbidities and complications of COPD

Comorbidities and complications of COPD

Overlap of asthma and COPD

Overlap of asthma and COPD

COPD and asthma can coexist. Many patients with COPD report a history of asthma, and people with a history of asthma are at increased risk of developing COPD. Differentiating the diagnosis can be difficult because symptoms are similar.

Clinical features favouring COPD include:

- onset after age 40
- persistent airflow limitation (as opposed to the variable airflow limitation typical of asthma)
- lack of response to asthma therapy (eg symptoms persisting after several weeks or months of inhaled corticosteroid [ICS] treatment)
- heavy tobacco smoke exposure.

Clinical features favouring asthma include:

- onset before age 20

- significant day-to-day variability in airflow limitation and symptoms
- normal lung function between symptoms
- symptoms worse at night or in the early morning
- family history of asthma or atopy
- seasonal variability in symptoms
- spontaneous improvement in symptoms.

Patients with features of both conditions may have overlap of asthma and COPD. These patients experience more rapid disease progression than those with either disease alone. They also have worse health-related quality of life, and experience more frequent and severe respiratory exacerbations.

Seek specialist advice for managing patients with overlap of asthma and COPD, as evidence is limited and approaches differ.
Patients with overlap of asthma and COPD have more rapid disease progression, and require specialist management.

ICS have a key role in preventing asthma-related deaths in patients with asthma, and long-acting $beta_2$ agonists (LABAs) have a significant role in COPD management. Use an ICS and long-acting bronchodilator combination in patients with overlap of asthma and COPD; avoid monotherapy.

Cardiovascular disease

Cardiovascular disease

Patients with COPD are at increased risk of cardiovascular disease. Diagnosing cardiovascular disease in COPD is complicated by the similarity in presentation, which in both cases can include breathlessness, fatigue and chest discomfort.

Beta-blocker therapy is commonly used for cardiovascular disease. In a 2019 randomised placebo-controlled trial of patients with COPD, beta-blocker therapy increased the incidence of severe and very severe exacerbations (requiring hospitalisation or intubation respectively), and possibly increased mortality [Note 10]. Patients with heart failure with reduced ejection fraction (HFrEF), or with a myocardial infarction within the last 3 years, were excluded from the trial—beta-blocker therapy has proven mortality benefits in these patients and should not be withheld on the grounds of coexisting COPD.

Note 10: Dransfield MT, Voelker H, Bhatt SP, Brenner K, Casaburi R, Come CE, et al. Metoprolol for the Prevention of Acute Exacerbations of COPD. N Engl J Med 2019. [URL]

Anxiety disorders (including panic attacks) and depression

Anxiety disorders (including panic attacks) and depression

Anxiety disorders (including panic attacks) and depression are more common in patients with COPD than in the general population, and adversely affect prognosis. Comprehensive pulmonary rehabilitation can significantly reduce symptoms of both anxiety and depression; cognitive behavioural therapy and a collaborative care model can also be beneficial. For management advice, see Anxiety and associated disorders and Depression.

Osteoporosis

Osteoporosis

Patients with COPD have an increased risk of bone fracture, and their bone mineral density is on average 10% lower than the general population. Identify patients at risk of osteoporosis, and implement measures to prevent fracture as necessary. For detailed information about the prevention and management of osteoporosis and minimal-trauma fracture, see here.

Diabetes

Diabetes

Patients with COPD are at increased risk of developing type 2 diabetes.

Patients with both COPD and diabetes who are using a high-dose ICS to manage COPD are at increased risk of complications from diabetes. If an ICS is required in these patients, use the minimum effective dose and monitor blood glucose control closely.

Limit the use of oral corticosteroids in patients with COPD and diabetes. Consider the benefits of treatment and the potential short- and long-term adverse effects. Hypoglycaemic therapy may need to be escalated during oral corticosteroid courses, and subsequently de-escalated. For specific advice about corticosteroid use in patients with diabetes, see Glucocorticoid-induced hyperglycaemia.

Pulmonary hypertension

Pulmonary hypertension

Mild to moderate pulmonary hypertension is a common complication of COPD. It is associated with an increased risk of exacerbations, increased mortality and worse quality of life.

Pulmonary vascular remodelling is thought to result from the combined effects of hypoxia, inflammation and loss of capillaries in severe emphysema. Most patients with pulmonary hypertension, especially those who have symptoms, should be referred to a specialised centre for evaluation and management; see Pulmonary hypertension for more information.

Cor pulmonale

Cor pulmonale

Cor pulmonale is defined as right ventricular hypertrophy and dilation secondary to lung disease; it should be considered in a patient with COPD who has any of the following:

- peripheral oedema
- raised jugular venous pressure
- a systolic parasternal heave
- a loud pulmonary secondary heart sound.

Refer patients with suspected cor pulmonale to a respiratory physician for assessment and management. Long-term oxygen therapy may be required. Oedema associated with cor pulmonale can usually be controlled with diuretic therapy.

Prognosis, palliative care and advance care planning for COPD

Prognosis, palliative care and advance care planning for COPD

Lung function impairment is a strong predictor of mortality; however, using lung function alone to classify disease severity does not capture the multidimensional nature of chronic obstructive pulmonary disease (COPD). Severe dyspnoea, cough, fatigue, social isolation, anxiety and depression are all features of late-stage COPD. As the disease progresses, a palliative approach to care may be appropriate.

The course of COPD is typically punctuated by recurrent exacerbations, which may require hospitalisation and consideration of assisted ventilation. Hospitalisation for an exacerbation increases subsequent mortality risk, and is a sentinel event that should prompt consideration of advance care planning.

Determining prognosis in end-stage COPD is difficult; however, features that should trigger discussions about a palliative approach to care, advance care planning, and end-of-life issues include:

- forced expiratory volume in 1 second (FEV_1) less than 25% of predicted
- oxygen dependence
- respiratory failure or hypercapnia
- heart failure or other comorbidities
- weight loss or cachexia
- decreased functional status
- increasing dependence on others
- advanced age.

Ideally, end-of-life discussions (eg resuscitation and intubation wishes, advance care planning) should occur in an outpatient setting when the patient's condition is relatively stable. These discussions should include consideration of the appointment of a substitute decision-maker.

Patients with severe COPD and their caregivers should be made aware of palliative care services, including carer respite and admission to hospice. See Advance care planning for further detail. The Advance Care Planning Australia website also provides useful information.

Patients with severe COPD may benefit from low-dose opioids, which reduce the sensation of breathlessness without significantly depressing respiration. See also Symptomatic relief of dyspnoea in palliative care. End-stage COPD gives further information on end-of-life considerations.

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Overview of cough in adults

Overview of cough in adults

Although cough is an essential reflex, it can become disordered and is one of the most common reasons for presentation to healthcare providers.

Cough can affect the patient's quality of life because of the adverse consequences it can cause (eg urinary incontinence in women, headaches, sleep disturbance, vomiting, rib fracture).

Cough in adults is classified according to its duration:

- acute cough lasts less than 3 weeks
- subacute cough lasts 3 to 8 weeks [Note 1]
- chronic cough lasts more than 8 weeks.

This classification assists in differential diagnosis; cough has many causes, including some serious conditions that need consideration and exclusion.

The scientific understanding of the pathophysiology of chronic cough has evolved. Chronic cough is now considered to have two components: trigger(s) and upper airway hypersensitivity, both of which need to be addressed to effectively manage cough. Triggers can be diseases or other factors that stimulate cough. Upper airway hypersensitivity is caused by laryngeal irritation and inflammation, and leads to a persistent urge to cough.

Note 1: The Australian Cough in Children and Adults: Diagnosis and Assessment guidelines do not include subacute cough as a category.

Initial assessment of cough in adults

Initial assessment of cough in adults

Initial assessment of cough in adults must include a thorough medical history, including review of medications, and examination to help identify triggers and determine the need for further investigations to exclude serious causes of cough. See also Management of chronic cough in adults for detail about specific investigations for chronic cough.

Consider additional investigations or referral to a relevant specialist if the patient has any of the alarm symptoms and findings listed in Figure 9.16.

Figure 9.16 Alarm symptoms and findings in an adult with cough

Consider additional investigations or referral to a relevant specialist if an adult with cough has any of the following symptoms and findings:

- haemoptysis
- smoker who:
  - has a greater than 20 pack-year smoking history [NB1] and a new or altered cough
  - is older than 45 years and has a new or altered cough, or cough with voice disturbance
- prominent dyspnoea, especially at rest or at night
- recurrent or chronic sputum production

- hoarseness
- systemic symptoms (eg fever, weight loss, vomiting, oedema)
- GORD associated with weight loss, anaemia, haematemesis or melaena, vomiting, dysphagia (difficulty swallowing), odynophagia (painful swallowing)
- GORD not responding to empirical treatment
- recurrent pneumonia
- abnormal clinical respiratory examination
- abnormal chest X-ray.

GORD = gastro-oesophageal reflux disease

NB1: Pack years is calculated using the formula: (years of smoking × cigarettes per day) / 20; see alsohere for an online calculator.

For a patient with a chronic cough that has no identifiable cause or is refractory to treatment of identifiable causes, refer to a multidisciplinary cough clinic for assessment (or respiratory specialist if a clinic is not accessible). See Chronic unexplained cough.

For detailed advice on diagnosis and assessment of cough, see the American College of Chest Physicians (CHEST) guidelines available here.

Acute cough in adults

Acute cough in adults

Causes of acute cough in adults

Causes of acute cough in adults

Acute cough in adults is defined as a cough lasting for up to 3 weeks.

Common or important causes of acute cough in adults are listed in Table 9.17. The most common causes are acute bronchitis caused by a viral respiratory tract infection (the common cold), exacerbations of chronic respiratory diseases (eg asthma, chronic obstructive pulmonary disease [COPD]), and pneumonia.

Table 9.17 Common or important causes of acute cough in adults

[NB1] [NB2]

Cause	Comments
viral upper respiratory tract infection	dry cough in the presence of other symptoms of an upper respiratory tract infection (eg sore throat, rhinorrhoea) no specific treatment required
acute bronchitis	productive or nonproductive cough in the presence of other symptoms of a lower respiratory tract infection antibiotics are **not** indicated $beta_2$ agonists are not recommended in the absence of airflow limitation
pneumonia	productive or nonproductive cough in patients with consolidation on chest X-ray may be allergic or nonallergic
acute rhinosinusitis	may be associated with acute rhinorrhoea, nasal congestion, ocular watering and itching, and sneezing antibiotics are generally not indicated

Cause	Comments
	consider in patients with cough lasting longer than 2 weeks
pertussis	other features may be present (eg paroxysms of coughing, inspiratory whoop, post-tussive vomiting)
asthma	uncontrolled asthma is a common cause of cough, but it is unusual for cough to be the sole symptom; other symptoms usually present (eg chest tightness, shortness of breath, wheeze, exercise limitation)
exacerbations of other chronic respiratory diseases	infective or noninfective exacerbation of underlying respiratory diseases (eg COPD, ILD, bronchiectasis)

COPD = chronic obstructive pulmonary disease, ILD = interstitial lung disease

NB1: Acute cough in adults is defined as a cough lasting for up to 3 weeks.

NB2: For detailed advice on diagnosis and assessment of cough, see the American College of Chest Physicians (CHEST) guidelines available here.

Treatment of acute cough in adults

Treatment of acute cough in adults

Reassure patients that acute cough usually resolves without treatment.

Many over-the-counter medications are available for acute cough. Although commonly used, they are not generally recommended because they have minimal, if any, benefit in acute cough and can cause adverse effects.

Evidence for over-the-counter medications in acute cough, as summarised in a systematic review [Note 2], is outlined below:

- **mucolytics**—bromhexine may reduce cough frequency
- **expectorants**—guafenesin has conflicting evidence of benefit in cough
- **antihistamines**—no more effective than placebo for cough
- **antihistamine+decongestant combinations**—have conflicting evidence of benefit in cough
- **cough suppressants**—dextromethorphan has conflicting evidence of benefit in cough; codeine is not more effective than placebo.

Evidence for the benefit of honey in cough mainly comes from studies of children. There is some evidence of benefit in adults with cough, although more studies are needed. Honey may be trialled in adults with cough because it is safe and easily accessible.

The expectorant senega with ammonia has no evidence of benefit in cough.

Evidence for benefit of complementary therapies (eg pelargonium, ivy leaf extract [*Hedera helix*], echinacea) in cough is uncertain. Severe allergic reactions have been reported with echinacea and pelargonium. There is no evidence for the use of 'salt therapy' (salt caves, salt rooms or inhalation of salt) in treatment of cough in adults.

For cough associated with a self-limiting respiratory tract infection (eg acute bronchitis, acute rhinosinusitis), many patients have an expectation of treatment with antibiotics. Effective communication with the patient or carer about the role of antibiotics is essential. The discussion should address misconceptions about the effectiveness of antibiotic therapy and the expectation of an antibiotic prescription. Resources to help discussion of the evidence for the potential benefits and harms of antibiotic therapy are available for:

- acute bronchitis
- acute rhinosinusitis
- exacerbations of COPD managed in the community

- sore throat.

Providing a ‘prescription’ with advice about nonspecific strategies for dealing with acute respiratory tract infection may also be useful to reduce patient expectation for antibiotics. The NPS MedicineWise website provides handouts with advice about nondrug management.

Note 2: Smith SM, Schroeder K, Fahey T. Over-the-counter (OTC) medications for acute cough in children and adults in community settings. Cochrane Database Syst Rev 2014;(11):CD001831. [URL]

Subacute cough in adults

Subacute cough in adults

Subacute cough in adults is defined as a cough lasting between 3 and 8 weeks.

The most common causes of subacute cough in adults are postviral infection and pertussis (cough usually lasts for 2 to 6 weeks, or longer); see Table 9.18 for more information on these causes.

Patients presenting with subacute cough may go on to develop chronic cough, so causes and treatment of chronic cough in adults should be considered.

Chronic cough in adults

Chronic cough in adults

Causes of chronic cough in adults

Causes of chronic cough in adults

Chronic cough is defined as a cough lasting more than 8 weeks.

Common or important causes of chronic cough in adults are listed in Table 9.18.

Table 9.18 Common or important causes of chronic cough in adults

[NB1] [NB2]

Cause [NB3]	Comments
postviral infection	cough following an acute viral respiratory tract infection such as acute rhinosinusitis or acute bronchitis; may last for more than 8 weeks antibiotics have no role in treatment
pertussis	consider if cough lasts for more than 2 weeks other features may be present (eg paroxysms of coughing, inspiratory whoop, post-tussive vomiting)
GORD	consider if patient has symptoms such as heartburn or regurgitation, night-time choking without symptoms of obstructive sleep apnoea, or if cough is worse at night or after eating specific foods diagnosis often made clinically or following a response to empirical treatment with PPIs
chronic rhinosinusitis	other symptoms usually present (eg nasal blockage, obstruction or congestion, mucopurulent nasal discharge [with anterior or posterior drainage], facial pain or pressure, reduced sense of smell and taste, nausea)

Cause [NB3]	Comments
upper airway cough syndrome (previously called postnasal drip)	coexisting allergic rhinitis may also present with symptoms such as sneezing, watery rhinorrhoea, nasal itching and itchy watery eyes may be associated with excessive mucus production (eg due to allergic or nonallergic rhinitis) may be the result of an increased perception of normal volumes of postnasal mucus
inducible laryngeal obstruction (also known as upper airway dysfunction or vocal cord dysfunction)	may be triggered by another cause of cough and worsened by irritants (eg gastro-oesophageal reflux, exposure to smoke or fumes, excessive use of the voice) refer to a speech pathologist with expertise in inducible laryngeal obstruction for assessment and treatment
somatic cough syndrome or tic cough (previously known as psychogenic or habit cough)	mostly occurs in children and adolescents cough generally not present during sleep
obstructive sleep apnoea	nocturnal reflux or inflammation of the pharynx from snoring may contribute to cough
tuberculosis	can present with or without sputum, fever or weight loss consider in patients who were born in or have visited countries where tuberculosis is endemic, or in patients with impaired immunity
lung or laryngeal cancer	consider in smokers older than 45 years with a new or altered cough, or cough with voice disturbance urgently refer to a specialist
recurrent aspiration	risk of recurrent aspiration increased in Parkinson disease, stroke, dementia, COPD, impaired consciousness, or neuromuscular disorders affecting bulbar muscles for definitions of aspiration-related terms and management of recurrent aspiration, see Aspiration pneumonia
asthma	uncontrolled asthma is a common cause of cough, but it is unusual for cough to be the sole symptom; other symptoms usually present (eg chest tightness, shortness of breath, wheeze, exercise limitation)
COPD or chronic bronchitis	productive cough, occurring every day for at least 3 months, at least 2 years in a row; more likely to present in heavy smokers of more than 20 pack years [NB4]
bronchiectasis	productive cough and recurrent chest infections
interstitial lung disease	dry cough, often associated with shortness of breath
cystic fibrosis	productive cough associated with gastrointestinal symptoms (eg frequent loose, oily bowel motions)
drug-induced cough	common precipitants include ACEIs and beta blockers close relationship between starting a drug and development of cough is not always seen review use of the precipitating drug

ACEIs = angiotensin converting enzyme inhibitors; COPD = chronic obstructive pulmonary disease; GORD = gastro-oesophageal reflux disease; PPI = proton pump inhibitor

NB1: Chronic cough in adults is defined as a cough lasting more than 8 weeks.

Cause [NB3]	Comments

NB2: For detailed advice on diagnosis and assessment of cough, see the American College of Chest Physicians (CHEST) guidelines available here.

NB3: Some of these diagnoses should also be considered as potential causes of acute and subacute cough because the patient may present soon after onset of cough.

NB4: Pack years is calculated using the formula (years of smoking × cigarettes per day) / 20; see here for an online calculator.

For a patient with a chronic cough that has no identifiable cause or is refractory to treatment of identifiable causes, refer to a multidisciplinary cough clinic for assessment (or respiratory specialist if a clinic is not accessible). See Chronic unexplained cough.

Management of chronic cough in adults

Management of chronic cough in adults

For all adults with chronic cough, perform an examination and take a thorough medical history, including questioning about nasal symptoms such as sneezing, nasal obstruction, and upper airway cough syndrome (previously called postnasal drip). In addition, perform spirometry and chest X-ray, and order a fractional exhaled nitric oxide (FeNO) test to look for evidence of airway inflammation (if possible); FeNO is commonly measured in specialist respiratory laboratories.

To effectively manage chronic cough, both the trigger and upper airway hypersensitivity need to be addressed.

Identify the trigger(s) of chronic cough (the condition or irritant causing cough); see Table 9.18. Treat any underlying conditions, and avoid irritants, if possible. For information about proton pump inhibitors for gastro-oesophageal reflux disease (GORD)–related cough, see here. Inhaled corticosteroids should only be trialled if clinical evidence of asthma is present; see here. Antibiotics should only be used for chronic cough in patients with an identified bacterial cause.

Regardless of the trigger, cough may become self-perpetuating because the laryngeal nerves become hypersensitive. In upper airway hypersensitivity, the patient coughs in response to a trigger that would not normally cause cough (eg odours, talking). To manage upper airway hypersensitivity, educate patients about environmental factors that may be contributing to or worsening their cough. For many patients with chronic dry cough, vocal hygiene is useful to break the self-perpetuating cycle and improve cough severity. For patients with chronic productive cough, strategies to facilitate sputum clearance may be useful.

For a summary of the evidence for over-the-counter and complementary therapies for cough, see Treatment of acute cough in adults.

Consider referring patients with severe or intractable chronic cough to a multidisciplinary cough clinic (or respiratory specialist if a clinic is not accessible) for assessment.

See Cough in palliative care for management advice in palliative care situations.

Proton pump inhibitors for GORD-related chronic cough in adults

Proton pump inhibitors for GORD-related chronic cough in adults

If gastro-oesophageal reflux disease (GORD) is considered likely (eg patient has heartburn or regurgitation, night-time choking without symptoms of obstructive sleep apnoea, cough that is worse at night or after eating specific foods), an empirical trial of a high-dose proton pump inhibitor (PPI) may be used. See Initial therapy for GORD in adults for standard dosing of proton pump inhibitors. In the absence of gastro-oesophageal reflux symptoms, PPIs are not recommended.

Nondrug measures should be used together with the PPI trial. These include diet modification to promote weight reduction in overweight or obese patients, and lifestyle modifications (eg head of bed elevation, avoiding meals within 3 hours of bedtime). PPIs alone are unlikely to be effective in cough due to GORD.

Review after 8 to 12 weeks and stop the PPI if there is no response.

Inhaled corticosteroids for chronic cough in adults

Inhaled corticosteroids for chronic cough in adults

An empirical trial of low-dose inhaled corticosteroids is only recommended if the patient has other features suggestive of asthma, such as dyspnoea, chest tightness, wheeze, obstructed spirometry or elevated fractional exhaled nitric oxide (FeNO).

For dosages of inhaled corticosteroids in asthma, see Table 9.3.

Review response after 2 to 4 weeks. If the cough responds, this does not necessarily indicate a diagnosis of asthma; testing for asthma should be undertaken. See Asthma diagnosis.

Nondrug interventions for chronic cough in adults

Nondrug interventions for chronic cough in adults
Minimising environmental factors

Advise patients to avoid exposure to environmental factors that may be contributing to or worsening their cough. This includes exposure to cold dry air, environmental tobacco smoke and other inhaled irritants.

Smoking cessation should be strongly recommended; see Smoking cessation. Warn patients that cough may temporarily increase during smoking cessation.

Vocal hygiene

In patients with chronic dry cough, vocal hygiene measures are aimed at reducing further laryngeal irritation (and upper airway hypersensitivity), which may be perpetuating the urge to cough. Strategies include:

- avoiding overuse of the voice
- avoiding smoky or polluted environments
- avoiding clearing the throat and minimising coughing (eg by taking sips of water with a hard swallow)
- having a family member draw attention to unwitting habitual coughing or throat-clearing
- referring to a cough clinic or speech pathologist for training in techniques to relieve glottal constriction during inspiration, and to recognise and alter the response to triggers.

Sputum clearance

For patients with a chronic productive cough, training in ‘Active Cycle of Breathing’ techniques can improve sputum clearance by moving secretions towards the mouth so they can be cleared. This can reduce irritation to the larynx (and upper airway hypersensitivity) caused by repetitive coughing.

Patient information about Active Cycle of Breathing for patients with chronic productive cough is available from the Bronchiectasis Toolbox website.

Chronic unexplained cough in adults

Chronic unexplained cough in adults

Chronic unexplained cough in adults is a chronic cough that has no identifiable cause (ie patient has normal physical examination, spirometry and chest X-ray) or is refractory to treatment of identifiable causes of cough. It is a diagnosis of exclusion.

Chronic unexplained cough occurs most commonly in older females.

Refer patients with chronic unexplained cough to a multidisciplinary cough clinic for assessment (or respiratory specialist if a clinic is not accessible). Speech therapy is recommended because it can improve cough severity.
Refer patients with chronic unexplained cough to a multidisciplinary cough clinic; speech therapy is recommended.

Neuromodulators such as gabapentin, pregabalin and amitriptyline may be effective in chronic unexplained cough, particularly in combination with speech therapy. These drugs should be used with advice from a cough clinic.

In the absence of elevated markers of eosinophilic inflammation (fractional exhaled nitric oxide [FeNO], blood or sputum eosinophils), inhaled corticosteroids are not recommended for chronic unexplained cough.

In the absence of gastro-oesophageal reflux symptoms (eg heartburn, regurgitation, night-time choking without symptoms of obstructive sleep apnoea, cough that is worse at night or after eating specific foods), proton pump inhibitors are not recommended for chronic unexplained cough.

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Key references: Overview of cough in adults

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Introduction to acute bronchiolitis

Introduction to acute bronchiolitis

Acute viral bronchiolitis is the most common lower respiratory tract infection in infants. It affects both the upper and lower airways. Respiratory syncytial virus is the most common associated virus, although other respiratory viruses such as rhinovirus, human metapneumovirus, parainfluenza and influenza may be involved.

The diagnosis of bronchiolitis is clinical and based on a typical history of rhinorrhoea and cough, with examination findings of tachypnoea, increased work of breathing, widespread inspiratory crackles or wheeze. Prevalence and severity peak in infants younger than 6 months. The diagnosis is usually limited to the first 12 months of life.

Symptoms are most severe around day 2 to 3 of the illness. Resolution occurs over 7 to 10 days; however, cough may persist for weeks.

Severity assessment of acute bronchiolitis

Severity assessment of acute bronchiolitis

Do not routinely undertake chest X-rays for the diagnosis of bronchiolitis in children.

Symptoms of **moderate to severe** acute bronchiolitis requiring admission to hospital are:

- difficulty feeding or reduced feeding (eg less than 50% of usual intake in previous 12 hours)
- moderate to severe work of breathing, including increased respiratory rate [Note 1]
- marked decrease in respiratory rate [Note 2]
- apnoeic episodes
- oxygen saturation measured by pulse oximetry (SpO_2) of 92% or less.

Consider early hospital admission (even if symptoms are mild) in infants with any of the following factors that increase the risk of rapid deterioration and requirement for escalated care:

- younger age (in particular children younger than 2 months)
- premature birth
- congenital heart disease
- chronic lung or neurological disease
- immunodeficiency
- Aboriginal or Torres Strait Islander ethnicity
- failure to thrive
- household exposure to tobacco smoke.

Note 1: Normal respiratory rates vary with a child’s age; see here

Note 2: Normal respiratory rates vary with a child's age; see here

Management of acute bronchiolitis

Management of acute bronchiolitis

A summary of the management of acute bronchiolitis is in Table 9.19.

Most children presenting to the general practitioner have **mild** acute bronchiolitis and can be managed in the community.

Table 9.19 Summary of management of acute bronchiolitis

Recommended

For all children with acute bronchiolitis:

- reassure carers
- educate carers about minimal handling
- provide carer information sheet [NB1]
- give small, frequent feeds.

For children with moderate to severe acute bronchiolitis, provide symptomatic care in hospital, including:

- supplemental oxygen, if required, to maintain SpO_2 92% or more
- nasogastric feeds or intravenous fluids if normal feeding is not possible [NB2].

For children with severe bronchiolitis, noninvasive ventilation (eg CPAP), high-flow nasal cannula therapy or invasive ventilation may be required.

Not recommended

Bronchodilators are not recommended (they do not reduce hospital length of stay or requirement for supplemental oxygen). However, a one-off trial may be considered in children hospitalised with severe bronchiolitis who are older than 10 months:

- if symptoms do not improve, do not continue therapy
- if symptoms improve (ie reduction in breathing effort, cough or wheeze), bronchodilator use may be continued with specialist input; dosage is lower than that used in asthma. If asthma is suspected, refer to a specialist.

Do not routinely give antibiotics; however, in very ill hospitalised children with bronchiolitis and suspected secondary bacterial infection, antibiotics may be indicated (see Community-acquired pneumonia in children).

Do not prescribe corticosteroids.

Do not prescribe nebulised hypertonic saline.

Do not prescribe adrenaline except in peri-arrest or arrest situation.

CPAP = continuous positive airway pressure; SpO_2 = oxygen saturation measured by pulse oximetry

NB1: A carer information sheet is available from The Royal Children's Hospital (Melbourne) website.

NB2: Nasogastric feeds may be preferred over intravenous fluids.

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Key references: Acute bronchiolitis

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Introduction to croup

Introduction to croup

Croup (acute laryngotracheobronchitis) presents with:

- an acute viral prodrome
- hoarseness (or husky voice in those old enough to speak)
- stridor (a respiratory noise produced by turbulent airflow through the upper airways)
- a harsh barking 'brassy' cough
- variable airway obstruction due to inflammatory oedema within the subglottis.

It usually occurs in children aged 6 months to 6 years and lasts for 2 to 5 days; however, a postinfective cough may persist for many weeks. Parainfluenza viruses are the most common cause of croup; antibiotics are not indicated. See the NPS MedicineWise website for information on rational antibiotic use in children with respiratory tract infections.

Spasmodic croup refers to typical croup symptoms that occur without the acute viral prodrome, usually presenting at night. It usually has a shorter course, is often recurrent, and occurs in older children. Affected children often have coexisting asthma. Treatment is the same as for croup.

Assessment of stridor and croup

Assessment of stridor and croup

Differential diagnosis of stridor

Differential diagnosis of stridor

Children with croup present with **acute stridor**; however, not all children with acute stridor have croup. Consider alternative diagnoses such as:

- infective causes—children with croup may have fever but do not have systemic signs of infection. If systemic signs of infection are present, consider causes such as bacterial tracheitis, acute epiglottitis, acute tonsillitis or pharyngitis (with or without peritonsillar abscess), or retropharyngeal abscess
- foreign body inhalation—should be suspected in children who present with acute stridor after a choking episode; urgently refer for specialist advice.

Refer infants with **chronic stridor**. Potential causes include:

- laryngomalacia—consider in a child with a chronic 'cog-wheel' high-pitched inspiratory stridor that has been present from the first few days or weeks of life; the stridor resolves spontaneously at 1 to 2 years of age
- subglottic haemangioma—consider in a child with inspiratory stridor that develops for the first time at 6 to 8 weeks of life, worsens and becomes biphasic (ie present on both inspiration and expiration).

Croup does not usually occur for the first time in children older than 6 years. In a child older than 6 years presenting with symptoms suggestive of croup, consider alternative diagnoses (eg tracheomalacia) if they do not have a history of croup.

Severity assessment of croup

Severity assessment of croup

The severity of croup can be categorised as:

- **mild**—no stridor at rest, mild chest wall retractions and normal respiratory rate
- **moderate**—stridor at rest, moderate chest wall retractions, use of accessory respiratory muscles, increased respiratory rate and tachycardia
- **severe**—persisting stridor at rest, increasing fatigue, markedly increased or decreased respiratory rate, markedly decreased air entry and marked tachycardia.

Important points in the early assessment of a child with suspected croup are:

- Loudness of stridor is not a good guide to the severity of obstruction.
- Avoid examination procedures that create anxiety (eg throat examination, physically separating the child from the parent or carer) because this exacerbates croup.
- Blood tests, oxygen therapy and nasopharyngeal aspirate are rarely indicated.

Restlessness, decreased level of consciousness, hypotonia, cyanosis and pallor are signs of life-threatening airway obstruction; arrange immediate transport to hospital for emergency-department treatment. Life-threatening croup requires immediate senior, intensive care or anaesthetics team involvement.

Restlessness, decreased level of consciousness, hypotonia, cyanosis and pallor are signs of life-threatening airway obstruction; arrange immediate transport to hospital.

The following children may be at risk of severe croup and require close observation:

- young children (eg aged less than 6 months)
- children with pre-existing narrowing of the upper airways (eg craniofacial abnormalities, Down syndrome)
- children with a history of previous severe croup
- children with a history of unplanned representation to hospital emergency department within 24 hours of first croup presentation.

Nondrug management of croup

Nondrug management of croup

Nondrug management of croup should include the following:

- minimising handling to avoid worsening of symptoms
- keeping the child with parents or carers to reduce distress—many children will become more settled if someone stays with them (especially during the night when croup becomes worse)
- keeping the child calm (eg sitting quietly, reading or watching TV)
- allowing the child to adopt a position of comfort that minimises airway obstruction
- reassuring and educating parents or carers on the cause, usual course and management of croup to relieve anxiety
- providing a carer information sheet; a fact sheet is available from The Royal Children's Hospital (Melbourne) website.

Inhalation of humidified air or steam is not recommended because there is no evidence of benefit and it can cause harm (eg scalds).

Management of mild to moderate croup

Management of mild to moderate croup

Mild to moderate croup (see Severity assessment of croup) can be treated in the community with a single dose of corticosteroid and nondrug management. The use of a single dose of corticosteroids in children with

mild to moderate croup reduces hospital admission rates and prevents repeat presentations.

For initial treatment of mild to moderate croup, use:

1 prednis(ol)one 1 mg/kg orally (up to 50 mg), as a single dose *croup, mild to moderate*

OR

2 dexamethasone 0.15 mg/kg orally (up to 12 mg), as a single dose [Note 1]. *croup, mild to moderate*

If oral steroids are not tolerated, consider:

budesonide 2 mg by inhalation via nebuliser; repeat every 12 hours for up to 48 hours, as required. *croup, mild to moderate*

Observe for at least 30 minutes after the dose of corticosteroid. If accessory muscle use, stridor at rest, or distress have not improved, treat as for severe croup.

If the child settles initially after treatment for mild to moderate croup, they can return home; advise parents or carers that if the child develops stridor at rest later the same day, they should go to hospital. Management as for severe croup is required.

Give paracetamol or ibuprofen if the child has pain and is irritable.

Cough suppressants such as codeine have no proven effect on the course or severity of croup, and can cause respiratory depression and increase sedation.
Antibiotics are not indicated for the management of uncomplicated croup.

Antibiotics are not indicated for the management of uncomplicated croup.

Note 1: Oral dexamethasone solution is only available in Australia as an extemporaneous preparation from hospital pharmacies.

Management of severe croup

Management of severe croup

For a child with severe croup (see Severity assessment of croup), arrange immediate transfer to hospital (if not already in hospital) because severe croup can rapidly progress to life-threatening croup.

For initial treatment of severe croup (in hospital or in the community while awaiting transfer to hospital) use:

adrenaline (epinephrine) 0.1% (1:1000, 1 mg/mL) solution 5 mL **by inhalation via nebuliser**, repeated after 30 minutes if no improvement [Note 2] [Note 3] *croup, severe*

PLUS ONE OF THE FOLLOWING

1 prednis(ol)one 2 mg/kg (up to 50 mg) orally, then 1 to 2 mg/kg (up to 50 mg) orally 24 hours later *croup, severe*

OR

1 dexamethasone 0.6 mg/kg (up to 12 mg) orally, as a single dose [Note 4] *croup, severe*

OR if the child is vomiting

1 dexamethasone 0.6 mg/kg (up to 12 mg) intramuscularly or intravenously, as a single dose.

Hydrocortisone should not be used because evidence of efficacy is lacking and it has a short duration of action.

Nondrug strategies should be used in the treatment of severe croup.

The decision to admit or discharge is made after initial assessment, treatment and observation. It should take into account the time of day, social circumstances, parents' or carers' comprehension and adherence, and access to rapid review.

Observe the child for at least 4 hours after giving initial treatment of severe croup.

If there is no stridor at rest, the child may be safe for discharge. Follow up all children who have had severe croup within 24 hours of discharge.

If there is no response (eg ongoing stridor at rest) or deterioration occurs, escalate to senior or intensive care team involvement, and arrange hospital admission. Differential diagnoses include bacterial tracheitis and conditions associated with airway obstruction or deep neck space infection (see here ...); antibiotics may be indicated.

More details on hospital management of croup is given in The Royal Children's Hospital (Melbourne) clinical practice guidelines.

Note 2: Notify the intensive care team if the child requires more than one dose of nebulised adrenaline (epinephrine) and arrange for hospital admission.

Note 3: The intravenous 1:1000 formulation of adrenaline (epinephrine) is used for the nebuliser.

Note 4: Oral dexamethasone solution is only available in Australia as an extemporaneous preparation from hospital pharmacies.

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Key references: Croup

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Overview of cystic fibrosis

Overview of cystic fibrosis

Cystic fibrosis (CF) is an inherited autosomal recessive condition, and is the most common cause of bronchiectasis and chronic suppurative lung disease in Caucasian children.

CF is a complex multisystem disease, which affects not only the lungs, gastrointestinal tract and pancreas, but also the liver, sinuses, sweat glands, kidneys, bones and reproductive system.

The CF gene codes for a protein known as the cystic fibrosis transmembrane conductance regulator (CFTR). CF gene mutations cause a variety of defects in CFTR production, location or function. Approximately 2000 mutations in the CF gene have been identified and these can be divided into several classes.

This topic is not a comprehensive CF management guide. All patients with CF in Australia are managed by, or in consultation with, a multidisciplinary specialist CF centre. This has been shown to improve clinical outcomes. Treatment protocols vary across different specialist CF centres. Changes in management should only be made after consultation with the specialist CF centre.

The Cystic Fibrosis Australia website has information brochures on CF for health professionals, patients, parents and carers.

Newborn screening and diagnosis of cystic fibrosis

Newborn screening and diagnosis of cystic fibrosis

All children born in Australia are screened for cystic fibrosis (CF) via the Newborn Screening Program, which involves measurement of immunoreactive trypsinogen (IRT) from a heel-prick blood sample taken on day 3 or 4 (or usually within 2 weeks) of life. If the blood sample trypsinogen level is above the 99th percentile, it is analysed for the most common CF gene mutations. Results are generally available when infants are approximately 6 to 8 weeks old. An infant with two CF gene mutations is referred directly to a specialist CF centre for confirmation of diagnosis with a sweat chloride test. An infant with only one gene mutation may have CF or may only be a carrier; a sweat chloride test is required.

The Newborn Screening Program may miss up to 5% of children affected with CF per year. Consider referral for a sweat chloride test in any child presenting with a chronic productive (wet or moist) cough, particularly if there is associated failure to thrive or frequent loose, oily bowel motions.

Occasionally, mild CF is not diagnosed until adulthood, either because the diagnosis was missed during screening, or because screening was not done at birth (the Newborn Screening Program was not introduced until around 1990 in some hospitals). Some people with atypical variants of CF have mild disease that does not become clinically significant until adulthood.

Prognosis in cystic fibrosis

Prognosis in cystic fibrosis

Cystic fibrosis (CF) was previously considered primarily a paediatric disease; however, most patients are now surviving to adulthood. The condition is now regarded as a life-limiting condition of adulthood. In 2017, around 50% of patients with CF in Australia were older than 18 years.

While there is still no cure for CF, improvements in respiratory and nutritional management continue to increase median survival. Based on data from the United States [Note 1], the median predicted survival for patients born between 2014 and 2018 is 44 years of age (ie half of people born with CF between 2014 and 2018 are expected to live beyond 44 years of age). This estimate assumes no further improvements in mortality rate from the current rates.

Note 1: Cystic Fibrosis Foundation Patient Registry. 2018 annual data report. Bethesda, MD: Cystic Fibrosis Foundation; 2019. [URL]

Principles of managing cystic fibrosis

Principles of managing cystic fibrosis

This topic is not a comprehensive guide to the management of cystic fibrosis (CF). All patients with CF in Australia are managed by, or in consultation with, a multidisciplinary specialist CF centre. This has been shown to improve clinical outcomes. Treatment protocols vary among different specialist CF centres. Changes in management should only be made after consultation with the specialist CF centre. If a patient with CF is admitted to hospital, contact the patient's specialist CF centre.

For patients with CF, inflammation and infection of the airways occur early in infancy, leading to structural changes of bronchiectasis that progress with age. Progressive lung disease is the major cause of morbidity and mortality in CF; aggressive management of lung disease is vital to limit progression.

The treatment modalities in CF include:

- effective airway clearance, using physical techniques and drug treatment (eg mucolytic agents)
- anti-inflammatory treatment
- drug treatment to correct cystic fibrosis transmembrane conductance regulator (CFTR) protein function in patients with particular mutations of the CF gene; see CFTR modulator therapy for CF
- early aggressive antibiotic therapy
- strict infection-control measures
- managing nonrespiratory aspects (eg nutrition, gastrointestinal aspects, cystic fibrosis–related diabetes, fertility, bone health, kidney disease, mental health).

Adherence to treatment is an important consideration in the management of CF; management can include complex, time-consuming and expensive treatment regimens. Keeping management as simple as possible, including minimising time-consuming treatments such as nebulised drugs, helps to reduce barriers to adherence. Involving the patient in treatment decisions, including in development of their management plan, can also improve adherence.

Exacerbations and declines in lung function can still occur despite good adherence to treatment; this can be discouraging to patients. Education about CF can prepare the patient for setbacks and encourage them to maintain adherence. Encourage the patient to ask questions about their disease and its management.

Asthma may coexist with CF. Asthma is difficult to diagnose in patients with CF because many of the respiratory symptoms and lung function test findings are similar. Treat asthma in a patient with CF as for any patient with asthma. See Asthma maintenance management in adults and adolescents and Asthma maintenance management in children.

The Cystic Fibrosis Australia website has information brochures on various CF treatments for health professionals, patients, parents and carers.

Airway clearance and exercise for cystic fibrosis

Airway clearance and exercise for cystic fibrosis

The aim of airway clearance for cystic fibrosis (CF) is to clear secretions from the bronchi; this relieves airway obstruction and prevents infection, which would otherwise lead to progressive lung injury.

Airway clearance methods include physical techniques and drug treatment.

An experienced respiratory physiotherapist with expertise in CF should develop an individualised airway clearance program for the patient. Airway clearance using forced expiration techniques is the most successful method of clearing bronchial secretions, and teaching this should be the basis of any airway clearance program for patients with CF. This is particularly relevant in young children.

Drug treatment for airway clearance can include inhaled bronchodilators and mucolytics.

Daily airway clearance is recommended for patients with CF. In general, airway clearance is performed once daily in those with mild lung disease when asymptomatic; airway clearance may be increased to twice daily (or more frequently as appropriate and if the patient is able) during an exacerbation.

An active lifestyle is encouraged; airway clearance combined with exercise results in a greater increase in lung function compared with airway clearance alone. Exercise should not replace an individualised airway clearance program in patients with CF.

For more information on different airway clearance techniques, see the Cystic Fibrosis Australia website. The Bronchiectasis Toolbox website also provides information and videos on airway clearance techniques.

Aerosolised mucolytics for cystic fibrosis

Aerosolised mucolytics for cystic fibrosis

Aerosolised mucolytics (eg dornase alfa, hypertonic saline, mannitol) may be prescribed by specialists for patients with cystic fibrosis (CF). These drugs are initiated in the specialist CF centre.

Bronchodilators are sometimes used as pretreatment before mucolytics to prevent bronchoconstriction and improve pulmonary deposition.

Dornase alfa is recombinant human DNase, which cleaves extracellular DNA and reduces sputum viscosity. Aerosolised dornase alfa facilitates sputum clearance, improves lung function and reduces exacerbations in patients with CF.

The initial phase of therapy consists of a 3-month trial. Use:

dornase alfa 2.5 mg by inhalation via nebuliser, once daily for 3 months. *cystic fibrosis*

Treatment can continue if there is no deterioration in forced expiratory volume in 1 second (FEV_1) during the trial, and if a clinical benefit is seen.

Nebulised hypertonic saline improves lung function and reduces acute infective exacerbations. A hypertonic saline challenge should be performed before it is prescribed because nebulised hypertonic saline may cause bronchospasm in susceptible patients.

Sodium chloride 6% solution is ideally used; sodium chloride 3% solution may be used in patients who do not tolerate the 6% solution.

Inhaled dry powder mannitol improves mucociliary clearance and lung function, and is used in patients with CF aged 6 years or older. Use:

mannitol 400 mg (ten 40 mg capsules) inhaled via dry powder inhaler, twice daily. *cystic fibrosis*

A Mannitol Tolerance Test should be performed before it is prescribed because inhaled mannitol may cause bronchospasm.

Anti-inflammatory treatment for cystic fibrosis

Anti-inflammatory treatment for cystic fibrosis

The host inflammatory response plays a role in lung injury in cystic fibrosis (CF); anti-inflammatory treatments have been shown to be beneficial.

The macrolide antibiotic azithromycin (usually given orally three times a week) is used in CF for its anti-inflammatory properties. Azithromycin can improve lung function, reduce the rate of exacerbations and achieve weight gain.

The best evidence for the anti-inflammatory effect of azithromycin is for CF with *Pseudomonas aeruginosa* infection, but it may also be beneficial for CF with other chronic bacterial infections such as *Staphylococcus aureus* and *Haemophilus influenzae*.

Do not routinely prescribe an inhaled or oral corticosteroid in a patient with CF unless the patient has another indication for a corticosteroid (eg inhaled corticosteroid for asthma, oral corticosteroid for allergic bronchopulmonary aspergillosis [ABPA]).

CFTR modulator therapy for cystic fibrosis

CFTR modulator therapy for cystic fibrosis

Cystic fibrosis transmembrane conductance regulator (CFTR) modulator therapy can be prescribed by specialists to improve CFTR protein function in patients with certain CF gene mutations. These drugs are mutation-specific. Multiple drugs can be used in combination to increase the effect.

At the time of writing, ivacaftor, lumacaftor+ivacaftor, and tezacaftor+ivacaftor drug formulations are available in Australia [Note 2]. Drugs targeting other gene mutations of the CFTR protein are in development.

Drug interactions with CFTR modulator therapy are common; check for drug interactions when starting new drugs in patients taking CFTR modulator therapy.

Note 2: For subsidised indications for ivacaftor, lumacaftor+ivacaftor, and tezacaftor+ivacaftor drug formulations, see the Pharmaceutical Benefits Scheme website.

Airway infection and antibiotic therapy in cystic fibrosis

Airway infection and antibiotic therapy in cystic fibrosis

Airway infection in cystic fibrosis

Airway infection in cystic fibrosis

Early cystic fibrosis (CF) lung disease is characterised by repeated episodes of endobronchial infection and inflammation. Bronchoalveolar lavage (BAL) studies have shown that lungs of patients with CF can become infected early in infancy.

Bacteria exhibit a biofilm mode of growth in the lungs of patients with CF, with large numbers of organisms surrounded by a layer of ‘slime’ consisting of complex proteins and polysaccharides. Established biofilms are resistant to antibiotic penetration; treatment aims to eradicate bacteria before formation of the biofilm.

Lung damage is caused by an influx of circulating blood neutrophils into the airway and release of neutrophil products, including elastolytic enzymes. Neutrophil-derived DNA is also released, increasing sputum viscosity and worsening airway obstruction.

The most common organisms found in airways of patients with CF are *Staphylococcus aureus*, *Haemophilus influenzae*, *Pseudomonas aeruginosa* and *Aspergillus* species.

S. aureus and *H. influenzae* are the most common organisms found in infants and young children with CF. *P. aeruginosa* becomes the dominant organism cultured from sputum during adolescence and adulthood; see Antibiotic therapy for P. aeruginosa infection for more information.

Other organisms that may be found in airways of patients with CF include *Burkholderia cepacia* complex, nontuberculous mycobacterium (eg *Mycobacterium abscessus*), methicillin-resistant *S. aureus* (MRSA), other Gram-negative organisms such as *Stenotrophomonas maltophilia, Achromobacter xylosoxidans* and fungi.

Patterns and trends in the epidemiology of lung bacteria have changed over the past decade; see the Australian Cystic Fibrosis Data Registry annual reports (available through the Cystic Fibrosis Australia website) for more information.

General information on antibiotic therapy for cystic fibrosis

General information on antibiotic therapy for cystic fibrosis

Antibiotic therapy in CF can be used for eradication of infection, to suppress chronic established infections, and to manage exacerbations.

Antibiotic therapy for lung disease in CF varies between different specialist CF centres, and is based on general principles and local experience because of a lack of evidence-based recommendations.

The dose of antibiotic therapy, including the dosing interval and duration, are different from those used for infections caused by the same pathogens in patients without CF. For all antibiotic therapy, the drug and dose must be directed by the patient's CF management plan or decided in consultation with the specialist CF centre.

Choice of drug and dose of antibiotic therapy must be directed by the patient's CF management plan or decided in consultation with the specialist CF centre.

The choice of drug may be determined by the infecting organism and its antibiotic susceptibility. Patients are often given the antibiotic used to successfully treat the pathogen cultured in the previous sputum sample while waiting for results of susceptibility testing of a current sputum sample. If the patient is clinically responding to the initial antibiotic, treatment is continued, even if the results of the current sputum sample suggest that the infection is not susceptible.

In young patients with CF, the pathogen may be unknown because many patients are not able to produce a sputum sample until the age of 6 to 7 years. Some centres in Australia use bronchoalveolar lavage (BAL) to obtain bronchial secretions in young children. The use of throat swab cultures in infants with CF is not ideal.

Most specialist CF centres obtain respiratory cultures four times a year, as well as during respiratory exacerbations. Antibiotic therapy for the eradication treatment is determined by the specialist CF centre.

Antibiotic therapy for Pseudomonas aeruginosa infection

Antibiotic therapy for Pseudomonas aeruginosa infection

There is some evidence that early intensive antibiotic treatment of initial *Pseudomonas aeruginosa* strains leads to eradication of infection. This treatment is offered by specialist CF centres to all affected patients.

There is no current evidence to suggest the best treatment protocol for *P. aeruginosa* eradication; several different protocols have been shown to be helpful. Oral and nebulised antibiotics for *P. aeruginosa* eradication need to be given for 2 to 3 months. Short courses of intravenous antibiotics can also be used.

Repeated eradication treatment can be considered for repeat infections.

Once chronic *P. aeruginosa* infection is established, antibiotic treatment aims to suppress infection and reduce morbidity. At the time of writing, there is little evidence to support one particular choice of treatment,

and antibiotic regimens vary. Many patients with chronic *P. aeruginosa* infection are managed with long-term inhaled antibiotics.

There is good evidence that patients with chronic *P. aeruginosa* infection show clinical improvement following treatment with the macrolide antibiotic azithromycin. The benefit is due to azithromycin's anti-inflammatory effect, rather than its antibiotic properties; see Anti-inflammatory treatment for cystic fibrosis for further information.

Infection control in cystic fibrosis

Infection control in cystic fibrosis

Some respiratory pathogens are highly transmissible. Strict infection-control measures are needed to prevent patients with CF being infected with respiratory pathogens, and also to prevent patients with CF from spreading infection to other patients with CF.

Infection-control information for patients with CF, their parents or carers, and health professionals can be found on the Cystic Fibrosis Australia website.

Everyday lifestyle changes to reduce the risk of acquiring and spreading an infection include:

- good hand hygiene after coughing, sneezing, touching the mouth or nose, and before eating
    - washing hands thoroughly with soap and water, or using alcohol-based hand sanitiser
    - drying hands with paper towel or clean towel
- sneezing or coughing into elbow, and disposing used tissues immediately
- avoiding people who are sick, and avoiding other people with CF when sick
- avoiding close or prolonged contact with other people with CF (maintain distance of at least 4 metres)
- avoiding sharing personal items (eg utensils, toothbrushes, soap bars, toys, pens, computers, gym equipment)
- avoiding high-risk environments (eg those with stagnant water mould or damp soil)
- maintaining current vaccination (eg annual influenza vaccination).

Initial infecting strains of *P. aeruginosa* are thought to be acquired from the environment. All specialist CF centres in Australia separate patients with chronic *P. aeruginosa* infection from patients without chronic infection, both in outpatient clinics and during hospitalisation. Some *P. aeruginosa* strains in Australia are highly transmissible, both to other patients with CF and to patients with bronchiectasis; separation of these patients should be considered.

Cross-infection has also been shown to occur for certain strains (or genomovars) of *B. cepacia*. Single rooms are provided during hospitalisations to separate all patients with CF who have *B. cepacia* complex infection from all other patients with CF, including other patients with *B. cepacia*.

Methicillin-resistant *S. aureus* (MRSA) and *Mycobacterium abscessus* are highly transmissible and patients with CF in whom these organisms have been isolated should also be included in cross-infection precautions.

Exacerbations of cystic fibrosis lung disease

Exacerbations of cystic fibrosis lung disease

Respiratory symptoms such as cough and increased sputum are the most common presenting features of a cystic fibrosis (CF) exacerbation. Abnormal respiratory signs (eg tachypnoea, increased work of breathing, crackles, wheeze) may be present. Nonrespiratory signs and symptoms include loss of appetite, weight and energy; occasionally, an exacerbation presents with only nonrespiratory features.

Pulmonary function may be reduced and new infiltrates may be present on the chest X-ray.

Approximately 10% of patients with CF have coexisting allergic bronchopulmonary aspergillosis (ABPA). Differentiating between ABPA and a CF exacerbation can be difficult; see ABPA for more information.

Respiratory infection should be treated promptly at the onset of signs or symptoms, even if chest examination is normal.

Management of exacerbations is usually directed by the patient's CF management plan and undertaken in consultation with a specialist CF centre.

Respiratory infection should be treated promptly at the onset of signs or symptoms, even if chest examination is normal. If symptoms are relatively mild, treatment may begin with a course of oral antibiotics. If there is no improvement after 2 to 4 weeks, a course of intravenous antibiotic treatment is given. Inhaled antibiotics may sometimes be used either as an adjunct to oral or intravenous antibiotics, or alone.

Severe advanced lung disease in cystic fibrosis

Severe advanced lung disease in cystic fibrosis

Severe advanced lung disease in cystic fibrosis (CF) occurs when progressive lung injury leads to a reduction in forced expiratory volume in 1 second (FEV_1) below 30%. This is often associated with marked exertional dyspnoea and hypoxaemia at rest, with frequent cough and copious sputum production.

Patients with severe advanced lung disease in CF are closely managed by their specialist CF centre. Therapeutic options include supplemental oxygen, noninvasive ventilation and lung transplantation.

Nonrespiratory aspects of cystic fibrosis

Nonrespiratory aspects of cystic fibrosis

Cystic fibrosis (CF) is a complex multisystem disease. In addition to the lungs, it affects the gastrointestinal tract, pancreas, liver, sinuses, sweat glands, kidneys, bones and reproductive system. Nonrespiratory aspects of the management of CF include management of nutrition, gastrointestinal health, cystic fibrosis–related diabetes (CFRD), sexual and reproductive health, bone health, kidney disease and mental health. See Table 9.20 for detail about each of these aspects of management.

Table 9.20 Summary of nonrespiratory aspects of cystic fibrosis management

[NB1]

Nutrition
Gastrointestinal health
Cystic fibrosis–related diabetes (CFRD)
Sexual and reproductive health
Bone health
Kidney disease
Hearing
Mental health

Nutrition [NB2]

Good nutrition is associated with better growth rates and respiratory outcomes.

Weight, weight percentile and BMI are used as an indication of nutritional adequacy.

Most patients with CF have pancreatic exocrine insufficiency, requiring pancreatic enzyme replacement therapy (PERT).

To maintain nutritional status, patients with CF may also require:

- specialist dietary advice
- 110 to 200% of the daily energy requirements of the general population
- supplementation with fat soluble vitamins (A, D, E and K) and salt
- other nutritional supplements or enteral feeding, if the above are insufficient
- CFTR modulator therapy to improve gastrointestinal function.

Gastrointestinal health

Gastrointestinal health in patients with CF is best managed by a multidisciplinary team (including dieticians and gastroenterologists with experience in CF) at a specialist CF centre.

Consider the following in patients with CF:

- general bowel problems (eg abdominal bloating and pain, diarrhoea, constipation, bowel obstruction) are common
- the risk of bowel cancer is increased; screening with colonoscopy usually begins at 40 years of age, with ongoing frequency determined by initial results
- distal intestinal obstruction syndrome (meconium ileus in infants) can occur, caused by impacted viscid faecal material in the small bowel; this requires urgent discussion with the specialist CF centre
- mild increases in liver enzymes (particularly alkaline phosphatase) are common, but advanced liver disease is uncommon
- cholelithiasis can occur; ursodeoxycholic acid can be used to rebalance the constituents of the bile salts
- infrequently, and mainly in children, biliary fibrosis results in biliary cirrhosis, portal hypertension, gastro-oesophageal varices, splenomegaly, ascites, hepatopulmonary syndrome, portopulmonary hypertension and hepatic encephalopathy; specialist treatment is required.

Cystic fibrosis–related diabetes (CFRD)

Occurrence of CFRD increases with age, affecting approximately 10% of adolescents and over 40% of adults older than 40 years.

Diagnosis and management of CFRD differs from Type I and Type 2 diabetes as follows:

- classic symptoms of hyperglycaemia (eg polyuria and polydipsia) are uncommon at diagnosis; patients may present only with an unexplained loss of lung function or weight
- glycated haemoglobin (HbA1c) is used to monitor patients with CFRD, but is not a sensitive screening tool to detect CFRD; screening with an annual oral glucose tolerance test is recommended
- insulin is usually the first-line therapy, rather than oral antihyperglycaemic drugs
- a high-calorie diet (including fats and carbohydrates), with maintenance of blood glucose control using insulin, is encouraged (as opposed to the dietary restrictions recommended for patients with Type 1 and Type 2 diabetes).

Good control of CFRD is essential to maintaining kidney health.

Diabetic ketoacidosis is well described but rare.

Sexual and reproductive health

Discussions about sexual and reproductive health are as important for patients with CF as for any other person.

Give adolescents the opportunity to be seen without their parents or carers present.

Delayed puberty is more common in patients with CF; referral to an endocrinologist may be required.

For males with CF, sexual and reproductive considerations include:

- 98% of males with CF have azoospermia
- recovery of sperm from the testis to allow assisted reproduction is often possible.

For females with CF, sexual and reproductive considerations include:

- most females with CF are fertile, and around 85% are able to conceive naturally
- standard advice about contraception, including the oral contraceptive pill, applies
- management of pregnancy requires multidisciplinary specialist involvement; collaboration between the obstetric service and the specialist CF centre is essential
- pregnancy is not typically associated with a worsening of respiratory status
- the risk of premature birth is increased
- *in vitro* fertilisation can be considered, and allows implantation of a fertilised ovum that is not homozygous for CF.

Bone health

Patients with CF have an increased risk of osteoporosis and osteopenia.

Multiple factors can contribute to low BMD, including less accrual of bone mass during childhood and adolescence.

BMD screening every 1 to 2 years (arranged by the specialist CF centre) usually begins around the age of puberty.

In addition to standard treatment of low BMD (eg nutrition, exercise, vitamin D and calcium supplementation, bisphosphonates), management of bone health in patients with CF may also include:

- limiting progression of chronic suppurative lung disease
- vitamin K supplementation
- recognising and treating delayed puberty.

Kidney disease

The incidence of kidney dysfunction in patients with CF increases with age; the incidence is increasing with the increase in life expectancy of patients with CF.

Estimated creatinine clearance rate is not a sensitive test of kidney function in patients with CF.

Causes of kidney dysfunction in CF include antibiotics (particularly aminoglycosides and vancomycin), CFRD, renal calculi, and calcineurin drugs (used after lung transplant); less common causes include amyloid nephropathy, drug-related interstitial nephritis and renal tubular necrosis.

Strategies to reduce exposure of the kidneys to nephrotoxic antibiotics include using inhaled rather than oral antibiotics, and close monitoring of intravenous antibiotics to avoid toxic concentrations.

Good control of CFRD is essential to maintaining kidney health.

Hearing

Patients with CF exposed to repeated doses of aminoglycosides are at a higher risk of hearing loss; monitoring for hearing loss is required.

Mental health [NB3]

CF is associated with an increased incidence of anxiety and depression in both patients, and parents or carers.

Be alert to signs and symptoms of anxiety and depression in patients with CF and their parents or carers; see Anxiety and Depression for more information.

Treatment is usually guided by the multidisciplinary specialist CF centre, which includes mental health professionals.

BMI = body mass index; BMD = bone mineral density; CF = cystic fibrosis; CFRD = cystic fibrosis–related diabetes; CFTR = cystic fibrosis transmembrane conductance regulator; HbA1c = glycated haemoglobin; PERT = pancreatic enzyme replacement therapy

NB1: Information brochures on nonrespiratory aspects for patients with CF, parents or carers and health professionals can be found on the Cystic Fibrosis Australia website

NB2: Specific information on nutrition in patients with CF can be found in the Nutrition Guidelines for Cystic Fibrosis in Australia and New Zealand, available on the Thoracic Society of Australia and New Zealand website

NB3: Information and resources on mental health for patients with CF, parents or carers and health professionals can be found on the Cystic Fibrosis Australia website

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Key references: Nonrespiratory aspects of cystic fibrosis

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Introduction to maintenance management of asthma in adults and adolescents

Introduction to maintenance management of asthma in adults and adolescents

The aim of management of asthma in adults and adolescents is to maintain a normal quality of life, free of asthma symptoms and exacerbations, and without adverse effects of asthma treatment.

Drug treatment for asthma in adults and adolescents is introduced in a stepwise manner as outlined in Figure 9.2, and managed with a cycle of assessment and adjustment of therapy. Before starting drug therapy for asthma, confirm the diagnosis (for information on diagnosis, see here).

In addition to drug treatment, optimised management of asthma should include:

- management of comorbid conditions that can affect asthma control
- avoidance of triggers and minimisation of risk factors
- a healthy lifestyle (including a good diet and regular exercise)
- a partnership between the patient and healthcare professional(s), including education and skills training for asthma self-management, including a written asthma action plan
- ongoing review.

For older adolescents (14 to 16 years old), the recommendations for managing asthma in adults described in this topic usually apply. For younger adolescents, the recommendations for managing asthma in children usually apply. See also Asthma in adolescents for information specific to adolescents.

Summary of stepwise maintenance management of asthma in adults and adolescents

Summary of stepwise maintenance management of asthma in adults and adolescents

Overview

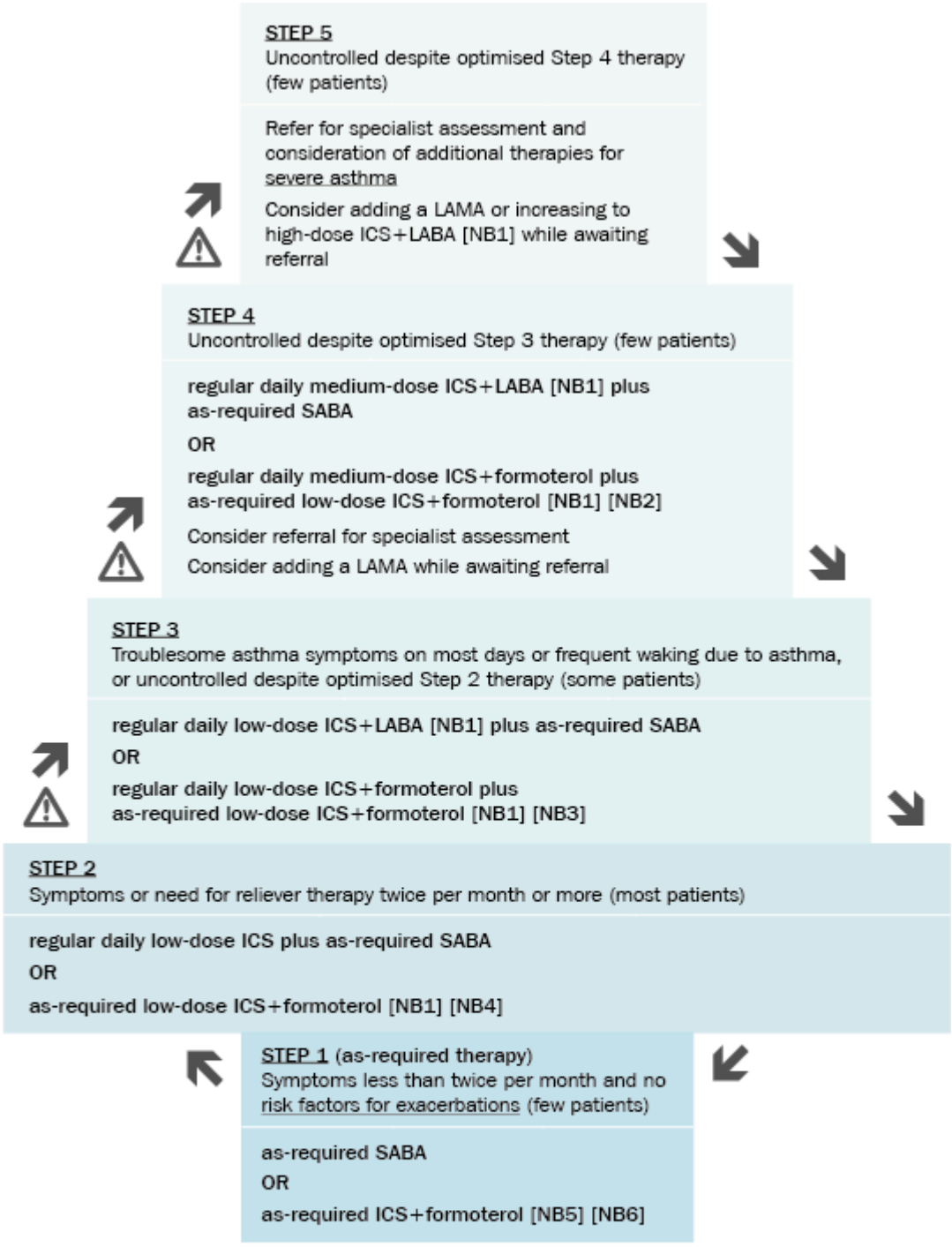
Overview

Drug treatment for asthma in adults and adolescents is introduced in a stepwise manner, as shown in Figure 9.2. For details about each step, including drug dosages, see the relevant sections—Step 1, Step 2, Step 3, Step 4 and Step 5.

Patients presenting with severe uncontrolled asthma may need a short course of oral corticosteroids, or to start therapy at a higher step (eg with medium- or high-dose inhaled corticosteroid [ICS] plus long-acting beta$_2$ agonist [LABA]), but this is not common. See also Acute asthma for advice about treating acute presentations.

Patients who remain uncontrolled despite optimised therapy (including management of comorbidities and other contributing factors), are considered to have severe asthma. Specialist assessment (eg phenotypic assessment) and treatment may be required—see Severe asthma in adults and adolescents: specialist management.

Figure 9.2 Stepped approach to starting and adjusting asthma therapy in adults and adolescents



⚠	Before considering stepping up therapy, review adherence and inhaler technique, check equipment (eg inhaler, spacer, mask) for breakage or blockage, assess for an alternative diagnosis or a comorbidity (eg rhinitis), and ensure exposure to triggers is minimised.
↗	Consider stepping up therapy if good control is not achieved despite good adherence and correct inhaler technique; see Assessing asthma symptom control for more information.
↘	If asthma has been stable and well controlled for 2 to 3 months, consider stepping down therapy; see Stepping down therapy for more information.

ICS = inhaled corticosteroid; LABA = long-acting beta$_2$ agonist; LAMA = long-acting muscarinic antagonist; SABA = short-acting beta$_2$ agonist

NB1: Always give ICS+LABA therapy as a combination inhaler to avoid the possibility of patients taking a LABA without an ICS; LABA monotherapy increases the risk of exacerbations and asthma-related death.

NB2: At the time of writing, the only combination product approved for use as Step 4 medium-dose maintenance and reliever therapy is budesonide+formoterol. Beclometasone+formoterol can only be used as

maintenance and reliever therapy for Step 3 low-dose therapy; it is not approved for Step 4 medium-dose maintenance and reliever therapy.

NB3: At the time of writing, the only combination products approved for use as Step 3 low-dose maintenance and reliever therapy are beclometasone+formoterol and budesonide+formoterol. Beclometasone+formoterol can only be used as maintenance and reliever therapy for Step 3 low-dose therapy; it is not approved for Step 4 medium-dose maintenance and reliever therapy.

NB4: At the time of writing, the only combination product approved for use as Step 2 as-required therapy is budesonide+formoterol.

NB5: No clinical trials have evaluated the effects of as-required budesonide+formoterol versus as-required SABA in patients with asthma symptoms less than twice per month and no waking due to asthma, and without risk factors for exacerbations (eg flare ups that required oral corticosteroids in the previous 12 months).

NB6: At the time of writing, the only combination product approved for use as Step 1 as-required therapy is budesonide+formoterol.

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Stepped adjustment of asthma therapy

Stepped adjustment of asthma therapy
Principles of stepped adjustment

The aim of stepped adjustment of asthma therapy is to establish the lowest dose of therapy that maintains asthma symptom control and prevents exacerbations. Most adults and adolescents with asthma have mild asthma that can be well controlled by Step 2 therapy; overtreatment with ICS+LABA combination therapy (Step 3 therapy) is common.

Most adults and adolescents with asthma have mild asthma that can be well controlled with Step 2 therapy.

Assess asthma symptom control 1 to 3 months after starting or adjusting asthma therapy to determine whether therapy needs to be stepped up or down. Different clinical features of asthma respond to ICS therapy at different rates; waking due to asthma can improve after a week of ICS therapy, while lung function can take months to improve.

Before stepping therapy up or down, check what regimen the patient is using—it may not be the same as the regimen prescribed.

Update the patient's written asthma action plan whenever treatment is changed.

Stepping up therapy

Stepping up asthma therapy can be considered if asthma symptom control remains partial or poor. Before stepping up therapy:

- confirm that symptoms are due to asthma
- assess inhaler technique
- assess adherence
- identify and manage any comorbid conditions that may be reducing asthma symptom control
- ensure that exposure to triggers is minimised.

Stepping down therapy

Stepping down asthma therapy can be considered if asthma is stable and well controlled for 2 to 3 months (see Assessing asthma symptom control). Assess the patient's risk factors for exacerbations (see Table 9.6)

and manage or minimise any modifiable risk factors. Avoid stepping down therapy when the patient has an acute respiratory infection, or when the patient's access to medical services is likely to be limited (eg while travelling).

To step down therapy:

- For a patient taking a medium- or high-dose ICS (either as monotherapy or in combination with a LABA), reduce ICS dose by 25 to 50% every 2 to 3 months—consider the practicality of dose adjustments with the inhaled formulation prescribed (see Table 9.3 for formulation details of inhalers).
- For a patient taking a low-dose ICS+LABA combination, step down to ICS monotherapy.
- For a patient taking regular budesonide+formoterol, step down to as-required budesonide+formoterol —this is associated with fewer exacerbations and better asthma control than using as-required SABA alone.

Stopping ICS preventer therapy in adults with asthma is associated with a significant risk of an asthma exacerbation. However, for patients who remain well controlled on minimum therapy (eg low-dose ICS), a closely monitored withdrawal of therapy can be trialled. Consider the strength of evidence for the original asthma diagnosis (eg variable airflow obstruction demonstrated on spirometry, compared with a symptom-based diagnosis). In two studies of patients diagnosed with asthma, one-third of patients had no evidence of variable airflow obstruction up to 12 months after withdrawing ICS therapy, even with bronchial provocation challenge [Note 1] [Note 2]; this was more likely if spirometry had not been performed at the time of diagnosis. See Asthma diagnosis for information about how to correctly diagnose asthma in adults, adolescents and children older than 6 years.

Advise patients to step up therapy if asthma control deteriorates after stepping down therapy.

If considering withdrawal of preventer therapy, discuss the risks with the patient and ensure they still have ready access to reliever therapy (either SABA or low-dose budesonide+formoterol). Following any step down in therapy, advise patients to step therapy back up asthma control deteriorates—this should be documented on their written asthma action plan.

Note 1: Aaron SD, Vandemheen KL, Boulet LP, McIvor RA, Fitzgerald JM, Hernandez P, et al. Overdiagnosis of asthma in obese and nonobese adults. CMAJ 2008;179(11):1121-31. [URL]

Note 2: Aaron SD, Vandemheen KL, FitzGerald JM, Ainslie M, Gupta S, Lemiere C, et al. Reevaluation of Diagnosis in Adults With Physician-Diagnosed Asthma. JAMA 2017;317(3):269-79. [URL]

Choice of reliever therapy

Choice of reliever therapy

All patients with asthma should carry a reliever containing a rapid-onset inhaled $beta_2$ agonist—either a short-acting $beta_2$ agonist (SABA) (salbutamol or terbutaline), or a long-acting $beta_2$ agonist (LABA) (formoterol) formulated in combination with low-dose inhaled corticosteroid (ICS) (budesonide, beclometasone).

SABA (salbutamol, terbutaline) should only be used on an as-required basis for acute asthma symptoms (eg wheezing). While SABA is effective at reducing acute symptoms, frequent use or use as monotherapy is associated with poor asthma outcomes, even if asthma appears well controlled. Use of three or more canisters of salbutamol per year is associated with increased risk of exacerbation, and use of more than 12 canisters per year is associated with increased risk of asthma-related death. Frequent use can also cause beta-receptor downregulation, rebound hyperresponsiveness and reduced bronchodilator response.

Low-dose budesonide+formoterol and low-dose beclometasone+formoterol can be used as 'maintenance and reliever therapy' (see Step 3 for information about maintenance and reliever therapy). Low-dose budesonide+formoterol can also be used on an as-required basis; a large randomised controlled trial showed

that it was more effective than as-required SABA in improving asthma symptom control in mild asthma [Note 3].

Increased requirement for reliever medication (either SABA or low-dose ICS+formoterol) indicates worsening asthma control (see Assessment of asthma control in adults and adolescents); consider whether a step up in preventer therapy is required. All patients should have a written asthma action plan that details multiple steps the patient can follow in response to asthma symptoms.

Note 3: O'Byrne PM, FitzGerald JM, Bateman ED, Barnes PJ, Zhong N, Keen C, et al. Inhaled Combined Budesonide-Formoterol as Needed in Mild Asthma. N Engl J Med 2018;378(20):1865-76 [URL]

Step 1 as-required therapy for asthma in adults and adolescents

Step 1 as-required therapy for asthma in adults and adolescents

Step 1 as-required therapy is indicated for patients with symptoms less than twice per month and without risk factors for exacerbations—few patients with asthma can be managed with Step 1 therapy.

Step 1 therapy consists of one of the following:

- as-required short-acting $beta_2$ agonist (SABA)
- as-required low-dose budesonide+formoterol.

For Step 1 as-required therapy, use:

1 budesonide+formoterol 200+6 micrograms by inhalation via pMDI with spacer or via DPI, as required (see Table 9.3 for regimen expressed as number of inhalations) *asthma, Step 1 as-required therapy (adult, adolescent)*

OR

1 salbutamol 200 micrograms by inhalation via pMDI with spacer, as required (see Table 9.4 for formulations) *asthma, Step 1 therapy (adult, adolescent)*

OR

2 terbutaline 500 micrograms by inhalation via DPI, as required (see Table 9.4 for formulations). *asthma, Step 1 therapy (adult, adolescent)*

There is no direct evidence from clinical trials to support as-required low-dose budesonide+formoterol in patients with symptoms less than twice per month and no waking due to asthma, and without risk factors for exacerbations (eg flare ups that required oral corticosteroids in the previous 12 months). However, the use of as-required budesonide+formoterol has a low risk of harm and may reduce the occurrence of acute severe asthma exacerbations, which can still occur in these patients. At the time of writing, other combination products (eg beclometasone+formoterol) are not approved by the Australian Therapeutic Goods Administration (TGA) for use as Step 1 as-required therapy.

SABA therapy effectively reduces acute symptoms. The requirement for SABA on two or more days per month is an indication that the patient requires Step 2 therapy. Frequent use or use as monotherapy is associated with poor asthma outcomes, even if asthma appears well controlled. See Choice of reliever therapy for information about the effects of over-reliance on SABA.

Step 2 therapy for asthma in adults and adolescents

Step 2 therapy for asthma in adults and adolescents

Standard Step 2 therapy

Standard Step 2 therapy

Step 2 therapy is indicated for patients with symptoms or need for reliever therapy twice per month or more. Also consider Step 2 therapy for patients with less frequent symptoms but with risk factors for poor outcomes (see Table 9.6).

Step 2 therapy consists of one of the following:

- regular daily low-dose inhaled corticosteroid (ICS) (plus as-required short-acting $beta_2$ agonist [SABA])
- as-required low-dose budesonide+formoterol.

Two large randomised controlled trials showed that as-required budesonide+formoterol is as effective as regular daily low-dose ICS therapy for reducing exacerbations in mild asthma, and exposes the patient to a lower total dose of ICS. However, it was less effective than regular daily low-dose ICS at improving asthma symptom control and lung function [Note 4] [Note 5]. At the time of writing, other combination products (eg beclometasone+formoterol) are not approved by the Australian Therapeutic Goods Administration (TGA) for use as Step 2 as-required therapy.

For Step 2 therapy with as-required low-dose budesonide+formoterol, use:

budesonide+formoterol 200+6 micrograms by inhalation via pMDI with spacer or via DPI, as required (see Table 9.3 for regimen expressed as number of inhalations) *asthma, Step 2 as-required therapy (adult, adolescent)*

For Step 2 therapy with regular daily low-dose ICS with SABA reliever therapy, use:

a SABA as required (see Step 1 for dosage)

PLUS ONE OF THE FOLLOWING

1 beclometasone 50 or 100 micrograms by inhalation via pMDI with spacer, twice daily (see Table 9.3 for regimen expressed as number of inhalations) *asthma, Step 2 therapy (adult, adolescent)*

OR

1 budesonide 100 or 200 micrograms by inhalation via DPI, twice daily (see Table 9.3 for regimen expressed as number of inhalations) *asthma, Step 2 therapy (adult, adolescent)*

OR

1 ciclesonide 80 or 160 micrograms by inhalation via pMDI with spacer, once daily (see Table 9.3 for regimen expressed as number of inhalations) *asthma, Step 2 therapy (adult, adolescent)*

OR

1 fluticasone propionate 50 or 100 micrograms by inhalation via pMDI with spacer or via DPI, twice daily (see Table 9.3 for regimen expressed as number of inhalations). *asthma, Step 2 therapy (adult, adolescent)*

Note 4: Bateman ED, Reddel HK, O'Byrne PM, Barnes PJ, Zhong N, Keen C, et al. As-Needed Budesonide-Formoterol versus Maintenance Budesonide in Mild Asthma. N Engl J Med 2018;378(20):1877-87. [URL]

Note 5: O'Byrne PM, FitzGerald JM, Bateman ED, Barnes PJ, Zhong N, Keen C, et al. Inhaled Combined Budesonide-Formoterol as Needed in Mild Asthma. N Engl J Med 2018;378(20):1865-76 [URL]

Other options for Step 2 therapy

Other options for Step 2 therapy

An alternative option for Step 2 therapy is to take a low dose of an ICS (using the doses above) whenever a dose of SABA is required, following a similar principle to using as-required low-dose budesonide+formoterol.

Montelukast can be considered instead of an ICS-based treatment, although it is less effective than regular daily low-dose ICS for controlling asthma symptoms and reducing exacerbation risk. It can be trialled in patients who have experienced adverse effects with ICS, or who remain unwilling to use steroid-based therapy after an informed discussion with their clinician. It may also be useful in patients with coexisting allergic rhinitis, or in whom inhaled therapy is not practical. Use:

montelukast 10 mg orally, once daily [Note 6]. *asthma, Step 2 therapy (adult, adolescent)*

Note 6: Montelukast has been associated with neuropsychiatric adverse effects, including nightmares, sleep disturbance, agitation, depression and, rarely, suicidal thinking and behaviour. Counsel patients and carers about these effects. They usually occur in the first 2 weeks of treatment. Stop treatment if these effects occur—the effects usually subside within a few days of stopping treatment. See the Australian Therapeutic Goods Administration (TGA) website for more information.

Assessing patient response to Step 2 therapy

Assessing patient response to Step 2 therapy

Assess symptom control 4 to 8 weeks after starting Step 2 therapy. See Assessment of asthma control in adults and adolescents for classification of good, partial and poor control.

If the patient's symptoms are well controlled with Step 2 therapy, continue treatment and review again after 3 months.

If the patient has partial or poor control on Step 2 therapy, review adherence and inhaler technique, and check equipment (drug device, spacer) for breakage or blockage. Before escalating to Step 3 therapy, also assess for comorbidities (eg rhinitis) that could reduce asthma control, and ensure exposure to triggers is minimised. Most patients with asthma can achieve good control with Step 2 therapy.

If the patient is taking montelukast and has partial or poor control, switch therapy to regular daily low-dose ICS or as-required low-dose budesonide+formoterol, if possible, rather than escalating to Step 3 therapy.

Every asthma assessment should include a review of treatment adherence and inhaler technique.

Step 3 therapy for asthma in adults and adolescents

Step 3 therapy for asthma in adults and adolescents

Standard Step 3 therapy

Standard Step 3 therapy

Step 3 therapy is indicated for patients who remain uncontrolled on optimised Step 2 therapy. Step 3 therapy could also be considered as initial therapy for patients with troublesome asthma symptoms occurring on most days, or with frequent waking due to asthma (particularly if the patient has risk factors for adverse asthma outcomes).

Step 3 therapy consists of regular daily low-dose inhaled corticosteroid plus long-acting beta$_2$ agonist (ICS+LABA) therapy, plus an as-required reliever.

Always give ICS+LABA therapy as a combination inhaler to avoid the possibility of a patient taking a LABA without an ICS—LABA monotherapy increases the risk of exacerbations and asthma-related death. Using separate inhalers risks the patient stopping the ICS because of a perceived lack of benefit compared with the LABA (which provides quick relief of symptoms).
Always give ICS+LABA as a combination inhaler—LABA monotherapy increases the risk of exacerbations and asthma-related death.

Patients taking ICS+formoterol maintenance therapy with either budesonide+formoterol or beclometasone+formoterol can use the same inhaler for reliever therapy (ICS+formoterol 'maintenance and reliever therapy'). ICS+formoterol maintenance and reliever therapy is associated with a lower risk of exacerbations than ICS+LABA maintenance plus SABA reliever therapy.

For Step 3 therapy with low-dose ICS+formoterol maintenance and reliever therapy, use:

1 beclometasone+formoterol 100+6 micrograms by inhalation via pMDI with spacer, twice daily [Note 7] [Note 8] *asthma, Step 3 maintenance and reliever therapy (adult, adolescent)*

PLUS

beclometasone+formoterol 100+6 micrograms by inhalation via pMDI with spacer, as required, up to a maximum total daily dose (including maintenance doses) of 800+48 micrograms daily (see Table 9.3 for regimen expressed as number of inhalations) [Note 7] [Note 8]

OR

1 budesonide+formoterol 100+6 or 200+6 micrograms by inhalation via pMDI with spacer or via DPI, twice daily *asthma, Step 3 maintenance and reliever therapy (adult, adolescent)*

PLUS

budesonide+formoterol 100+6 or 200+6 micrograms by inhalation via pMDI with spacer or via DPI, as required, up to a maximum total daily dose (including maintenance doses) of 2400+72 micrograms daily (see Table 9.3 for regimen expressed as number of inhalations).

For Step 3 therapy with regular daily low-dose ICS+LABA combination with SABA reliever therapy, use:

a SABA as required (see Step 1 for dosage)

PLUS ONE OF THE FOLLOWING

1 beclometasone+formoterol 100+6 micrograms by inhalation via pMDI with spacer, twice daily (see Table 9.3 for regimen expressed as number of inhalations) [Note 8] *asthma, Step 3 maintenance therapy (adult, adolescent)*

OR

1 budesonide+formoterol 100+6 or 200+6 micrograms by inhalation via pMDI with spacer or via DPI, twice daily (see Table 9.3 for regimen expressed as number of inhalations) *asthma, Step 3 maintenance therapy (adult, adolescent)*

OR

1 fluticasone propionate+formoterol 100+10 micrograms by inhalation via pMDI with spacer, twice daily (see Table 9.3 for regimen expressed as number of inhalations) *asthma, Step 3 therapy (adult, adolescent)*

OR

1 fluticasone propionate+salmeterol 100+50 micrograms by inhalation via pMDI with spacer or via DPI, twice daily (see Table 9.3 for regimen expressed as number of inhalations). *asthma, Step 3 therapy (adult, adolescent)*

OR

1mometasone+indacaterol 62.5+125 micrograms by inhalation via DPI, once daily (see Table 9.3 for regimen expressed as number of inhalations).

Note 7: At the time of writing, beclometasone+formoterol is not available on the Pharmaceutical Benefits Scheme (PBS) as maintenance and reliever therapy. See the PBS website for current information.

Note 8: Beclometasone+formoterol is not approved by the Australian Therapeutic Goods Administration (TGA) for use in patients under 18 years.

Other options for Step 3 therapy

Other options for Step 3 therapy

Adding a LABA to low-dose ICS monotherapy (as above) is generally more effective than increasing to medium-dose ICS monotherapy; however, medium-dose ICS monotherapy can be considered as an alternative for individual patients. See Table 9.3 for dosage, formulation and device details of medium-dose ICS-based inhalers available in Australia for asthma.

Montelukast added to regular daily low-dose ICS therapy (Step 2) can be considered as an alternative to low-dose ICS+LABA therapy (Step 3), but is less effective. It may be useful in patients with coexisting allergic rhinitis. The recommended montelukast dose is outlined in Other options for Step 2 therapy [Note 9].

Note 9: Montelukast has been associated with neuropsychiatric adverse effects, including nightmares, sleep disturbance, agitation, depression and, rarely, suicidal thinking and behaviour. Counsel patients and carers about these effects. They usually occur in the first 2 weeks of treatment. Stop treatment if these effects occur—the effects usually subside within a few days of stopping treatment. See the Australian Therapeutic Goods Administration (TGA) website for more information.

Assessing patient response to Step 3 therapy

Assessing patient response to Step 3 therapy

Assess symptom control 4 to 8 weeks after starting Step 3 therapy. See Assessment of asthma control in adults and adolescents for classification of good, partial and poor control.

If the patient's symptoms are well controlled with Step 3 therapy, continue treatment and review again after 3 months. Therapy may be able to be stepped down if control remains good.

Every asthma assessment should include a review of treatment adherence and inhaler technique.

If the patient has partial or poor control on Step 3 therapy, review adherence and inhaler technique, and check equipment (drug device, spacer) for breakage or blockage. Before escalating to Step 4 therapy, also assess for comorbidities (eg rhinitis), and ensure exposure to triggers is minimised.

If the patient is using a therapy other than ICS+LABA (eg montelukast, ICS monotherapy) and has partial or poor control, switch therapy to ICS+LABA rather than escalating to Step 4 therapy, if possible.

If the patient has shown minimal response to treatment consider an alternative diagnosis, see clinical diagnosis of asthma.

Step 4 therapy for asthma in adults and adolescents

Step 4 therapy for asthma in adults and adolescents

Overview of Step 4 therapy

Overview of Step 4 therapy

Step 4 therapy is indicated for patients who remain uncontrolled despite optimised Step 3 therapy. It is rarely indicated as initial therapy.

Consider referral to a respiratory physician if the diagnosis is in doubt.

Step 4 therapy consists of:

- regular daily medium-dose inhaled corticosteroid plus long-acting beta2 agonist (ICS+LABA) therapy, plus an as-required reliever—most likely to be beneficial in patients with type 2 airway inflammation (identified by elevated blood eosinophil concentration [more than 300 microlitres] or elevated fractional exhaled nitric oxide [FeNO] [more than 25 parts per billion])
- triple therapy using a low-dose ICS+LABA (Step 3) with a long-acting muscarinic antagonist (LAMA), plus an as-required reliever—most likely to be beneficial in patients without type 2 airway inflammation.

Other options for Step 4 therapy are used less frequently.

Step 4 therapy for patients with type 2 airway inflammation

Step 4 therapy for patients with type 2 airway inflammation

Patients with poor asthma symptom control (see Assessing asthma symptom control in adults and adolescents) and type 2 airway inflammation may respond better to increasing the ICS dose than adding a LAMA. Type 2 airway inflammation can be identified by elevated blood eosinophil concentration (more than 300 microlitres) or elevated fractional exhaled nitric oxide (FeNO) (more than 25 parts per billion).

For **initial** Step 4 therapy with medium-dose ICS+LABA combination therapy, with SABA reliever therapy, use:

a SABA as required (see Step 1 for dosage)

PLUS ONE OF THE FOLLOWING

1beclometasone+formoterol 200+12 micrograms by inhalation via pMDI with spacer, twice daily (see Table 9.3 for regimen expressed as number of inhalations) [Note 10] *asthma, Step 4 maintenance and reliever therapy (adult, adolescent)*

OR

1budesonide+formoterol 400+12 micrograms by inhalation via pMDI with spacer or via DPI, twice daily (see Table 9.3 for regimen expressed as number of inhalations). *asthma, Step 4 maintenance therapy (adult, adolescent)*

OR

1fluticasone furoate+vilanterol 100+25 micrograms by inhalation via DPI, once daily (see Table 9.3 for regimen expressed as number of inhalations) *asthma, Step 4 maintenance therapy (adult, adolescent)*

OR

1fluticasone propionate+formoterol 250+10 micrograms by inhalation via pMDI with spacer, twice daily (see Table 9.3 for regimen expressed as number of inhalations) *asthma, Step 4 maintenance therapy (adult, adolescent)*

OR

1fluticasone propionate+salmeterol 250+50 micrograms by inhalation via pMDI with spacer or via DPI, twice daily (see Table 9.3 for regimen expressed as number of inhalations) *asthma, Step 4 therapy (adult, adolescent)*

OR

1mometasone+indacaterol 127.5+125 micrograms by inhalation via DPI, once daily (see Table 9.3 for regimen expressed as number of inhalations).

Patients taking budesonide+formoterol maintenance therapy can use the same inhaler for reliever therapy (budesonide+formoterol 'maintenance and reliever therapy'). Budesonide+formoterol maintenance and reliever therapy is associated with a lower risk of exacerbations than ICS+LABA maintenance plus SABA reliever therapy.

At the time of writing, beclometasone+formoterol is not approved by the Australian Therapeutic Goods Administration (TGA) for use as Step 4 medium-dose ICS+LABA maintenance and reliever therapy.

For **initial** Step 4 therapy with medium-dose budesonide+formoterol maintenance and reliever therapy, use:

budesonide+formoterol 400+12 micrograms by inhalation via pMDI with spacer or via DPI, twice daily [Note 11]. *asthma, Step 4 maintenance therapy (adult, adolescent)*

PLUS

budesonide+formoterol 100+6 or 200+6 micrograms by inhalation via pMDI with spacer or via DPI, as required, up to a maximum total daily dose (including maintenance doses) of 2400+72 micrograms daily (see Table 9.3 for regimen expressed as number of inhalations). *asthma, Step 4 maintenance therapy (adult, adolescent)*

Always give ICS+LABA therapy as a combination inhaler to avoid the possibility of patients taking a LABA without an ICS—LABA monotherapy increases the risk of exacerbations and asthma-related death. Using separate inhalers risks the patient stopping the ICS because of a perceived lack of benefit compared with the LABA (which provides quick relief of symptoms).

For patients who **no longer have type 2 airway inflammation but have persistent poor asthma symptom control** (see Assessing asthma symptom control in adults and adolescents) despite the above therapy, consider adding a LAMA to medium-dose ICS+LABA. Triple therapy modestly improves symptoms, reduces exacerbations and improves lung function in these patients. It can be given as an ICS+LABA combination inhaler plus a separate LAMA inhaler, or as a single combination inhaler containing all three drug classes.

To add a LAMA to low- or medium-dose ICS+LABA therapy, use:

tiotropium 5 micrograms by inhalation via mist inhaler, once daily (see Table 9.4 for formulations).

For triple therapy using a low-dose ICS+LABA+LAMA combination inhaler, use:

1fluticasone furoate+umeclidinium+vilanterol 100+62.5+25 micrograms by inhalation via DPI, once daily (see Table 9.3 for formulations)

OR

1mometasone+indacaterol+glycopyrronium 68+114+46 micrograms via DPI, once daily (see Table 9.3 for formulations).

Note 10: Beclometasone+formoterol is not approved by the Australian Therapeutic Goods Administration (TGA) for use in patients under 18 years.

Note 11: The budesonide+formoterol 400+12 microgram formulation is not suitable for use as reliever therapy; to use the same device for both maintenance and reliever therapy, use the 200+6 microgram formulation.

Step 4 therapy for patients without type 2 airway inflammation

Step 4 therapy for patients without type 2 airway inflammation

Patients with poor asthma symptom control (see Assessing asthma symptom control in adults and adolescents) without type 2 airway inflammation may respond better to adding a LAMA than increasing to medium-dose ICS+LABA (as above).

In adults and adolescents with persistent symptoms despite ICS+LABA therapy, the addition of a LAMA modestly improves symptoms, reduces exacerbations and improves lung function.

Triple therapy can be given as an ICS+LABA combination inhaler plus a separate LAMA inhaler, or as a single combination inhaler containing all three drug classes.

To add a LAMA to low-dose ICS+LABA therapy (Step 3), use:

tiotropium 5 micrograms by inhalation via mist inhaler, once daily (see Table 9.4 for formulations).

For triple therapy using a low-dose ICS+LABA+LAMA combination inhaler, use:

1mometasone+indacaterol+glycopyrronium 68+114+46 micrograms via DPI, once daily (see Table 9.3 for formulations).

Other options for Step 4 therapy

Other options for Step 4 therapy

Adding a LABA to medium-dose ICS monotherapy is generally more effective than increasing to high-dose ICS monotherapy; however, high-dose ICS monotherapy can be considered as an alternative for individual patients.

Montelukast added to low-dose ICS+LABA therapy (Step 3) can be considered as an alternative to medium-dose ICS+LABA therapy (Step 4), although there is no evidence to support this approach. The recommended montelukast dose is outlined in Other options for Step 2 therapy [Note 12]. Adults and adolescents who have severe allergic or eosinophilic asthma (identified by elevated total immunoglobulin E) may require monoclonal antibodies.

Note 12: Montelukast has been associated with neuropsychiatric adverse effects, including nightmares, sleep disturbance, agitation, depression and, rarely, suicidal thinking and behaviour. Counsel patients and carers about these effects. They usually occur in the first 2 weeks of treatment. Stop treatment if these effects occur—the effects usually subside within a few days of stopping treatment. See the Australian Therapeutic Goods Administration (TGA) website for more information.

Assessing patient response to Step 4 therapy

Assessing patient response to Step 4 therapy

Assess symptom control 4 to 8 weeks after starting Step 4 therapy. See Assessment of asthma control in adults and adolescents for classification of good, partial and poor control.

If the patient's symptoms are well controlled with Step 4 therapy, continue treatment and review again after 3 months. Attempt to step down therapy if control remains good. Few patients require long-term treatment with Step 4 therapy.

If the patient has partial or poor control on Step 4 therapy, review adherence and inhaler technique, and check equipment (drug device, spacer) for breakage or blockage. Before escalating to Step 5 therapy, also assess for comorbidities (eg rhinitis) that could be reducing asthma control, and ensure exposure to triggers is minimised.
Every asthma assessment should include a review of treatment adherence and inhaler technique.

If the patient is using a therapy other than ICS+LABA (eg montelukast, ICS monotherapy) and has partial or poor control, switch therapy to ICS+LABA rather than escalating to Step 5 therapy, if possible.

All patients who are uncontrolled on Step 4 therapy should be referred to a respiratory physician, particularly if the patient has shown minimal response to treatment or if the diagnosis is in doubt.

Step 5 therapy for asthma in adults and adolescents

Step 5 therapy for asthma in adults and adolescents

Overview of Step 5 therapy

Overview of Step 5 therapy

Step 5 therapy is indicated for patients with uncontrolled asthma despite optimised Step 4 therapy. Refer these patients to a respiratory physician for consideration of alternative treatments (see Severe asthma in adults and adolescents: specialist management). Except in young patients, while awaiting respiratory physician review, consider starting Step 5 therapy. Few patients require long-term treatment with Step 5 therapy.

Refer all patients requiring Step 5 therapy to a respiratory physician.

Step 5 therapy consists of either:

- increasing to high-dose ICS+LABA—most likely to be beneficial in patients with type 2 airway inflammation (identified by elevated blood eosinophil concentration [more than 300 microlitres] or elevated fractional exhaled nitric oxide [FeNO] [more than 25 parts per billion])
- starting a long-acting muscarinic antagonist (LAMA)—most likely to be beneficial in patients without type 2 airway inflammation.

Step 5 therapy for patients with type 2 airway inflammation

Step 5 therapy for patients with type 2 airway inflammation

Patients with poor asthma symptom control (see Assessing asthma symptom control in adults and adolescents) and type 2 airway inflammation may respond better to increasing the ICS dose than adding a LAMA. Type 2 airway inflammation can be identified by elevated blood eosinophil concentration (more than 300 microlitres) or elevated fractional exhaled nitric oxide (FeNO) (more than 25 parts per billion).

For **initial** Step 5 therapy with high-dose ICS+LABA combination therapy, with SABA reliever therapy, use:

a SABA as required (see Step 1 for dosage)

PLUS ONE OF THE FOLLOWING

1budesonide+formoterol 800+24 micrograms by inhalation via pMDI with spacer or via DPI, twice daily (see Table 9.3 for regimen expressed as number of inhalations). *asthma, Step 5 maintenance therapy (adult, adolescent)*

OR

1fluticasone furoate+vilanterol 200+25 micrograms by inhalation via DPI, once daily (see Table 9.3 for regimen expressed as number of inhalations) *asthma, Step 5 maintenance therapy (adult, adolescent)*

OR

1fluticasone propionate+formoterol 500+20 micrograms by inhalation via pMDI with spacer, twice daily (see Table 9.3 for regimen expressed as number of inhalations) *asthma, Step 5 maintenance therapy (adult, adolescent)*

OR

1fluticasone propionate+salmeterol 500+50 micrograms by inhalation via pMDI with spacer or via DPI, twice daily (see Table 9.3 for regimen expressed as number of inhalations) *asthma, Step 5 therapy (adult, adolescent)*

OR

1mometasone+indacaterol 260+125 micrograms by inhalation via DPI, once daily (see Table 9.3 for regimen expressed as number of inhalations).

The combination inhaler of beclometasone+formoterol is not available in a formulation containing a high dose of beclometasone, so is not appropriate for Step 5 therapy.

Patients taking budesonide+formoterol maintenance therapy can use the same inhaler for reliever therapy (budesonide+formoterol 'maintenance and reliever therapy'). For budesonide+formoterol maintenance and reliever therapy, use:

budesonide+formoterol 800+24 micrograms by inhalation via pMDI with spacer or via DPI, twice daily [Note 13]. *asthma, Step 5 maintenance therapy (adult, adolescent)*

PLUS

budesonide+formoterol 100+6 or 200+6 micrograms by inhalation via pMDI with spacer or via DPI, as required, up to a maximum total daily dose (including maintenance doses) of 2400+72 micrograms daily (see Table 9.3 for regimen expressed as number of inhalations). *asthma, Step 5 maintenance therapy (adult, adolescent)*

Always give ICS+LABA therapy as a combination inhaler to avoid the possibility of patients taking a LABA without an ICS—LABA monotherapy increases the risk of exacerbations and asthma-related death. Using separate inhalers risks the patient stopping the ICS because of a perceived lack of benefit compared with the LABA (which provides quick relief of symptoms).

Patients who have **persistent type 2 airway inflammation** despite the above therapy may require monoclonal antibodies. Patients who have severe allergic or eosinophilic asthma (identified by elevated total immunoglobulin E) may also require monoclonal antibodies.

For patients who **no longer have type 2 airway inflammation but have persistent poor asthma symptom control** (see Assessing asthma symptom control in adults and adolescents) despite the above therapy, consider adding a LAMA to high-dose ICS+LABA therapy. Triple therapy modestly improves symptoms, reduces exacerbations and improves lung function in these patients. It can be given as an ICS+LABA combination inhaler plus a separate LAMA inhaler, or as a single combination inhaler containing all three drug classes.

To add a LAMA to high-dose ICS+LABA therapy, use:

tiotropium 5 micrograms by inhalation via mist inhaler, once daily (see Table 9.4 for formulations).

For triple therapy using a high-dose ICS+LABA+LAMA combination inhaler, use:

1fluticasone furoate+umeclidinium+vilanterol 200+62.5+25 micrograms by inhalation via DPI, once daily (see Table 9.3 for formulations).

Note 13: The budesonide+formoterol 400+12 microgram formulation is not suitable for use as reliever therapy; to use the same device for both maintenance and reliever therapy, use the 200+6 microgram formulation.

Step 5 therapy for patients without type 2 airway inflammation

Step 5 therapy for patients without type 2 airway inflammation

Patients with poor asthma symptom control (see Assessing asthma symptom control in adults and adolescents) **without** type 2 airway inflammation may respond better to adding a LAMA than increasing to high-dose ICS+LABA (as above); adding a LAMA is particularly helpful in patients with persistent airflow limitation. Triple therapy modestly improves symptoms, reduces exacerbations and improves lung function.

Triple therapy can be given as an ICS+LABA combination inhaler plus a separate LAMA inhaler, or as a single combination inhaler containing all three drug classes.

To add a LAMA to medium-dose ICS+LABA therapy (Step 4), use:

tiotropium 5 micrograms by inhalation via mist inhaler, once daily (see Table 9.4 for formulations).

For triple therapy using a medium-dose ICS+LABA+LAMA combination inhaler, use:

1fluticasone furoate+umeclidinium+vilanterol 100+62.5+25 micrograms by inhalation via DPI, once daily (see Table 9.3 for formulations)

OR

1mometasone+indacaterol+glycopyrronium 136+114+46 micrograms via DPI, once daily (see Table 9.3 for formulations).

Assessing patient response to Step 5 therapy

Assessing patient response to Step 5 therapy

Assess symptom control 4 to 8 weeks after starting Step 5 therapy. See Assessment of asthma control in adults and adolescents for classification of good, partial and poor control.

If the patient's symptoms are well controlled, continue treatment and review again after 3 months. Attempt to step down therapy if control remains good. Few patients should require long-term Step 5 therapy.

If the patient has partial or poor control on Step 5 therapy, review adherence and inhaler technique, and check equipment (drug device, spacer) for breakage or blockage. Also assess for comorbidities (eg rhinitis) that could be reducing asthma control, and ensure exposure to triggers is minimised.

Every asthma assessment should include a review of treatment adherence and inhaler technique.

Refer all patients requiring Step 5 therapy to a respiratory physician, particularly if the patient has shown minimal response to treatment, or if the diagnosis is in doubt. See Severe asthma in adults and adolescents: specialist management for information about specialist treatments.

Severe asthma in adults and adolescents: specialist management

Severe asthma in adults and adolescents: specialist management

Specialist referral

Specialist referral

Severe asthma is described as asthma that remains uncontrolled despite optimised therapy, including management of comorbidities and other contributing factors. Refer patients with severe asthma to a respiratory physician for assessment and management.

In addition to severe asthma, specialist consultation is recommended:

- for asthma associated with anaphylaxis
- following a life-threatening asthma exacerbation requiring hospitalisation
- for frequent asthma-related emergency-department or urgent general practitioner visits
- asthma in patients who appear to have good lung function but experience frequent symptoms or exacerbations
- for patients with poor self-management skills (if referral to a practice nurse or asthma educator has not helped)
- if there is doubt about the diagnosis of asthma
- for suspected occupational asthma.

Specialist management of asthma includes reassessment of the diagnosis, assessment of the asthma phenotype, assessment of adherence, inhaler technique and comorbidities, and education about self-management skills. Additional treatments are individualised and consider all aspects of the patient's condition —see Specialist treatments for severe asthma. Specialist management may be best achieved in a multidisciplinary severe asthma clinic.

For detailed information about severe asthma, see the Severe Asthma Toolkit, an Australian resource for assessing and managing severe asthma.

Specialist treatments for severe asthma

Specialist treatments for severe asthma
Monoclonal antibodies

In patients with severe allergic or eosinophilic asthma, monoclonal antibodies improve symptoms and quality of life, and reduce exacerbations and exposure to oral corticosteroids.

Monoclonal antibodies used for asthma include omalizumab, mepolizumab and benralizumab. They are given as a subcutaneous injection; mepolizumab and benralizumab are available in an autoinjector device, which aids self-administration by the patient.

Treatment with any monoclonal antibody requires assessment by a clinician specialised in respiratory medicine or immunology, or a general physician with expertise in managing severe asthma.

For detailed information about monoclonal antibodies and their role in the Australian setting, see the Severe Asthma Toolkit.

Macrolide antibiotics

Maintenance therapy with a macrolide antibiotic (azithromycin, erythromycin, clarithromycin) is occasionally used by respiratory physicians for patients with severe asthma.

A systematic review of two studies showed that in patients with asthma who experience exacerbations despite inhaled corticosteroid and long-acting beta$_2$ agonist (ICS+LABA) combination therapy, treatment with azithromycin reduced exacerbations [Note 14]. Benefit was seen in patients with eosinophilic or noneosinophilic severe asthma.

Use of macrolide antibiotics for asthma is not approved by the Australian Therapeutic Good Administration (TGA). All patients requiring maintenance macrolide therapy should be under the care of a respiratory physician.

Note 14: Hiles SA, McDonald VM, Guilhermino M, Brusselle GG, Gibson PG. Does maintenance azithromycin reduce asthma exacerbations? An individual participant data meta-analysis. Eur Respir J 2019;54(5) [URL]

Allergen immunotherapy

The addition of allergen immunotherapy to standard asthma therapy may be effective in some patients with confirmed dust mite, cat or pollen allergy. Allergen immunotherapy in asthma is most often used in patients with concurrent allergic rhinitis or allergic rhinoconjunctivitis.

Subcutaneous immunotherapy is always given under medical supervision because it can cause both immediate- and slower-onset systemic reactions. These range from mild urticaria and rhinitis, through to angioedema, severe acute asthma and anaphylactic shock.

Sublingual immunotherapy should be given under medical supervision for the first dose, but subsequent doses can be taken at home. Local adverse reactions to sublingual immunotherapy occur in 20 to 30% of patients, but systemic adverse effects are rare.

Bronchial thermoplasty

Bronchial thermoplasty is a specialist invasive physical intervention. It delivers thermal energy (65°C) to the proximal airways. The mechanism of action is unclear, but may result from smooth muscle atrophy, and mechanical alterations to air flow.

Although bronchial thermoplasty has been associated with a short-term increase in symptoms and has no effect on lung function, it has also been shown to reduce severe exacerbations and hospital presentations, and improve quality of life.

At the time of writing, no controlled trials of bronchial thermoplasty have been performed in patients with severe asthma.

For more information, see the Severe Asthma Toolkit.

Inhaled drugs for asthma in adults and adolescents: formulation and device summary

Inhaled drugs for asthma in adults and adolescents: formulation and device summary

For a summary of inhaled drugs available in Australia for asthma in adults and adolescents, see:

- Table 9.3 for inhaled corticosteroid (ICS)–based inhalers
- Table 9.4 for non–ICS-based inhalers.

For information about delivery devices, including links to videos and patient handouts, see Inhalational drug delivery devices. See also the National Asthma Council website for a poster of asthma inhalers, including pictures.

Table 9.3 Inhaled corticosteroid–based inhalers available in Australia for asthma in adults and adolescents

Device (brand examples) [NB1]	Dose per actuation	Low-dose regimen	Medium-dose regimen	High-dose regimen [NB2]
beclometasone (Qvar)		50 or 100 micrograms twice daily	200 micrograms twice daily	300 or 400 micrograms twice daily
pMDI	50 micrograms	1 or 2 inhalations twice daily	n/a	n/a

Device (brand examples) [NB1]	Dose per actuation	Low-dose regimen	Medium-dose regimen	High-dose regimen [NB2]
breath-activated pMDI (Autohaler)	100 micrograms	1 inhalation twice daily	2 inhalations twice daily	3 or 4 inhalations twice daily
	50 micrograms	1 or 2 inhalations twice daily	n/a	n/a
	100 micrograms	1 inhalation twice daily	2 inhalations twice daily	3 or 4 inhalations twice daily
budesonide (Pulmicort) multiple-dose DPI (Turbuhaler)	100 micrograms	100 or 200 micrograms twice daily	400 micrograms twice daily	600 or 800 micrograms twice daily maximum 2400 micrograms daily in divided doses
	100 micrograms	1 or 2 inhalations twice daily	n/a	n/a
	200 micrograms	1 inhalation twice daily	2 inhalations twice daily	3 or 4 inhalations twice daily (maximum 12 inhalations daily)
	400 micrograms	n/a	1 inhalation twice daily	2 inhalations twice daily (maximum 6 inhalations daily)
ciclesonide (Alvesco) pMDI	80 micrograms	80 or 160 micrograms once daily	320 micrograms once daily	doses above 320 micrograms daily not usually used
		1 or 2 inhalations once daily	n/a	n/a
	160 micrograms	1 inhalation once daily	2 inhalations once daily	
fluticasone furoate (Arnuity) multiple-dose DPI (Ellipta)	100 micrograms	n/a [NB3]	100 micrograms once daily	200 micrograms once daily
		n/a	1 inhalation once daily	2 inhalations once daily
	200 micrograms	n/a	n/a	1 inhalation once daily
fluticasone propionate (Flixotide)		50 or 100 micrograms twice daily	125 to 250 micrograms twice daily	500 micrograms twice daily maximum 1000 micrograms twice daily
pMDI	50 micrograms	1 or 2 inhalations twice daily	n/a	n/a
	125 micrograms	n/a	1 or 2 inhalations twice daily	n/a
	250 micrograms	n/a	1 inhalation twice daily	2 inhalations twice daily

Device (brand examples) [NB1]	Dose per actuation	Low-dose regimen	Medium-dose regimen	High-dose regimen [NB2]
				(maximum 4 inhalations twice daily)
multiple-dose DPI (Accuhaler)	100 micrograms	1 inhalation twice daily	2 inhalations twice daily	n/a
	250 micrograms	n/a	1 inhalation twice daily	2 inhalations twice daily
	500 micrograms	n/a	n/a	1 inhalation twice daily
beclometasone+formoterol (Fostair) [NB4]		100+6 micrograms twice daily	200+12 micrograms twice daily	n/a [NB5]
pMDI	100+6 micrograms	1 inhalation twice daily	2 inhalations twice daily	n/a
budesonide+formoterol (Symbicort, Duoresp) [NB6]		100+6 to 200+6 micrograms twice daily	400+12 micrograms twice daily	800+24 micrograms twice daily maximum 2400+72 micrograms daily [NB7]
pMDI (Rapihaler)	50+3 micrograms	2 inhalations twice daily	n/a	n/a
	100+3 micrograms	2 inhalations twice daily	4 inhalations twice daily	n/a
	200+6 micrograms	1 inhalation twice daily	2 inhalations twice daily	4 inhalations twice daily
multiple-dose DPI (Turbuhaler, Spiromax)	100+6 micrograms	1 inhalation twice daily	n/a	n/a
	200+6 micrograms	1 inhalation twice daily	2 inhalations twice daily	4 inhalations twice daily
	400+12 micrograms	n/a	1 inhalation twice daily	2 inhalations twice daily
fluticasone furoate+vilanterol (Breo)		n/a [NB3]	100+25 micrograms once daily	200+25 micrograms once daily
multiple-dose DPI (Ellipta)	100+25 micrograms	n/a	1 inhalation once daily	n/a
	200+25 micrograms	n/a	n/a	1 inhalation once daily
fluticasone propionate+formoterol (Flutiform)		100+10 micrograms twice daily	250+10 micrograms twice daily	500+20 micrograms twice daily
pMDI	50+5 micrograms	2 inhalations twice daily	n/a	n/a
	125+5 micrograms	n/a	2 inhalations twice daily	n/a
	250+10 micrograms	n/a	1 inhalation twice daily	2 inhalations twice daily

Device (brand examples) [NB1]	Dose per actuation	Low-dose regimen	Medium-dose regimen	High-dose regimen [NB2]
fluticasone propionate+salmeterol (Seretide, Pavtide, Cipla, SalplusF)		100+50 micrograms twice daily	250+50 micrograms twice daily	500+50 micrograms twice daily
pMDI	50+25 micrograms	2 inhalations twice daily	n/a	n/a
	125+25 micrograms	n/a	2 inhalations twice daily	n/a
	250+25 micrograms	n/a	n/a	2 inhalations twice daily
multiple-dose DPI (Accuhaler)	100+50 micrograms	1 inhalation twice daily	n/a	n/a
	250+50 micrograms	n/a	1 inhalation twice daily	n/a
	500+50 micrograms	n/a	n/a	1 inhalation twice daily
mometasone+indacaterol (Atectura)		62.5+125 micrograms once daily	127.5+125 micrograms once daily	260+125 micrograms once daily
single-dose DPI (Breezhaler)	62.5+125 micrograms	1 inhalation once daily	n/a	n/a
	127.5+125 micrograms	n/a	1 inhalation once daily	n/a
	260+125 micrograms	n/a	n/a	1 inhalation once daily
fluticasone furoate+umeclidinium+vilanterol (Trelegy)		n/a [NB3]	100+62.5+25 micrograms once daily	200+62.5+25 micrograms once daily
single-dose DPI (Ellipta)	100+62.5+25 micrograms	n/a	1 inhalation once daily	n/a
	200+62.5+25 micrograms	n/a	n/a	1 inhalation once daily
mometasone+indacaterol+glycopyrronium (Enerzair)		68+114+46 micrograms once daily	136+114+46 micrograms once daily	n/a
single-dose DPI (Breezhaler)	68+114+46 micrograms	1 inhalation once daily	n/a	n/a
	136+114+46 micrograms	n/a	1 inhalation once daily	n/a

n/a = not applicable

NB1: For information about delivery devices, including links to videos and patient handouts, see Inhalational drug delivery devices.

NB2: Unless a maximum daily dose is specified, the high-dose regimen is also the maximum daily dose.

NB3: At the time of writing, evidence to define a low dose of fluticasone furoate (either alone or in combination with vilanterol) is insufficient; some publications consider formulations containing 100 micrograms as low dose.

Device (brand examples) [NB1]	Dose per actuation	Low-dose regimen	Medium-dose regimen	High-dose regimen [NB2]

NB4: Suggested low- and medium-dose regimens of beclometasone+formoterol refer to regular maintenance doses, not as-required doses or 'maintenance and reliever' regimens.

NB5: The combination inhaler of beclometasone+formoterol is not available in a formulation containing a high dose of beclometasone, so is not appropriate for Step 5 therapy. The maximum daily dose of beclometasone+formoterol, including all doses taken as maintenance and reliever therapy, is 800+48 micrograms.

NB6: Suggested low- medium- and high-dose regimens of budesonide+formoterol refer to regular maintenance doses, not as-required doses or 'maintenance and reliever' regimens.

NB7: The maximum daily dose of budesonide+formoterol includes doses taken as reliever and maintenance therapy.

Table 9.4 Non–ICS inhalers available in Australia for asthma

[NB1]

Drug (brand examples)	Device (brand example) [NB2]	Dose per inhalation
SABA inhalers		
salbutamol (Ventolin, Asmol, Airomir)	pMDI	100 micrograms
	breath-activated pMDI (Autohaler)	100 micrograms
terbutaline (Bricanyl)	multiple-dose DPI (Turbuhaler)	500 micrograms
LAMA inhalers		
tiotropium (Spiriva)	mist inhaler (Respimat)	2.5 micrograms

ICS = inhaled corticosteroid; LAMA = long-acting muscarinic agonist; SABA = short-acting $beta_2$ agonist

NB1: Cromones (cromoglycate, nedocromil) were formerly used to treat asthma, but they are less effective than inhaled corticosteroids for controlling asthma and improving lung function, so are rarely used.

NB2: For information about delivery devices, including links to videos and patient handouts, see Inhalational drug delivery devices.

Assessing asthma symptom control in adults and adolescents

Assessing asthma symptom control in adults and adolescents

Classification of asthma symptom control is based on the frequency of asthma symptoms over the previous 4 weeks, and is classified as good, partial or poor, as detailed in Table 9.5.

Asthma symptom control should be assessed at diagnosis, following any change to treatment, and at each regular review.

Table 9.5 Classification of asthma symptom control

[NB1]

Good control	Partial control	Poor control
All of the following features: • daytime symptoms on 2 or fewer days per week • need for SABA reliever on 2 or fewer days per week [NB2] • no limitation of activities • no symptoms during night or on waking	One or two of the following features: • daytime symptoms on more than 2 days per week • need for SABA reliever on more than 2 days per week [NB2] • any limitation of activities • any symptoms during night or on waking	Three or more of the following features: • daytime symptoms on more than 2 days per week • need for SABA reliever on more than 2 days per week [NB2] • any limitation of activities • any symptoms during night or on waking

SABA = short-acting beta$_2$ agonist

NB1: Asthma symptom control is based on symptoms over the previous 4 weeks.

NB2: Not including SABA taken prophylactically before exercise; record this separately and consider when assessing management.

Adapted from the Australian Asthma Handbook © 2020 National Asthma Council Australia. Accessed 31 August 2020.

Assessment of asthma symptom control can be supplemented with a validated composite score such as the Asthma Control Test (also known as the Asthma Score). The Primary care Asthma Control Screening tool (PACS) can be used to quickly identify patients who need more detailed assessment of their asthma symptom control.

Lung function testing should be part of the assessment of asthma control because reported symptoms and reliever use may be an unreliable indicator of control in some patients.

Infrequent symptoms and reliever use may not reflect good control in patients who are:

- inactive (ie with insufficient activity to experience symptoms)
- poor perceivers of airway obstruction—consider if a substantial change in lung function (eg 20% increase after bronchodilator, or similar decrease after exercise or during bronchial provocation testing) is not accompanied by a change in symptoms
- using long-acting bronchodilator alone without inhaled corticosteroid (ICS). These patients may have few symptoms, but are at increased risk of exacerbations and asthma-related death due to uncontrolled airway inflammation.

Frequent symptoms and reliever use may not reflect poor control in patients who are:

- experiencing symptoms caused by conditions other than asthma (eg shortness of breath caused by obesity, cough caused by chronic upper airway cough syndrome [postnasal drip])
- overperceivers of airway obstruction
- using excessive doses of short-acting beta$_2$ agonist through habit or anxiety.

Risk factors for adverse asthma outcomes

Risk factors for adverse asthma outcomes

Assess patients with asthma for risk factors for adverse asthma outcomes, including exacerbations, faster than normal decline in lung function and adverse effects of treatment.

Risk factors associated with adverse asthma outcomes are listed in Table 9.6. Minimise or manage any modifiable risk factors, and consider reviewing patients at risk of adverse outcomes more frequently.

Table 9.6 Risk factors for adverse asthma outcomes in adults and adolescents

Risk factors for exacerbations
poor adherence
inadequate inhaler technique
poor asthma symptom control
any asthma exacerbation during the previous 12 months
lack of written asthma action plan
difficulty perceiving airflow limitation or severity of exacerbation
poor lung function (even if few symptoms)
peripheral blood eosinophilia (suggests eosinophilic airway inflammation)
elevated FeNO
exposure to tobacco smoke (personal or second-hand smoking)
socioeconomic disadvantage
use of illegal substances
major psychosocial problems
mental illness
other chronic lung disease
high bronchodilator reversibility
allergic rhinitis or rhinosinusitis
obesity
Risk factors for life-threatening asthma
intubation or admission to intensive care unit because of asthma (ever)
two or more hospitalisations for asthma in the past year
three or more ED visits for asthma in the past year
hospitalisation or ED visit for asthma in the past month
high SABA use (use of three or more canisters per year is associated with increased risk of exacerbation; use of more than 12 canisters per year is associated with increased risk of asthma-related death)
history of delayed presentation to hospital during exacerbations
history of sudden-onset acute asthma
lack of written asthma action plan
sensitivity to an unavoidable allergen (eg *Alternaria* species of common moulds)
confirmed food allergy
inadequate treatment

experience of adverse effects of oral corticosteroids (may contribute to under treatment or delayed presentation to hospital during exacerbations)

socioeconomic disadvantage

living alone

mental illness

use of alcohol or illegal substances

poor access to health care (eg rural or remote region)

cardiovascular disease

Risk factors for accelerated decline in lung function

chronic mucus hypersecretion

severe asthma exacerbation in a patient not using ICS

occupational asthma

poor lung function

peripheral blood eosinophilia (suggests eosinophilic airway inflammation)

exposure to tobacco smoke (personal or second-hand smoking)

Risk factors for treatment-related adverse events

long-term high-dose ICS

frequent use of oral corticosteroids

anxiety disorder (may be associated with increased sensitivity to asthma symptoms and reluctance to reduce ICS dose when asthma is well controlled)

euphoria with oral corticosteroid use

ED = emergency department; FeNO = fractional exhaled nitric oxide; ICS = inhaled corticosteroid; SABA = short-acting $beta_2$ agonist.

Adapted from the *Australian Asthma Handbook* © 2020 National Asthma Council Australia. Accessed 31 August 2020.

General measures to improve asthma control in adults and adolescents

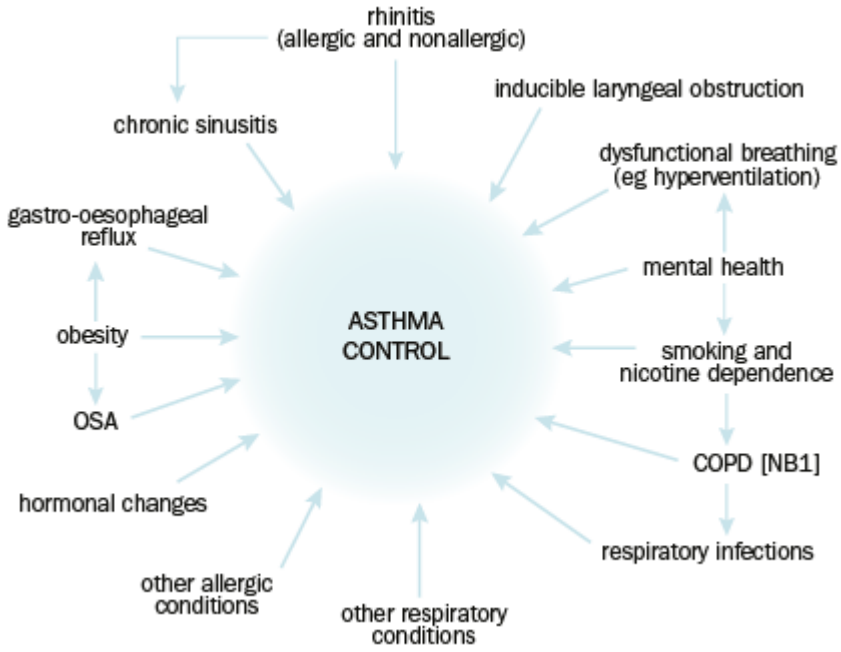
General measures to improve asthma control in adults and adolescents

Managing comorbidities

Managing comorbidities

Comorbidities such as obesity, gastro-oesophageal reflux, rhinitis and rhinosinusitis, inducible laryngeal obstruction and anxiety and depression can worsen asthma control or contribute to the risk of exacerbations. Figure 9.3 outlines relevant comorbidities. Managing these conditions can improve asthma control and should always be considered before stepping up asthma therapy.

Figure 9.3 Conditions that can affect asthma control or increase the risk of exacerbations



COPD = chronic obstructive pulmonary disease; OSA = obstructive sleep apnoea

NB1: See Overlap of asthma and COPD for further information.

Anxiety disorders and depression

Anxiety disorders and depression are more common in patients with asthma, particularly severe asthma, than in the general population.

Anxiety disorders can be a trigger for asthma symptoms, and can also affect perception of symptoms (eg over perception of symptom severity). Dysfunctional breathing (eg hyperventilation related to a panic attack) can be confused for asthma symptoms. Patients with comorbid asthma and an anxiety disorder may experience worse control of symptoms than other patients with asthma.

Depression can be a risk factor for poor medication adherence and self-management, which can in turn reduce asthma control.

Actively screen for mental health disorders in patients with asthma, particularly severe asthma. For management advice, see Depression and Anxiety and associated disorders.

Obesity

Obesity (defined as a body mass index [BMI] more than 30 kg/m^2) is associated with an increased prevalence of asthma. Obese patients are more likely to have obstructive sleep apnoea and gastro-oesophageal reflux, which can also worsen asthma control.

Weight loss of at least 5 to 10% may result in clinically significant improvements in asthma control.

Obese people experience more dyspnoea and asthma-like symptoms than nonobese people—before starting or escalating asthma treatment in an obese patient, confirm that the symptoms are caused by asthma with lung function testing.

Gastro-oesophageal reflux

Patients with asthma have higher rates of gastro-oesophageal reflux. Asthma drugs can cause relaxation of the lower oesophageal sphincter, which can worsen gastro-oesophageal reflux. The presence of gastro-oesophageal reflux can also worsen asthma control or contribute to coughing.

For advice on management of gastro-oesophageal reflux, see here. Treatment of gastro-oesophageal reflux will not necessarily improve asthma symptoms.

Rhinitis and rhinosinusitis

Rhinitis or chronic rhinosinusitus commonly coexists with asthma (sometimes referred to as 'United Airway Disease'). Asthma occurs in 30% of patients with allergic rhinitis, and allergic rhinitis occurs in more than 80% of patients with allergic asthma.

Assess patients with asthma for rhinitis and rhinosinusitis, particularly if their asthma is related to allergies, or is difficult to control. Poorly controlled rhinitis and rhinosinusitis can worsen asthma control—see Rhinitis and Chronic rhinosinusitis for management advice.

Inducible laryngeal obstruction (upper airway dysfunction or vocal cord dysfunction)

Inducible laryngeal obstruction (also known as upper airway dysfunction or vocal cord dysfunction) results from abnormal and intermittent adduction of the vocal cords or supraglottic muscles during respiration. It can mimic, and is often misdiagnosed as, asthma. The condition presents with intermittent and variable symptoms, including wheeze, dyspnoea and cough. Most patients with inducible laryngeal obstruction experience inspiratory breathing difficulties, and may describe a choking sensation, or a sensation of breathing through a straw. Symptoms can be triggered or worsened by exercise, gastro-oesophageal reflux, chronic rhinosinusitis, irritants (eg pollutants, occupational irritants) and emotional stress.

These episodes can be frightening to the patient. Symptoms do not respond to short-acting $beta_2$ agonists.

Inducible laryngeal obstruction can occur independently or coexist with asthma. If it is not diagnosed and managed, it can worsen asthma control and lead to overtreatment of asthma. If inducible laryngeal obstruction is suspected, seek specialist advice.

Avoiding triggers

Avoiding triggers

Triggers for asthma vary widely and differ between patients. Possible triggers for asthma are listed in Table 9.7.

Table 9.7 Triggers for exacerbations of existing asthma

Action	Trigger
Always avoid	cigarette smoke
	allergens (eg pollen, dust mite)
	airborne or environmental irritants (eg cold or dry air, occupational irritants, pollution, smoke)
Avoid or minimise if possible	drugs associated with asthma exacerbations (eg NSAIDs for patients with aspirin-exacerbated respiratory disease, beta blockers [NB1])
	dietary triggers (either temperature related [eg cold drinks] or allergy related [for patients with food allergies]) [NB2]
	respiratory tract infections
Manage	comorbidities (eg allergic rhinitis, gastro-oesophageal reflux, nasal polyposis, obesity, inducible laryngeal obstruction)
	physiological and psychological changes (extreme emotions, hormonal changes, pregnancy, sexual activity)

NSAID = nonsteroidal anti-inflammatory drug

Action Trigger

NB1: If a patient with asthma develops an indication for beta-blocker therapy (eg heart failure, myocardial infarction), start beta-blocker therapy at a low dose under supervision.

NB2: Food allergies rarely trigger acute asthma; however, a confirmed food allergy is a risk factor for asthma-related death.

Diet

Diet

Encourage healthy eating for all patients with asthma [Note 15]. Dietary supplements, including vitamin D, have not been shown to be of benefit for asthma. Dietary restrictions such as low-salt diets, or avoiding dairy foods or food additives are not recommended without dietetic or medical supervision.

Note 15: See the National Health and Medical Research Council *Australian Dietary Guidelines* for further information; available at [URL]

Exercise

Exercise

Asthma is not a contraindication to physical exercise, and all patients with asthma should be encouraged to exercise regularly. Exercise improves asthma symptoms, quality of life, exercise capacity, bronchial hyperreactivity and exercise-induced bronchospasm, and can achieve small improvements in forced expiratory volume in 1 second (FEV_1).

Breathlessness triggered by exercise may be due to lack of fitness rather than exercise-induced bronchoconstriction. Breathlessness that worsens in the minutes after stopping exercise is likely to be due to asthma. Exercise-induced bronchoconstriction can be managed and is not a reason to avoid exercise.

Breathing exercises

Breathing exercises

Breathing exercises can improve asthma symptoms and quality of life, and may have a modest effect on lung function. Some of the reported benefit may be related to relaxation strategies that are often incorporated with breathing exercises. Breathing exercises can be considered in conjunction with prescribed maintenance asthma therapy.

For a summary of breathing exercises that may improve asthma symptoms, see the Global Allergy & Airways Patient Platform website.

Complementary medicine

Complementary medicine

Although there is no good evidence that complementary medicines are beneficial for asthma, patients frequently use them. Ensure patients trialling complementary medicine continue with their usual medications.

Provide information about the possible harms and benefits of complementary medicine. For a summary of evidence for complementary therapies in asthma, see the *Australian Asthma Handbook* .

Self-management and asthma action plans for adults and adolescents

Self-management and asthma action plans for adults and adolescents

Self-management

Self-management

Effective asthma care requires the patient and healthcare professional(s) to manage asthma in a partnership. Actively involving the patient in their own care can achieve a significant reduction in emergency healthcare use and asthma morbidity.

Provide core information about asthma to form a basis for understanding its treatment. Personalise the education to the patient's asthma severity and health literacy. Key information that can assist in self-management includes:

- an explanation of asthma
- rationale for treatment (including the difference between relievers and preventers, and the importance of adherence)
- education on correct inhaler technique
- potential adverse effects of treatment
- how to recognise worsening asthma and what to do, including a written asthma action plan.

Written asthma action plans for adults

Written asthma action plans for adults
Overview

All patients should have an individualised written asthma action plan that outlines:

- the usual preventer and reliever drug regimen
- how to recognise symptoms of asthma deterioration
- when to start or change reliever and preventer therapy, and when to start oral corticosteroid therapy
- when to seek medical attention.

Review the action plan at least annually and whenever therapy is changed.

All patients with asthma must know when to seek medical attention.

Asthma action plan templates that can be individualised are available from the National Asthma Council.

Symptom-based action plans are suitable for the majority of patients. Action plans based on peak expiratory flow (PEF) measurements are recommended for patients who are poor perceivers or overperceivers of symptoms, and patients prone to sudden severe exacerbations. Plans based on PEF measurements should use personal-best PEF rather than predicted PEF for action points. A PEF monitoring chart is available from the National Asthma Council.

Principles of adjusting drug therapy for an asthma action plan

For the principles of asthma action plans for adolescents, see Written asthma action plans for children.

Asthma action plans detail steps for adjusting drug therapy that should be followed when symptoms occur. Individualise the plan to the patient's current treatment regimen, their usual asthma symptoms and pattern of reliever use, and their willingness and ability to self-manage worsening asthma. Also consider the patient's history of exacerbations, including the severity and their ability to seek appropriate medical attention. Asthma action plan templates that can be individualised are available from the National Asthma Council.

For a mild, transient increase in symptoms, the action plan should recommend that the patient use their reliever therapy. If the symptoms respond well and do not recur, this step is enough.

For a nonurgent but persistent increase in symptoms (eg requiring reliever more than three times per week, symptoms recurring within a few hours of reliever therapy, asthma interfering with daily activities), the action plan should recommend a short-term increase in corticosteroid intake (in addition to using reliever therapy), which can prevent progression to an acute exacerbation. This can be achieved by increasing the dose of inhaled corticosteroids (ICS), or using a short course of oral prednis(ol)one.

Increasing the ICS dose is usually preferred as the initial step because it exposes the patient to a lower total dose of corticosteroid than using oral prednis(ol)one. However, oral prednis(ol)one may be preferred in patients with a history of severe exacerbations or rapid progression to a severe exacerbation, or patients who cannot tolerate the increased risk of dysphonia with higher ICS doses (eg singers, actors, teachers).

For patients using low- to medium-dose ICS monotherapy , quadrupling the dose of ICS for 1 to 2 weeks is recommended; doubling the ICS dose is not sufficient. If symptoms do not respond to the increased ICS dose, the action plan should recommend that the patient start oral prednis(ol)one and return to their usual ICS dose.

For patients using low- to medium-dose ICS+LABA combination therapy, oral prednis(ol)one may be preferred because increasing the ICS dose requires a separate ICS-only inhaler (to avoid excessive LABA dosing), which may not be practical.

For patients using high-dose ICS (either as monotherapy or ICS+LABA combination therapy), increasing the ICS dose further is unlikely to be of additional benefit, so the action plan should recommend oral prednis(ol)one.

For patients using budesonide+formoterol as required, or as maintenance and reliever therapy, taking extra doses on an as-required basis to manage symptoms inherently increases ICS intake. Oral prednis(ol)one should be added if symptoms do not respond to the extra doses.

Consider the practicality of dose adjustments with the inhaled formulation prescribed. See Table 9.3 for formulation details of inhalers, including maximum doses of ICS monotherapy and ICS+LABA combination therapy inhalers. Ensure the action plan clearly states the daily maximum number of inhalations specific to the patient's inhaler.

If a short course of oral prednis(ol)one is required, use:

prednis(ol)one 37.5 to 50 mg orally, daily for 5 to 10 days. *asthma, written action plan (adult)* _

Ongoing review of adults and adolescents with asthma

Ongoing review of adults and adolescents with asthma

Ongoing review of adults and adolescents with asthma is integral to optimal management. In addition to reviewing patients following medication changes or exacerbations, schedule regular reviews:

- annually for well-controlled patients who have had no exacerbations in the past 12 months
- every 6 months for a patient who has had an exacerbation in the past 12 months, or who has risk factors for adverse asthma outcomes
- every 3 months for a patient with severe asthma (with consideration of specialist appointments), a patient who is a poor perceiver, or who has comorbidities that affect asthma control.

Explain to the patient that regular reviews help to detect and respond to changes in their asthma early, to minimise deterioration in lung function and exacerbations. Ongoing review also aids in titrating drug therapy to the lowest effective regimen.

At regular asthma reviews:

- address any concerns the patient has about their asthma
- assess asthma symptom control according to symptoms over the previous 4 weeks

- assess lung function with spirometry (every 1 to 2 years is usually enough, but perform more regularly for patients with poor control, severe asthma or risk factors for accelerated decline in lung function [see Table 9.6])
- update the written asthma action plan, if required, and confirm the patient's comprehension of the plan
- risk factors for adverse asthma outcomes
- comorbidities
- drug therapy, including:
    - the need to step up or step down drug therapy (see Stepped adjustment of asthma therapy)
    - adherence
    - inhaler technique
    - any concerns the patient has about their treatment.

The 'Asthma cycle of care' has been established in Australia to assist general practitioners in managing asthma; it is a requirement of the Medicare Practice Incentive Program for asthma. For further information, see the National Asthma Council.

Inhaler technique

Inhaler technique

Correct inhaler technique is essential for good asthma outcomes. Up to 90% of patients have incorrect inhaler technique, but most are not aware that they have a problem. Correcting inhaler technique can lead to significant improvement in asthma symptom control.

Up to 90% of patients use their inhaler incorrectly.

Before prescribing an inhaler device, train the patient in its use and confirm that they are able to use it correctly. Avoid prescribing multiple different inhaler devices if possible, to reduce confusion. See Inhalational drug delivery devices for further information.

Check inhaler technique at every opportunity by watching the patient use their inhaler, and comparing their technique with a device-specific checklist; see Checklist for device use. Correct the patient's technique using a physical demonstration, focusing on incorrect steps.

Adherence

Adherence

If asthma symptom control is poor or exacerbations continue to occur despite adequate treatment, consider poor inhaler technique and adherence. Adherence often worsens with improvement in symptoms.

Strategies that may improve adherence include:

- using an open, nonjudgmental approach when discussing adherence
- allowing the patient to express their concerns about drugs and devices (including about adverse effects), and addressing these concerns
- improving the patient's understanding of asthma management over time; comprehensive information given at one visit is often not well retained
- explaining the goals of treatment and aligning them with the patient's goals
- keeping treatment simple (eg using once- or twice-daily dosing if possible, using as few devices as possible)
- identifying useful daily associations (eg mealtimes, brushing teeth) or medication reminders (eg on phones or electronic devices) to improve adherence
- enlisting support of the patient's family and peers
- keeping in touch and using reminder letters or phone calls.

Asthma in adolescence

Asthma in adolescence

Adolescence is generally defined as 12 to 18 years of age. For adolescents older than 14 years, the recommendations for managing asthma in adults usually apply. For younger adolescents, the recommendations for managing asthma in children usually apply.

About one-third of adolescents experience asthma remission during puberty; the reason for this is unknown. However, asthma may improve or worsen in adolescence, or it may be the time of first presentation.

Give adolescents the opportunity to be seen without parents or carers present. This allows discussion of sensitive issues impacting on asthma management, such as tobacco and drug use, adherence and their concerns about their asthma. Assure appropriate confidentiality will be maintained.

Assess health literacy and provide the appropriate level of verbal and written information.

Asthma in older people

Asthma in older people

The prevalence of asthma in patients older than 65 years is the same as in the general adult population. Asthma first presenting in this age group is often called late-onset asthma.

Asthma may be harder to diagnose in older people because of under-reporting of symptoms that are assumed to be related to ageing and concurrent conditions (eg chronic obstructive pulmonary disease [COPD], heart failure, deconditioning). The coexistence of asthma (increased airflow variability) and COPD (incompletely reversible airflow limitation) is common in this age group; see Overlap of asthma and COPD.

Consider the potential for drug interactions and aggravation of pre-existing conditions (eg tachyarrhythmias, diabetes) when prescribing drugs for asthma.

Choose suitable inhaler devices and train patients in their use. For consideration of device choice in older adults, see here. If possible, avoid prescribing multiple different inhaler devices. Although poor inhaler technique is common in all patients, additional factors in older patients can contribute to poor technique, including mechanical difficulties (eg osteoarthritis), visual or cognitive impairment, and poor inspiratory flow.

Asthma and pregnancy

Asthma and pregnancy

If a woman with asthma is planning to become pregnant, explain the importance of maintaining good control of asthma throughout pregnancy. Exacerbations and poor asthma control increase the risk of pre-eclampsia and preterm delivery and low birth weight, but with good control of asthma, the risk of these complications is similar to the normal population.

Women may be concerned about using drug therapy during pregnancy; explain that the advantages of maintaining good asthma control significantly outweigh any risks associated with drug therapy. Asthma slightly increases the risk of congenital abnormalities, but this risk is not influenced by drug therapy. Inhaled corticosteroids, beta agonists and montelukast are not associated with fetal abnormalities. Consider changing preventer therapy to budesonide monotherapy (the only preventer therapy classed Category A for pregnancy by the Therapeutic Goods Administration) before conception. However, this is not essential, and should not be tried in a woman who is already pregnant—stepping down therapy increases the risk of an exacerbation.

Advise women that uncontrolled asthma is a greater risk to their baby than using asthma medications.

Asthma often changes during pregnancy—around one-third of women experience an improvement in control, while at least one-third experience worsening of control. Measure baseline spirometry before conception.

Manage asthma during pregnancy as for asthma in other adults, but with more regular review (eg every 4 to 6 weeks). Treat asthma exacerbations in pregnant women the same as exacerbations in nonpregnant women—oral corticosteroids should not be avoided. See Acute asthma for details about the management of asthma exacerbations.

Strongly advise women with asthma who are pregnant not to smoke, and to avoid exposure to tobacco smoke.

Recommend vaccination according to the Australian Immunisation Handbook.

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Assessment and classification of cough in children

Assessment and classification of cough in children

Cough is classified according to its duration because this assists in differential diagnosis.

In children, cough is classified as:

- acute cough, lasting up to 2 weeks
- protracted acute cough, lasting 2 to 4 weeks
- chronic cough, lasting longer than 4 weeks.

This differs from the classification of cough in adults.

Identify the cause of acute cough, protracted acute cough [Note 1] or chronic cough to determine appropriate treatment.

If a child with cough has systemic symptoms (eg fever, weight loss, failure to thrive), consider additional investigations or referral to a relevant specialist.

For detailed advice on diagnosis and assessment of chronic cough in children, see the European Respiratory Society guidelines available here.

Note 1: In children with protracted acute cough, consider causes of acute cough and chronic cough.

Causes of acute cough in children

Causes of acute cough in children

The most common cause of acute cough in children is acute viral respiratory tract infection. Acute cough can be productive (wet or moist) or dry, and symptoms settle spontaneously in 7 to 10 days; 90% of affected children are cough-free within 3 weeks.

Suspect acute bacterial pneumonia in children with acute cough who have persistent fever, increased effort of breathing, and tachypnoea at rest. Children with bacterial pneumonia are lethargic and appear unwell.

Suspect inhaled foreign body if cough is sudden in onset, particularly if cough started while the child was eating or playing with small objects. Wheeze may also be present; urgently refer infants or children in whom there is clinical suspicion of foreign body aspiration.

Consider croup in children with a barking or brassy acute cough.

Also consider causes of chronic cough because children may present soon after onset of cough.

Causes of chronic cough in children

Causes of chronic cough in children

There are many causes of chronic cough in children.

Causes of chronic cough in children include:

- protracted bacterial bronchitis—most likely cause of an isolated chronic productive (wet or moist) cough in the absence of indicators to suggest an alternate cause
- asthma—consider if wheeze, shortness of breath and night cough are present
- environmental exposure to cigarette smoke—smoke is a significant trigger for cough. Parent or carer smoking cessation reduces cough in children
- postviral cough—following an acute viral respiratory tract infection, such as acute rhinosinusitis or acute bronchitis; cough may last up to 8 weeks
- upper airway cough syndrome (previously called postnasal drip)—consider if the child has acute rhinitis (see here)
- retained inhaled foreign body—if the cough was sudden in onset, particularly if cough started while the child was eating or playing with small objects; urgently refer to a paediatrician, an ear, nose and throat specialist, or a respiratory specialist
- infections including pertussis (whooping cough), lung abscess or tuberculosis
- congenital airway abnormalities (eg tracheomalacia, vascular ring)
- chronic lung disease (eg bronchiectasis, cystic fibrosis)—consider if recurrent episodes of protracted productive (wet or moist) cough, clubbing of the fingers, chest wall deformity, or abnormal growth or development are observed
- somatic cough syndrome (previously known as psychogenic cough)—if child presents with a bizarre honking cough; exclude other causes of cough (eg tic cough)
- tic cough (previously known as habit cough)—if child presents with a cough associated with suppressibility, distractibility, suggestibility and variability; cough may be isolated or occur in the context of other tics.

Also consider causes of acute cough because children may present late after onset of cough.

Management of cough in children

Management of cough in children

Identify and treat the cause of cough in children; see Causes of acute cough in children and Causes of chronic cough in children. For more detail on the diagnosis and management of chronic cough in children, including children-specific algorithms, see the European Respiratory Society guidelines.

Antibiotic therapy is not required for cough in children unless they have acute bacterial pneumonia or a bacterial cause of chronic cough (such as protracted bacterial bronchitis, pertussis, lung abscess or tuberculosis).

Honey has some evidence of benefit in children with cough; it may be trialled in children older than 12 months.

Cough and cold medicines for children have minimal, if any, evidence of efficacy, are costly, and can cause harm. The Australian Therapeutic Goods Administration (TGA) has advised that cough and cold medicines, including cough suppressants, antihistamines, decongestants and combination products, should not be given to children younger than 6 years. The Australian TGA advises that cough and cold medicines should only be given to children aged 6 to 11 years on the advice of a doctor, pharmacist or nurse practitioner. Caution should be used when treating children in this age group with cough and cold medicines; advise parents or carers of the minimal evidence of efficacy, and potential harms.

Cough and cold medicines for children have limited evidence of efficacy, are costly and can cause harm.

There is no evidence for the use of ‘salt therapy’ (salt caves, salt rooms or inhalation of salt) in treatment of cough in children.

If chronic cough persists despite treatment trial, refer to a paediatric respiratory physician.

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Key references: Cough in children

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Overview of wheeze

Overview of wheeze

Wheeze is produced by turbulent airflow in the lower airways. It is most commonly heard as a high-pitched whistle on expiration.

Parents and carers often incorrectly identify wheeze. The ‘What is asthma?’ video on The Royal Children’s Hospital (Melbourne) website can be used to educate parents or carers to correctly identify wheeze. Hearing the wheeze in person or via a recording can help confirm the symptom.

Wheeze can be acute or chronic.

Acute wheeze is common in infants and children. Causes of acute wheeze vary, but asthma should not be the assumed diagnosis, particularly in infants. See Acute wheeze in infants 12 months and younger and Acute wheeze and assessment for asthma in children 1 to 5 years for more information.

Urgently refer infants or children with sudden-onset acute wheeze if foreign body aspiration or anaphylaxis is suspected.

Chronic wheeze in infants and children can be caused by a number of conditions. In a thriving infant, ongoing daily expiratory wheeze occurring from the first few weeks of life, without respiratory distress, sleep disturbance or cough may be due to tracheobronchomalacia rather than asthma. Referral is indicated for most infants and children with chronic wheeze.

Acute wheeze in infants 12 months and younger

Acute wheeze in infants 12 months and younger

Urgently refer infants with sudden-onset wheeze if foreign body aspiration or anaphylaxis is suspected. Acute wheeze in an infant younger than 12 months is most commonly a symptom of acute bronchiolitis. Asthma cannot be diagnosed in this age group, and infants should not be treated with asthma medication.

Acute wheeze and assessment for asthma in children 1 to 5 years

Acute wheeze and assessment for asthma in children 1 to 5 years

Overview of wheeze and asthma in children 1 to 5 years

Overview of wheeze and asthma in children 1 to 5 years

Recurrent wheeze is common in children aged 1 to 5 years, and is most often a symptom of a viral respiratory tract infection, which can occur 6 to 8 times per year in this age group. Most of these children do not have asthma.

Wheeze in a child 1 to 5 years old is more likely to be a symptom of a viral respiratory tract infection than asthma.

Assess children aged 1 to 5 years with wheeze to determine whether treatment is required, and to investigate alternative diagnoses.

Asthma cannot be formally diagnosed or excluded in young children, as they are unable to perform spirometry and too young for a clear pattern of symptoms to be established. A trial of a short-acting beta$_2$ agonist (SABA) is not diagnostic—many young children whose symptoms respond to SABA therapy do not have asthma in later childhood. Even a 'provisional' diagnosis of asthma in this age group requires continuous reassessment, and a long-term diagnosis must not be made until the child is old enough to perform spirometry, or the pattern of symptoms is clear. See Clinical assessment of wheeze in children 1 to 5 years for more information.

Treatment of wheeze in children 1 to 5 years is often not necessary. It is usually initiated when symptoms are bothersome (eg limit daytime activities, affect sleep). For recurrent bothersome symptoms, short-term treatment with an as-required SABA reliever (eg salbutamol) is usually sufficient. A small number of children with frequent or severe viral-induced symptoms (eg requiring emergency-department visits), or with symptoms between infections, may benefit from a regular preventer. Drug therapy in this age group should always be considered a treatment trial, with continuous reassessment to determine the need for ongoing treatment. See Treatment trial for wheeze and asthma in children 1 to 5 years for more information.

Clinical assessment of wheeze and asthma in children 1 to 5 years

Clinical assessment of wheeze and asthma in children 1 to 5 years

In children aged 1 to 5 years with reported wheeze, confirm that the symptom is actually wheeze—parents and carers often incorrectly identify wheeze. Hearing the wheeze either in person, or via a video recording, can help confirm the symptom (see the video from The Royal Children's Hospital [Melbourne]).

Spirometry is not feasible in children 5 years and younger, so assessment of children in this age group with wheeze relies on clinical findings. Take a detailed history and perform a physical examination to determine whether a treatment trial is appropriate, and to exclude possible alternative diagnoses.

Features in a young child that suggest an alternative diagnosis or warrant referral include focal wheeze, poor growth or developmental delay. Table 9.2 also outlines conditions commonly confused with asthma in children.

The history should include details of:

- current symptoms (wheeze, cough, shortness of breath, chest discomfort or tightness, increased respiratory rate and work of breathing)
- pattern of symptoms (frequency, time of day or night)
- severity of symptoms (impact on alertness, activity and play)
- aggravating or precipitating factors (eg viral infections, exercise, laughing)
- allergies (eg atopic dermatitis, allergic rhinitis)
- exposure to second-hand smoke in the home and biomass smoke (eg indoor fires for heating or cooking)
- family history of allergies or asthma
- relieving factors (including medication trials).

The physical examination should include:

- height and weight
- chest auscultation
- inspection for chest deformity
- inspection of the upper respiratory tract for signs of allergic rhinitis, and skin for signs of atopic dermatitis.

Chest X-ray is generally not necessary for assessment of wheeze and asthma in children—it can be considered for unusual symptoms, or for suspected alternative diagnoses (eg pneumonia).

While assessment can't definitively confirm or exclude a diagnosis of asthma in children 1 to 5 years, certain features increase the probability that a child with wheeze will have asthma in later childhood and adulthood.

See Table 9.8 for a list of features that increase and decrease the likelihood of asthma. Although the probability of asthma does not necessarily change initial management, it can be a useful part of the discussion with parents and carers.

If the child has unusual symptoms or if an alternative diagnosis is suspected but can't be confirmed, consider referral to a specialist for further investigation.

Table 9.8 Clinical features that increase and decrease the probability of a children 1 to 5 years with wheeze having asthma in later childhood and adulthood

CLINICAL FEATURES THAT INCREASE THE PROBABILITY OF ASTHMA
more than one of the following symptoms: wheeze, breathlessness, chest tightness or discomfort, cough—particularly if symptoms: • are worse at night and in the early morning • occur in response to active play, laughing, allergen exposure or cold air • are recurrent
wheeze occurring when the child does not have a cold
history of atopic disorder (eg allergic rhinitis, atopic dermatitis)
family history of asthma or atopic disorder
widespread wheeze heard on auscultation of the chest
improvement in symptoms in response to trial of asthma therapy
otherwise unexplained peripheral blood eosinophilia
presence of conditions associated with asthma (eg bronchopulmonary dysplasia, obstructive sleep apnoea, recurrent bronchiolitis)
CLINICAL FEATURES THAT LOWER THE PROBABILITY OF ASTHMA
chronic productive cough in the absence of wheeze or breathlessness
repeatedly normal auscultation of chest when symptomatic
voice disturbance or throat tightness
prominent dizziness, light-headedness, peripheral tingling
no response to a trial of asthma therapy
clinical features supporting an alternative diagnosis

Treatment trial for wheeze and asthma in children 1 to 5 years

Treatment trial for wheeze and asthma in children 1 to 5 years

Many children aged 1 to 5 years don't require acute treatment for their wheezing episodes as they do not limit activity or affect sleep.

For recurrent bothersome wheeze associated with increased work of breathing, asthma treatment can be trialled to reduce the frequency and severity of symptoms. Drug therapy in children aged 1 to 5 years should always be considered a treatment trial, with continuous reassessment to determine the need for ongoing treatment.

Short-term treatment with an as-required reliever (salbutamol via pressurised metered dose inhaler [pMDI]) is usually sufficient. Use:

salbutamol 100 micrograms, 2 to 6 inhalations via pMDI with spacer (and face mask if required), as required.
asthma or wheeze, treatment trial (child 1 to 5 years)

If the child's symptoms do not show a clear response to correctly used bronchodilator therapy, consider possible alternative diagnoses (see Table 9.2) as this could indicate that the provisional diagnosis of asthma is incorrect.

Counsel parents and carers to give salbutamol when the child has wheeze associated with increased work of breathing; it is not necessary for isolated cough or for mild wheeze without increased work of breathing.

Educate parents and carers about how to use the inhaler, including advice about using a spacer (recommended for all children) and a mask (useful for young children). See here for information about using masks and spacers, and Table 9.31 for links to instructional videos and patient handouts for pMDIs.

A small number of children with frequent, severe symptoms that occur with viral respiratory tract infections, or with symptoms between infections, may benefit from a preventer. For detailed information about trialling preventer therapy in children aged 1 to 5 years, see Maintenance management of asthma in children.

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Principles of maintenance management of asthma in children

Principles of maintenance management of asthma in children

The aim of management of asthma in children is to maintain a normal quality of life, free of asthma symptoms and without adverse effects of asthma treatment.

Before starting drug therapy for asthma in children, confirm that the diagnosis is correct. Diagnosis differs between age groups:

- for diagnosis in children 6 years and older, see Asthma diagnosis: children 6 years and older, adolescents and adults
- for diagnosis in children 5 years and younger, see Assessment of wheeze and asthma in children 5 years and younger—it is not possible to make a formal diagnosis of asthma in this age group.

For information about wheeze in infants 12 months and younger, see here. Wheezing in infants 12 months and younger is most commonly a symptom of acute viral bronchiolitis rather than asthma.

Drug therapy for asthma in children is introduced in a stepwise manner—see Stepwise therapy of wheeze and asthma: children 1 to 5 years and Stepwise therapy of asthma: children 6 years and older. For younger adolescents (younger than 14 years), the recommendations for managing asthma in children apply in most situations. For older adolescents, the recommendations for managing asthma in adults apply in most situations; see Maintenance management of asthma in adults and adolescents.

Control of asthma is defined as good, partial or poor—see Table 9.9. Maintenance management relies on a continuous cycle of reviewing response and adjusting therapy, aiming to establish the minimum drug regimen that achieves good control.

In addition to drug treatment, optimised management of asthma in children should include:

- a written asthma action plan to manage exacerbations
- training in inhaler technique (see Inhalational drug delivery devices)
- management of comorbidities that can reduce asthma control (eg obesity, rhinitis and rhinosinusitis, and anxiety and depression)
- patient and carer education about avoiding triggers for asthma—in children, a viral respiratory tract infection is the most common trigger for asthma
- general advice about maintaining a healthy lifestyle (diet, weight and activity)
- maintenance of current immunisations—including annual influenza vaccination (for more information about vaccinations, see the *Australian Immunisation Handbook*).

Stepwise therapy for wheeze and asthma: children 1 to 5 years

Stepwise therapy for wheeze and asthma: children 1 to 5 years

Overview of stepwise therapy for children 1 to 5 years

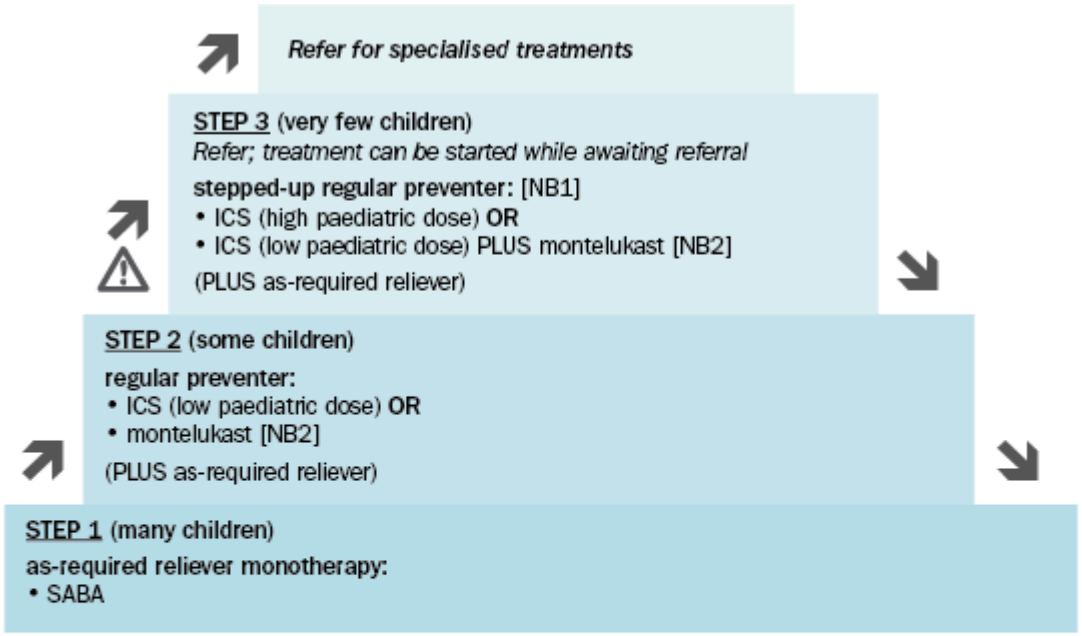
Overview of stepwise therapy for children 1 to 5 years

A definitive diagnosis of asthma is not possible in children aged 1 to 5 years, so drug therapy should always be considered a trial, with continuous reassessment to determine the need for ongoing treatment. For detailed information about assessment of wheeze and asthma in children aged 1 to 5 years, including guidance on the

clinical assessment and decision to trial treatment, see Acute wheeze and assessment of asthma in children 1 to 5.

Treatment of wheeze in children 1 to 5 years is often not necessary, particularly if symptoms are not bothersome (eg do not limit activity or affect sleep). For recurrent bothersome symptoms associated with increased work of breathing, short-term Step 1 therapy with an as-required short-acting $beta_2$ agonist (SABA) (salbutamol) is usually sufficient. A small number of children with frequent or severe symptoms (eg requiring emergency-department visits) that occur with viral respiratory tract infections, or with symptoms between infections, may benefit from Step 2 therapy with a regular preventer. Step 3 therapy is required for very few children. Therapy is summarised in Figure 9.4. See each step for detailed information about indications, treatment options and drug doses.

Figure 9.4 Stepped approach to starting and adjusting therapy for wheeze and asthma in children 1 to 5 years old



⚠	Before considering stepping up therapy, review adherence and inhaler technique, check equipment (eg inhaler, spacer, mask) for breakage or blockage, assess for an alternative diagnosis or a comorbidity (eg rhinitis), and ensure exposure to triggers is minimised.
↗	Consider stepping up therapy if good control is not achieved despite good adherence and correct inhaler technique; see Assessment of asthma control in children for more information.
↘	If symptoms have been stable and well controlled for at least 3 months, consider stepping down therapy; see Stepping down asthma therapy in children for more information.

ICS = inhaled corticosteroid; LABA = long-acting $beta_2$ agonist; SABA = short-acting $beta_2$ agonist

NB1: Use of LABAs in children younger than 5 years is not supported by evidence; they are not recommended in this age group.

NB2: Montelukast is less effective than ICS and has been associated with neuropsychiatric adverse effects, including nightmares, sleep disturbance, agitation, depression and, rarely, suicidal thinking and behaviour. Counsel parents and carers about these effects. They usually occur in the first 2 weeks of treatment. Stop treatment if these effects occur—the effects usually subside within a few days of stopping treatment. See the Australian Therapeutic Goods Administration (TGA) website for more information.

Adapted from the Australian Asthma Handbook © 2020 National Asthma Council Australia. Accessed 31 August 2020.

Review symptom control 4 to 6 weeks after starting therapy to determine whether good control has been achieved. A continuous cycle of reviewing response and adjusting therapy (stepping up or down) is

recommended, aiming to achieve a normal quality of life using the minimal dose regimen. See Review and ongoing management of asthma in children.

Control of asthma is defined as good, partial or poor—see Table 9.9. Children who are well controlled with Step 1 or Step 2 therapy are considered to have mild asthma. Children who require Step 3 therapy are considered to have severe asthma and should be referred for specialist management—see Severe asthma in children.

Step 1 therapy for children 1 to 5 years

Step 1 therapy for children 1 to 5 years

Many children aged 1 to 5 years don't require acute treatment for their wheezing episodes as they are not bothersome (eg do not limit activity or affect sleep). For a recurrent bothersome wheeze associated with increased work of breathing, consider a trial of reliever therapy. Use the short-acting $beta_2$ agonist (SABA) salbutamol (via a pressurised metered dose inhaler [pMDI]):

salbutamol 100 micrograms, 2 to 6 inhalations via pMDI with spacer (and face mask if required), as required.
asthma or wheeze, Step 1 therapy (child 1 to 5 years)

If symptoms do not show a clear response to correctly used salbutamol, the provisional diagnosis of asthma may be incorrect. Consider possible alternative diagnoses (see Table 9.2) and stop salbutamol therapy.

Poor response to correctly used SABA therapy could indicate that the provisional diagnosis of asthma is incorrect.

If symptoms do respond to the treatment trial of salbutamol, as-required salbutamol should continue to be used during episodes of bothersome wheezing. It is not necessary to use as-required salbutamol for isolated cough or for mild wheeze without increased work of breathing.

Educate parents and carers about how to use the pMDI, including advice about using a spacer (recommended for all children) and a mask (if required). See Inhalational drug delivery devices for information about using masks and spacers, and Table 9.31 for links to instructional videos and patient handouts for pMDIs.

Short-term as-required treatment with salbutamol is sufficient for most young children with wheeze. However, some children also require regular preventer therapy—see Step 2 therapy. Before escalating to Step 2 therapy, review inhaler technique and check equipment (inhaler, spacer, mask) for breakage or blockage. Also assess for symptoms and signs that indicate an alternative diagnosis or a comorbidity (eg rhinitis), and ensure exposure to triggers are minimised.

Step 2 therapy for children 1 to 5 years

Step 2 therapy for children 1 to 5 years

Some children aged 1 to 5 years who wheeze benefit from Step 2 therapy with a preventer, to reduce the frequency and severity of symptoms and maintain a normal quality of life. Children who start preventer therapy should still be prescribed salbutamol for relief of acute symptoms.

Trial a regular preventer in children aged 1 to 5 years:

- who have symptoms requiring salbutamol occurring at least once a week
- who have had two or more moderate wheezing episodes (requiring emergency-department care or oral corticosteroids) in the last year
- following any severe wheezing episodes (requiring hospital admission).

Consider a preventer for children with symptoms that are infrequent (eg every 4 to 6 weeks) but severe (eg post-tussive vomiting, nocturnal cough) or occur between viral respiratory tract infections.

An inhaled corticosteroid (ICS) is the preferred preventer for most children. Fluticasone propionate is the only ICS suitable for children 1 to 5 years. If a preventer is indicated, start therapy with a low dose of fluticasone propionate. Use:

fluticasone propionate 50 to 100 micrograms by inhalation via pMDI with spacer (and mask if required), twice daily. *asthma, Step 2 therapy (child 1 to 5 years)*

Explain that ICS therapy needs to be used every day to be effective, and does not relieve acute symptoms. See also Inhaled corticosteroids for asthma in children for general considerations about using ICS in children.

Educate parents and carers about how to use the inhaler, including advice about using a spacer (recommended for all children) and a mask (if required). See here for information about using masks and spacers, and Table 9.31 for links to instructional videos and patient handouts for pMDIs.

Montelukast can be considered instead of an ICS in children unable to use a pMDI (with spacer and mask), or if the child's parents or carers remain concerned about using an ICS after an informed discussion. Montelukast may also be beneficial in children with coexisting allergic rhinitis, or exercise-induced bronchoconstriction. Use:

montelukast 4 mg orally, once daily [Note 1]. *asthma, Step 2 therapy (child 1 to 5 years)*

Explain that montelukast needs to be used every day to be effective, and does not relieve acute symptoms.

Assess symptom control 4 to 6 weeks after starting fluticasone propionate or montelukast. See Assessment of asthma control in children for details about review, and definitions of good, partial and poor control.

If symptoms are well controlled with Step 2 therapy, continue therapy and review the child again after 3 months. Therapy may be able to be stepped down if control remains good—see Stepping down therapy.

If the child has partial or poor control on Step 2 therapy, review adherence and, if using fluticasone propionate, review inhaler technique and check equipment (inhaler, spacer, mask) for breakage or blockage. Before escalating to Step 3 therapy, also assess for symptoms and signs that indicate an alternative diagnosis or a comorbidity (eg rhinitis), and ensure exposure to triggers are minimised. Poor response to therapy (particularly to correctly used ICS) could indicate that the provisional diagnosis of asthma is incorrect. Very few children aged 1 to 5 years require Step 3 therapy to achieve good control.

If the child is taking montelukast, switch therapy to low-dose fluticasone propionate, if possible, rather than escalating to Step 3 therapy.

Note 1: Montelukast has been associated with neuropsychiatric adverse effects, including nightmares, sleep disturbance, agitation, depression and, rarely, suicidal thinking and behaviour. Counsel parents and carers about these effects. They usually occur in the first 2 weeks of treatment. Stop treatment if these effects occur—the effects usually subside within a few days of stopping treatment. See the Australian Therapeutic Goods Administration (TGA) website for more information.

Step 3 therapy for children 1 to 5 years

Step 3 therapy for children 1 to 5 years

Very few children aged 1 to 5 years require Step 3 therapy to control symptoms. Step 3 therapy can be considered in children who do not achieve good control with Step 2 therapy despite good adherence and inhaler technique, and after exclusion of alternative diagnoses.

Refer all children requiring Step 3 therapy to a paediatrician or paediatric respiratory physician. Step 3 therapy can be started while awaiting specialist review.

Refer all children requiring Step 3 therapy to a paediatrician or paediatric respiratory physician.

If Step 3 therapy is appropriate, use either:

- a high paediatric dose of fluticasone propionate—this is the preferred option in most children
- a low paediatric dose of fluticasone propionate plus montelukast—this may be more effective in children with coexisting allergic rhinitis, and may be used to reduce corticosteroid exposure.

If high-dose fluticasone propionate is preferred, use:

fluticasone propionate 125 micrograms by inhalation via pMDI with spacer (and mask if required), twice daily [Note 2]. *asthma, Step 3 therapy (child 1 to 5 years)*

If low-dose fluticasone propionate plus montelukast is preferred, use:

fluticasone propionate 50 to 100 micrograms by inhalation via pMDI with spacer (and mask if required), twice daily

PLUS

montelukast 4 mg orally, once daily [Note 3]. *asthma, Step 3 therapy (child 1 to 5 years)*

Explain that preventer therapy needs to be used every day to be effective, and does not relieve acute symptoms. See also Inhaled corticosteroids for asthma in children for general considerations about using ICS in children.

Educate parents and carers about how to use inhaled medication, including advice about using a spacer (recommended for all children) and a mask (if required). See Inhalational drug delivery devices for information about using masks and spacers, and Table 9.31 for links to instructional videos and patient handouts for pMDIs.

Assess symptom control after 4 to 6 weeks. See Assessment of asthma control in children for details about review, and definitions of good, partial and poor control.

If symptoms are well controlled, continue treatment and review the child again after 3 months. Therapy may be able to be stepped down if control remains good—see Stepping down therapy.

If symptoms remain uncontrolled with Step 3 therapy, review the diagnosis and arrange referral (if not already arranged). See also Severe asthma in children for information on specialist treatments for asthma.

Note 2: Doses of fluticasone propionate up to 250 micrograms twice daily can be used in children 1 to 5 years under specialist advice.

Note 3: Montelukast has been associated with neuropsychiatric adverse effects, including nightmares, sleep disturbance, agitation, depression and, rarely, suicidal thinking and behaviour. Counsel parents and carers about these effects. They usually occur in the first 2 weeks of treatment. Stop treatment if these effects occur—the effects usually subside within a few days of stopping treatment. See the Australian Therapeutic Goods Administration (TGA) website for more information.

Other treatment options for children 1 to 5 years: cromones

Other treatment options for children 1 to 5 years: cromones

Cromones (cromoglycate, nedocromil) are rarely used alternative preventer therapies. Cromones are not as effective as ICS and require more frequent dosing and meticulous daily care to prevent clogging of the inhaler device.

Cromoglycate can be considered for children 1 to 5 years if other preventer therapy is not suitable or tolerated. Use:

cromoglycate 10 mg by inhalation via pMDI with spacer, 3 or 4 times daily. *asthma, maintenance (child 1 to 5 years)*

Nedocromil has not been studied in children 1 to 5 years.

Stepwise therapy for asthma: children 6 years and older

Stepwise therapy for asthma: children 6 years and older

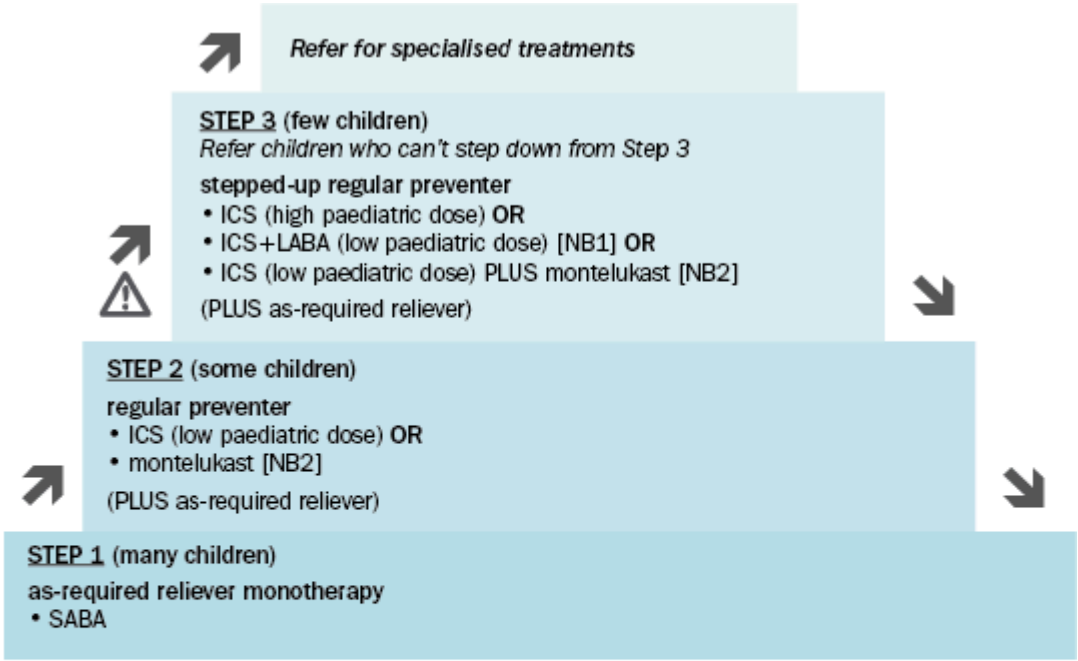
Overview of stepwise therapy for children 6 years and older

Overview of stepwise therapy for children 6 years and older

Drug therapy for asthma in children 6 years and older is introduced in a stepwise manner, as shown in Figure 9.5. For younger adolescents (younger than 14 years), the recommendations for managing asthma in children described in this topic apply in most situations. For older adolescents, the recommendations for managing asthma in adults apply in most situations; see Maintenance management of asthma in adults and adolescents.

The initial treatment step is determined by the frequency and severity of symptoms. For details about each step, including drug dosages, see the relevant sections—Step 1, Step 2 and Step 3.

Figure 9.5 Stepped approach to starting and adjusting asthma therapy in children 6 years and older



⚠	Before considering stepping up treatment, review adherence and inhaler technique, check equipment (eg inhaler, spacer, mask) for breakage or blockage, assess for an alternative diagnosis or a comorbidity (eg rhinitis), and ensure exposure to triggers is minimised.
↗	Consider stepping up if good control is not achieved despite good adherence and correct inhaler technique; see Assessment of asthma control in children for more information.
↘	If asthma has been stable and well controlled for at least 3 months, consider stepping down therapy; see Stepping down asthma therapy in children for more information.

ICS = inhaled corticosteroid; LABA = long-acting beta$_2$ agonist; SABA = short-acting beta$_2$ agonist

NB1: Always give ICS+LABA therapy as a fixed-dose combination inhaler to avoid the possibility of patients taking a LABA without an ICS; LABA monotherapy increases the risk of exacerbations and asthma-related death.

NB2: Montelukast is less effective than ICS and has been associated with neuropsychiatric adverse effects, including nightmares, sleep disturbance, agitation, depression and, rarely, suicidal thinking and behaviour. Counsel parents and carers about these effects. They usually occur in the first 2 weeks of treatment. Stop

treatment if these effects occur—the effects usually subside within a few days of stopping treatment. See the Australian Therapeutic Goods Administration (TGA) website for more information.

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Review symptom control 4 to 6 weeks after starting therapy to determine whether good control has been achieved. A continuous cycle of reviewing response and adjusting therapy (stepping up or down) is recommended, aiming to achieve a normal quality of life using the minimal dose regimen. See Review and ongoing management of asthma in children.

Control of asthma is defined as good, partial or poor—see Table 9.9. Children who are well controlled with Step 1 or Step 2 therapy are considered to have mild asthma. Children who remain uncontrolled despite Step 3 therapy, are considered to have severe asthma. These children require referral for specialist management—see Severe asthma in children.

Step 1 therapy for children 6 years and older

Step 1 therapy for children 6 years and older

Prescribe as-required reliever therapy for all children aged 6 years and older with a diagnosis of asthma. Use a short-acting beta$_2$ agonist (SABA)—either salbutamol (via a pressurised metered dose inhaler [pMDI]) or terbutaline (via dry powder inhaler [DPI]):

1 salbutamol 100 micrograms, 2 to 12 inhalations via pMDI with spacer, as required *asthma, Step 1 therapy (child 6 years or older)*

OR

2 terbutaline 500 micrograms, 1 to 6 inhalations via DPI, as required [Note 4]. *asthma, Step 1 therapy (child 6 years or older)*

Counsel parents and carers to give reliever therapy when the child has wheeze associated with increased work of breathing; it is not usually necessary for isolated cough or mild wheeze without increased work of breathing.

Educate parents and carers about how to use the inhaler, including advice about using a spacer (recommended for all children using a pMDI) and a mask (if required for children using a pMDI). See Table 9.31 for links to instructional videos and patient handouts for devices.

For children aged 6 years and older with asthma, as-required SABA therapy is often sufficient to manage symptoms.

If symptoms do not show a clear response to SABA therapy, review inhaler technique and check equipment (inhaler, spacer, mask) for breakage or blockage. Poor response to correctly used SABA therapy could indicate that the diagnosis of asthma is incorrect—assess for possible alternative diagnoses (see Table 9.2).

Some children also require regular preventer therapy—see Step 2 therapy for indications.

There is some evidence to suggest adding a dose of low-dose inhaled corticosteroid (ICS) taken whenever a dose of SABA is required can lower the risk of asthma exacerbations compared to SABA alone. At the time of writing, this is not usual practice in children.

Note 4: pMDI with spacer is usually the preferred option for all children. Older children (eg children older than 10 years) can use a DPI based on individual ability following device training.

Step 2 therapy for children 6 years and older

Step 2 therapy for children 6 years and older

Some children with asthma benefit from Step 2 therapy with a preventer, to reduce the risk of exacerbations, and minimise the interference of asthma in the child's life. The need for preventer therapy depends on the frequency and severity of symptoms. Trial a regular preventer in children aged 6 years and older:

- who have persistent asthma (daytime symptoms at least once per week, night-time symptoms at least twice per month, or symptoms that restrict activity or sleep)
- who always require SABA therapy before exercise
- who have had two or more moderate exacerbations (requiring emergency-department care or oral corticosteroids) in the last year, and also have symptoms at least every 6 weeks
- following any severe exacerbation (requiring hospital admission including ICU admission).

Also consider a preventer for children who have:

- frequent intermittent asthma (symptoms at least every 6 weeks)
- had two or more moderate exacerbations (requiring emergency-department care or oral corticosteroids) in the last year, but usually have infrequent intermittent asthma (symptoms less than every 6 weeks).

Children who start preventer therapy must be prescribed a SABA for relief of acute symptoms.

An inhaled corticosteroid (ICS) is the preferred preventer for most children. For Step 2 therapy with regular low-dose ICS, with SABA reliever therapy, use:

a SABA as required (see Step 1 for dosage)

PLUS ONE OF THE FOLLOWING

1 fluticasone propionate 50 to 100 micrograms by inhalation via pMDI with spacer or via DPI, twice daily [Note 5] *asthma, Step 2 therapy (child 6 years or older)*

OR

1 ciclesonide 80 to 160 micrograms by inhalation via pMDI with spacer, once daily *asthma, Step 2 therapy (child 6 years or older)*

OR

1 budesonide 100 to 200 micrograms by inhalation via DPI, twice daily [Note 5] [Note 6] *asthma, Step 2 therapy (child 6 years or older)*

OR

1 beclometasone 50 to 100 micrograms by inhalation via pMDI with spacer, twice daily. *asthma, Step 2 therapy (child 6 years or older)*

Explain that ICS therapy needs to be used every day to be effective, and does not relieve acute symptoms. See also Inhaled corticosteroids for asthma in children for general considerations about using ICS in children.

Educate parents and carers about how to use the inhaler, including advice about using a spacer (recommended for all children using a pMDI) and a mask (if required for children using a pMDI). See Inhalational drug delivery devices for information about using masks and spacers, and Table 9.31 for links to instructional videos and patient handouts for devices.

Montelukast can be considered instead of an ICS in children unable to use an inhaler (including a pMDI with spacer and mask), or if the parents or carers remain concerned about using an ICS after an informed discussion. Montelukast may also be beneficial in children with coexisting allergic rhinitis, or exercise-induced bronchoconstriction. Use:

montelukast 5 mg orally, once daily [Note 7]. *asthma, Step 2 therapy (child 6 years or older)*

Explain that montelukast needs to be used every day to be effective, and does not relieve acute symptoms.

Assess symptom control (see Assessment of asthma control in children) 4 to 6 weeks after starting preventer therapy. See Assessment of asthma control in children for details about review, and definitions of good, partial and poor control.

If symptoms are well controlled with Step 2 therapy, continue treatment and review the child again after 3 months. Therapy may be able to be stepped down if control remains good—see Stepping down therapy.

If the child has partial or poor control on Step 2 therapy, review adherence and, if using ICS, review inhaler technique and check equipment (inhaler, spacer, mask) for breakage or blockage. Before escalating to Step 3 therapy, also assess for symptoms and signs that indicate an alternative diagnosis or a comorbidity (eg rhinitis), and ensure exposure to triggers is minimised. Poor response to therapy (particularly to correctly used ICS) could indicate that the diagnosis of asthma is incorrect. Few children aged 6 years and older require Step 3 therapy to achieve good control.

If the child is taking montelukast, switch therapy to low-dose ICS therapy, if possible, rather than escalating to Step 3 therapy.

Note 5: pMDI with spacer is usually the preferred option for all children. Older children (eg children older than 10 years) can use a DPI based on individual ability following device training.

Note 6: In stable asthma, daily doses of budesonide up to 400 micrograms can be given once daily.

Note 7: Montelukast has been associated with neuropsychiatric adverse effects, including nightmares, sleep disturbance, agitation, depression and, rarely, suicidal thinking and behaviour. Counsel parents and carers about these effects. They usually occur in the first 2 weeks of treatment. Stop treatment if these effects occur—the effects usually subside within a few days of stopping treatment. See the Australian Therapeutic Goods Administration (TGA) website for more information.

Step 3 therapy for children 6 years and older

Step 3 therapy for children 6 years and older

Few children aged 6 years and older require Step 3 therapy to control symptoms. Step 3 therapy can be considered in children who do not achieve good control with Step 2 therapy, despite good adherence and inhaler technique, and after exclusion of alternative diagnoses.

If Step 3 therapy is required, use one of the following options:

- a high paediatric dose of ICS
- a low paediatric dose of ICS plus a long-acting beta$_2$ agonist (LABA) (given as a fixed-dose combination)
- a low paediatric dose of ICS plus montelukast.

High-dose ICS or low-dose ICS+LABA may be more effective than ICS plus montelukast, although response varies widely among children. ICS plus montelukast appears to be more effective than ICS+LABA for children with exercise-induced bronchoconstriction.

If a high paediatric dose of ICS, with SABA reliever therapy, is preferred, use:

a SABA as required (see Step 1 for dosage)

PLUS ONE OF THE FOLLOWING

1 fluticasone propionate 125 to 250 micrograms by inhalation via pMDI with spacer or via DPI, twice daily [Note 8] *asthma, Step 3 therapy (child 6 years or older)*

OR

1 ciclesonide 240 to 320 micrograms by inhalation via pMDI with spacer, once daily *asthma, Step 3 therapy (child 6 years or older)*

OR

1 budesonide 300 to 400 micrograms by inhalation via DPI, twice daily [Note 8] [Note 9] *asthma, Step 3 therapy (child 6 years or older)*[*asthma, Step 3 therapy (child 6 years or older)*

OR

1 beclometasone 200 micrograms by inhalation via pMDI with spacer, twice daily. *asthma, Step 3 therapy (child 6 years or older)*

If a low paediatric dose of ICS+LABA is preferred, always use a fixed-dose combination inhaler; using separate inhalers increases the risk of the child using LABA alone, which is associated with increased risk of exacerbations. Use:

a SABA as required (see Step 1 for dosage)

PLUS

fluticasone propionate+salmeterol 100+50 micrograms by inhalation via pMDI with spacer or via DPI, twice daily [Note 8] *asthma, Step 3 therapy (child 6 years or older)*. *asthma, Step 3 therapy (child 6 years or older)*

If a low paediatric dose of ICS plus montelukast is preferred, use the dosages outlined in Step 2 with SABA reliever therapy.

For children aged 12 years and older, consider the use of budesonide+formoterol maintenance and reliever therapy. Budesonide+formoterol maintenance and reliever therapy is associated with a lower risk of exacerbations than ICS+LABA maintenance plus SABA reliever therapy. For Step 3 therapy with low-dose budesonide+formoterol maintenance and reliever therapy, use the dose outlined here. Budesonide+formoterol maintenance and reliever therapy is not approved for use in children under 12 years old.

Assess symptom control after 4 to 6 weeks. See Assessment of asthma control in children for details about review, and definitions of good, partial and poor control.

If symptoms are well controlled, continue treatment and review the child again after 3 months. Therapy may be able to be stepped down if control remains good—see Stepping down asthma therapy in children.

If symptoms remain uncontrolled with Step 3 therapy, or if good control cannot be maintained 3 to 6 months after stepping down from Step 3 therapy, review the diagnosis and arrange referral to a paediatrician or paediatric respiratory physician. See also Severe asthma in children for information on specialist treatments for asthma.

Note 8: pMDI with spacer is usually the preferred option for all children. Older children (eg children older than 10 years) can use a DPI based on individual ability following device training.

Note 9: In stable asthma, daily doses of budesonide up to 400 micrograms can be given once daily.

Severe asthma in children

Severe asthma in children

Children who remain uncontrolled despite Step 3 therapy (with good adherence and inhaler technique, and no likely alternative diagnoses) are considered to have severe asthma. These children require referral to a

specialist (a paediatrician or paediatric respiratory physician) for investigation and management.

Specialist management of asthma may include the addition of tiotropium, monoclonal antibodies or allergen immunotherapy to standard therapy.

For detailed information about severe asthma in children; see the Severe Asthma Toolkit, an Australian resource for assessing and managing severe asthma.

Review and ongoing management of asthma in children

Review and ongoing management of asthma in children

Assessment of asthma control in children

Assessment of asthma control in children

After starting or adjusting asthma therapy (reliever or preventer) in a child, assess symptom control and response to therapy after 4 to 6 weeks (or earlier as required) to determine ongoing management. Asthma symptom control is defined by the frequency of symptoms over the previous 4 weeks—see Table 9.9 for definitions of good, partial and poor control.

If asthma is well controlled, consider stepping down therapy—see Stepping down asthma therapy in children for details.

If asthma remains only partially or poorly controlled, consider stepping up therapy—see Stepping up asthma therapy in children for details.

Table 9.9 Classification of asthma symptom control in children

[NB1]

Good control	Partial control	Poor control
All of the following features: • daytime symptoms (eg wheezing or breathing problems) on 2 or fewer days per week, **lasting a few minutes** and **rapidly relieved** by SABA • no limitation of activities; child is fully active, runs and plays without symptoms • no symptoms during night or on waking, including no coughing during sleep • need for SABA reliever on 2 or fewer days per week [NB2]	One or two of the following features: • daytime symptoms (eg wheezing or breathing problems) on more than 2 days per week, **lasting a few minutes** and **rapidly relieved** by SABA • any limitation of activities; wheeze or breathlessness during exercise, vigorous play or laughter • any symptoms during night or on waking (eg waking with symptoms of wheezing or breathing problems) • need for SABA reliever on more than 2 days per week [NB2]	Either of the following features: • daytime symptoms (eg wheezing or breathing problems) on more than 2 days per week, **lasting minutes to hours** or **recurring**, and **partially or fully relieved** by SABA • three or more features of partial control per week

SABA = short-acting $beta_2$ agonist

NB1: Asthma symptom control is based on symptoms over the previous 4 weeks.

Good control	Partial control	Poor control

NB2: Not including SABA taken prophylactically before exercise; record this separately and consider when assessing management.

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Stepping up asthma therapy in children

Stepping up asthma therapy in children

If asthma remains partially or poorly controlled after 4 to 6 weeks of treatment, consider stepping up therapy.

Before increasing therapy, review adherence and inhaler technique, and check equipment (inhaler, spacer, mask) for breakage or blockage. Ensure exposure to triggers is minimised, and assess for symptoms or signs that could indicate an alternative diagnosis or a comorbidity that could reduce asthma control (eg allergic rhinitis). Poor response to therapy (particularly to correctly used inhaled corticosteroid [ICS]) could indicate that the diagnosis of asthma is incorrect. Most children with asthma can achieve good control with Step 2 therapy.

Stepping down asthma therapy in children

Stepping down asthma therapy in children

If asthma has been stable and well controlled for at least 3 months, gradually step down therapy to the minimum regimen that maintains good asthma symptom control—see Table 9.9 for definitions. Using the minimum regimen can reduce the risk of treatment-related adverse effects. Review symptom control and perform spirometry (if appropriate) 4 to 6 weeks after adjusting therapy.

Avoid stepping down therapy at the start of the preschool or school year, or at the start of the peak asthma season in children with seasonal variation.

In a child whose asthma has been well controlled for at least 3 months, consider stepping down therapy with the following approach:

- For children taking high-dose ICS, gradually reduce to lower-dose ICS.
- For children taking low-dose ICS plus montelukast, switch to ICS monotherapy.
- For children taking an ICS plus a long-acting $beta_2$ agonist (LABA), reduce the dose of ICS; if low-dose ICS+LABA is already being used, switch to ICS monotherapy.

If control remains good on low-dose ICS monotherapy or montelukast monotherapy, consider stopping preventer therapy and using only as-required short-acting $beta_2$ agonist (SABA). Stopping ICS altogether is associated with a significant risk of an asthma exacerbation. If considering withdrawal of preventer therapy, discuss the risks with the patient and their parents or carers and ensure they still have ready access to reliever therapy.

Advise the child and their parents or carers to step up therapy if asthma control deteriorates after stepping down therapy.

Ongoing management of asthma in children

Ongoing management of asthma in children

Once asthma is stable and well controlled, and the minimum regimen has been established, 3- to 6-monthly review is sufficient.

At each review:

- assess symptom control
- check adherence and inhaler technique (see Table 9.31 for links to patient handouts and videos demonstrating inhaler technique)
- reiterate advice about avoiding asthma triggers and maintaining a healthy lifestyle and up-to-date immunisations
- assess and manage comorbid conditions that can worsen asthma control (eg allergic rhinitis)
- ensure the written asthma action plan is up to date and the child (and their parents or carers) understand how to use it
- provide advice and education to facilitate supported self-management.

A more detailed assessment including spirometry should be performed if the patient's symptoms have changed or if the diagnosis is uncertain.

Supported self-management and asthma action plans for children

Supported self-management and asthma action plans for children

Self-management

Self-management

Assist and educate children to be as involved in their own asthma management as is developmentally appropriate (known as supported self-management). The child's involvement in their care can increase as they develop and transition to adult care.

Educate children, parents and carers about:

- asthma symptoms—day-to-day variation versus an exacerbation requiring treatment or medical attention, recognising and anticipating triggers
- asthma drugs—adherence and inhaler technique, reliever versus preventer therapy, care of spacers.

Written asthma action plan for children

Written asthma action plan for children

The principles of asthma action plans for children also apply to adolescents.

All children with asthma or recurrent wheeze should have a written asthma action plan. The asthma action plan should include:

- the usual preventer and reliever drug regimen
- how to recognise symptoms of asthma deterioration
- when to start or change reliever and preventer therapy, and when to start oral corticosteroid therapy
- when to seek medical attention
- details of the child's emergency contact.

Review the written asthma action plan whenever therapy is changed, and at least every 6 months.

Asthma action plans detail steps for adjusting drug therapy that should be followed when symptoms occur, according to the severity and duration of symptoms. Individualise the plan to the patient's current treatment regimen, their usual asthma symptoms and pattern of reliever use, and their willingness and ability to self-manage worsening asthma. Also consider the patient's history of exacerbations, including the severity and their ability to seek appropriate medical attention. Asthma action plan templates are available on the National Asthma Council Australia website.

For a mild, transient increase in symptoms, the action plan should recommend that the patient use their reliever therapy. If the symptoms respond well and do not recur, this step is enough.

For a nonurgent but persistent increase in symptoms (eg requiring reliever more than three times per week, symptoms recurring within a few hours of reliever therapy, asthma interfering with daily activities), the action plan should recommend a short course of oral prednis(ol)one (in addition to using reliever therapy). This can prevent progression to an acute exacerbation. Use:

prednis(ol)one 1 mg/kg up to 50 mg orally, daily for 3 to 5 days. *asthma, written action plan (child, adolescent)* _

Considerations for using inhaled corticosteroids for asthma in children

Considerations for using inhaled corticosteroids for asthma in children

Inhaled corticosteroids (ICS) are the mainstay of therapy for asthma. It is common for parents and carers to be concerned about potential growth suppression caused by ICS therapy, and this can be a barrier to therapy. Explain to parents and carers that poorly controlled asthma is also associated with growth suppression, and that the benefits of good asthma control outweigh the risk of growth suppression related to ICS.

ICS therapy has a small effect on growth velocity in children; however, poorly controlled asthma is also associated with growth suppression.

The effect of ICS on growth velocity appears to be dose dependent, and is most pronounced during the first year of treatment. A Cochrane review showed daily low- to medium-dose ICS was associated with a mean reduction in linear growth velocity of 0.48 cm per year, and 0.61 cm less growth after 1 year of treatment, compared with placebo or nonsteroidal treatment [Note 10]. Although growth velocity returns to normal within a few years of starting an ICS, one study found that the mean adult height was 1.2 cm lower in patients who used ICS during their childhood compared with placebo [Note 11].

The difference in effect on growth between individual ICS is uncertain. A Cochrane review found that fluticasone propionate had a smaller impact on growth than equivalent doses of budesonide or beclometasone [Note 12]. Another study found no significant difference in effect on height between ciclesonide and fluticasone propionate [Note 13]. More evidence is needed to inform a clear recommendation about which steroid has the least effect on growth.

Use the minimum effective dose of ICS to reduce the risk of adverse effects.

To minimise the risk of all adverse effects, use the minimum effective dose of ICS; see Stepping down asthma therapy in children for information about reducing therapy. Recommend that children rinse their mouth with water and spit out straight after using the ICS to minimise the risk of oropharyngeal candidiasis and systemic absorption.

Although corticosteroid therapy can cause adrenal suppression and reduce bone density, these effects are unlikely with the recommended doses of ICS for asthma in children.

If starting an ICS for asthma in a child, discuss the goals of therapy with child and their parent or carer. Explain that prioritising good control of asthma is crucial to minimise the impact of asthma on the child's quality of life, and avoid exacerbations.

Note 10: Zhang L, Prietsch SO, Ducharme FM. Inhaled corticosteroids in children with persistent asthma: effects on growth. Cochrane Database Syst Rev 2014;(7):CD009471. [URL]

Note 11: Kelly HW, Sternberg AL, Lescher R, Fuhlbrigge AL, Williams P, Zeiger RS, et al. Effect of inhaled glucocorticoids in childhood on adult height. N Engl J Med 2012;367(10):904-12. [URL]

Note 12: Axelsson I, Naumburg E, Prietsch SO, Zhang L. Inhaled corticosteroids in children with persistent asthma: effects of different drugs and delivery devices on growth. Cochrane Database Syst Rev

2019;6:CD010126. [URL]

Note 13: Pruteanu AI, Chauhan BF, Zhang L, Prietsch SO, Ducharme FM. Inhaled corticosteroids in children with persistent asthma: dose-response effects on growth. Cochrane Database Syst Rev 2014; (7):CD009878. [URL]

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Overview of acute asthma

Overview of acute asthma

Acute asthma (also known as an asthma exacerbation, attack or flare up) is an acute worsening of lung function and asthma symptoms. Typical symptoms include shortness of breath, wheeze, cough and chest tightness.

Acute asthma usually occurs in response to a trigger, such as a viral respiratory tract infection or an irritant (eg pollen, pollution, cold air). Lack of adherence with preventer therapy is also a common factor.

First aid treatment administered by the patient, parents, carers or community members is often the first intervention—see First aid for acute asthma. Educate all patients with asthma (and parents and carers) to recognise the early symptoms of asthma deterioration, and to start reliever therapy according to their asthma action plan. For information about self-management and action plans, see Self-management and asthma action plans for adults and Supported self-management and asthma action plans in children.

In a clinical setting, management is determined by the severity of the exacerbation. A rapid preliminary severity assessment determines initial treatment; a more detailed secondary severity assessment guides ongoing management. See Summary of management of acute asthma.

The information in this topic is not relevant for infants younger than 12 months as asthma cannot be diagnosed in this age group—see here for more information. Infants younger than 12 months should be urgently referred if they have sudden-onset wheeze, and foreign body aspiration or anaphylaxis is suspected; infants should not be treated with asthma medication.

Anaphylaxis and acute asthma

Anaphylaxis and acute asthma

Anaphylaxis is a life-threatening condition and an important differential diagnosis in a patient presenting with acute respiratory symptoms. Identify and treat anaphylaxis early; the patient can deteriorate within minutes.

Sudden-onset shortness of breath and typical skin features (eg any of urticarial rash, erythema, flushing or angioedema) is diagnostic of anaphylaxis. Anaphylaxis should also be considered if a patient presents with sudden-onset shortness of breath and cardiovascular symptoms (eg dizziness, hypotension) or gastrointestinal symptoms (eg diarrhoea, vomiting), even if typical skin features are not present.

Intramuscular adrenaline (epinephrine) is first-line treatment in suspected anaphylaxis.

If anaphylaxis is suspected or cannot be excluded, give empirical intramuscular adrenaline (epinephrine) according to national guidelines or local protocols; see here for links to Australian protocols.

First aid for acute asthma for patients and community members

First aid for acute asthma for patients and community members

First aid treatment in a community setting is often the initial intervention in acute asthma. All patients with asthma should have an individualised written asthma action plan that can be implemented at the first signs of

an asthma exacerbation. For information about individualised asthma action plans; see Written asthma action plan for adults and Written asthma action plan for children.

The National Asthma Council '4×4×4' first aid plan for treating acute asthma with salbutamol (via pressurised metered dose inhaler [pMDI]) is used by many community and sports organisations. It is simple to remember and easy to follow—the plan recommends:

salbutamol 100 micrograms per actuation, 4 actuations, 1 at a time via pMDI (with spacer if available, taking 4 breaths from the spacer after each actuation); repeat after 4 minutes if required. If still no response, call an ambulance, and continue giving 4 actuations (or up to 8 actuations in an adult) every 4 minutes. *asthma, first aid*

If salbutamol is not immediately available, terbutaline or budesonide+formoterol can be used:

terbutaline (for people 6 years or older) 500 micrograms per actuation, 2 actuations, one at a time via DPI; give 1 more actuation after 4 minutes, if required. If still no response, call an ambulance and continue giving 1 actuation every 4 minutes *asthma, first aid*

OR

budesonide+formoterol (for people 12 years or older), 2 actuations, one at a time via pMDI (with spacer if available) or DPI; give 1 more actuation after 4 minutes, if required. If still no response, call an ambulance and continue giving 1 actuation every 4 minutes [Note 1] up to a maximum total of 6 doses. *asthma, first aid*

If the patient does not respond rapidly and significantly to initial treatment, an ambulance should be called (advising that the patient is having a 'severe asthma attack'). If the patient initially responds to treatment but reliever therapy is needed more than 3 to 4 hourly, a same-day medical review is required. If symptoms are escalating, referral to an emergency department may be required.

See the National Asthma Council website for links to printable wallcharts of the first aid plans.

Note 1: Budesonide+formoterol has multiple formulations containing various doses per actuation (see Table 9.3). Use the formulation immediately available at the time of the acute asthma event.

Summary of management of acute asthma

Summary of management of acute asthma

The management of acute asthma in a clinical setting is summarised in Figure 9.6.

Management is determined by the severity of the exacerbation. At presentation, immediately perform a rapid severity assessment of the patient to determine initial management. After starting treatment, perform a more detailed secondary severity assessment to determine ongoing management. Continuously reassess severity and response to therapy. If the patient is not responding to treatment at the assessed severity level, escalate treatment to the next level.

If the patient does not respond to treatment at the assessed severity level, escalate treatment to the next level.

Bronchodilator therapy (eg salbutamol, ipratropium) is the mainstay of treatment of acute asthma. Oral corticosteroid therapy is also recommended for most patients—see Corticosteroid therapy for acute asthma for details.

Oxygen is used if the patient is hypoxaemic, and intravenous magnesium sulfate can be considered if the patient does not respond to initial treatment.

For detailed information on the management of acute asthma by severity, including drug dosages, see:

- Treatment of mild to moderate acute asthma
- Treatment of severe acute asthma

- Treatment of life-threatening acute asthma.

Antibiotic therapy has no role in the management of acute asthma unless the patient has strong evidence of lung infection (eg radiographic evidence of pneumonia). Oral $beta_2$ agonist therapy also has no role.
Figure 9.6 Summary of management of acute asthma

If at any stage the patient is not responding to treatment at the assessed severity level, escalate treatment to the next level

IMMEDIATELY: perform a rapid severity assessment to determine initial management

MILD TO MODERATE	SEVERE	LIFE-THREATENING
give salbutamol via pMDI with spacer	give salbutamol and ipratropium via pMDI with spacer, or via intermittent nebulisation driven by air (or oxygen, if required)	**arrange immediate transfer to a critical care facility** give salbutamol and ipratropium via continuous nebulisation (oxygen usually required; use to drive nebuliser) consider adrenaline (epinephrine) if the patient is unresponsive, has poor respiratory effort, and cannot inhale bronchodilators, or is considered to be peri-arrest consider the possibility of anaphylaxis and manage if suspected
	start oxygen if SpO_2 is less than 92%	

WITHIN MINUTES: perform a more detailed secondary severity assessment
repeat severity assessment frequently within the first hour (eg after each dose of inhaled salbutamol)

MILD TO MODERATE	SEVERE	LIFE-THREATENING
repeat salbutamol dose as needed	repeat salbutamol and ipratropium every 20 minutes (or sooner if needed) for the first hour if continued insufficient response, arrange transfer to hospital if in primary care	continue nebulised salbutamol and ipratropium
	if poor response, add intravenous magnesium sulfate (not recommended for children younger than 2 years)	

AS SOON AS PRACTICAL, AND AT LEAST WITHIN THE FIRST HOUR give oral corticosteroid therapy [NB1] for:

- all adults and children 6 years or older
- children 1 to 5 years, unless the child has only a mild to moderate wheeze that responds to initial bronchodilator treatment

CONTINUOUSLY reassess severity and response to treatment

- if symptoms resolve, treatment can be stepped down or stopped; observe the patient for at least 1 hour after symptoms resolve
- if symptoms persist, arrange transfer and admission to hospital; continue monitoring and bronchodilator treatment
- if severe or life-threatening asthma persists, arrange transfer and admission to a critical care facility, and seek urgent specialist advice about additional treatment

pMDI = pressurised metered dose inhaler; SpO_2= oxygen saturation measured by pulse oximetry

NB1: Use intravenous corticosteroid therapy if oral intake is not tolerated.

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Mild to moderate exacerbations can usually be managed in the primary care setting. Consider escalating the level of care according to the severity, response to initial treatment, limitations of the current care setting, and ease of access to more advanced assistance. In the emergency department, early involvement of senior staff is desirable for very sick patients. If transfer to a higher-level facility is anticipated, start this process early.

Review the diagnosis if the patient does not respond to therapy. If the patient appears to respond initially and then relapses, consider the possibility of complications such as pneumothorax. Also consider adverse effects of treatment—high doses of salbutamol can cause paradoxical worsening of respiratory failure (thought to be related to metabolic acidosis, increased blood lactate concentration and increased metabolic rate). If suspected, seek expert advice and cautiously reduce salbutamol dosage.

Hypokalaemia and hypomagnesaemia are likely with repeated high doses of salbutamol—anticipate and manage early. Cardiovascular effects (eg myocardial ischaemia, prolonged QT interval predisposing to arrhythmias) can also occur.

Assessing severity of acute asthma

Assessing severity of acute asthma

Overview

Overview

Management of acute asthma is determined by the severity of the exacerbation. For a patient with a suspected asthma exacerbation, immediately perform a rapid severity assessment to determine initial management. After starting treatment, perform a more detailed secondary severity assessment to determine subsequent management. See Figure 9.6 for a summary of management.

The most important indicators of severity in acute asthma are the patient's general appearance or mental state, and work of breathing (eg accessory muscle use, chest wall recession in children).

While individual features can help identify the severity of an asthma exacerbation, assessing multiple signs and symptoms gives a better indication of severity. Of particular note:

- Wheezing is an unreliable indicator of the severity of an acute asthma exacerbation. In severe acute asthma, wheeze may be essentially absent ('silent chest'), and only become apparent as the airway obstruction is relieved.
- Cyanosis is only visible with marked hypoxaemia; it indicates life-threatening acute asthma, but its absence does not exclude life-threatening acute asthma.
- Pulsus paradoxus is not a reliable indicator of the severity of acute asthma.

Continuous reassessment of severity and monitoring of response to therapy is critical. If the patient is not responding to treatment at the assessed level of severity, treat according to the next level.

The severity category can change with time, either as more information becomes available (eg results of pulse oximetry, spirometry or blood gases) or because the patient's condition has improved or deteriorated.

Initial rapid severity assessment

Initial rapid severity assessment

For a patient with a suspected asthma exacerbation, immediately perform an initial rapid severity assessment to determine initial management. See Table 9.10 for details of an initial rapid severity assessment.

Table 9.10 Initial rapid severity assessment of acute asthma

Mild to moderate:	Severe:	Life-threatening:
all of the following	any of the following	any of the following
		reduced consciousness
	unable to complete sentences in one breath	collapse
can walk and speak whole sentences in one breath	increased work of breathing with use of accessory muscles (eg tracheal tug, intercostal or subcostal recession, marked abdominal breathing, chest wall recession in children)	soft or absent breath sounds
		poor respiratory effort
SpO_2 more than 94%	obvious respiratory distress	exhaustion
	SpO_2 90 to 94%	cyanosis
		SpO_2 less than 90%

SpO_2 = oxygen saturation measured by pulse oximetry

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Secondary severity assessment

Secondary severity assessment

Following the initial severity assessment and initiation of treatment, perform a more detailed secondary severity assessment as outlined in Table 9.11 to determine ongoing management.

Assessment of response to treatment is an ongoing process; tailor the frequency of assessment to the severity of the exacerbation. Repeat secondary severity assessment frequently within the first hour (eg after each dose of salbutamol). In more severe cases, remain at the bedside until the patient is stabilised.

Secondary assessment of acute asthma should also take into account any risk factors for fatal asthma—see Figure 9.7.

Table 9.11 Secondary severity assessment of acute asthma

Mild to moderate:	Severe:	Life-threatening:
all of the following	any of the following	any of the following
consciousness		
alert	may be the same as mild to moderate and does not determine severity	reduced consciousness (eg drowsy or unconscious)
speech		
can finish a sentence in one breath	children 1 to 5 years: may be the same as mild to moderate and does not determine severity adults: unable to complete sentences in one breath	can't speak or can only speak single words because of dyspnoea
posture		
can walk (or, if an infant, crawl)	difficulty lying flat because of dyspnoea	collapsed or exhausted

Mild to moderate:	Severe:	Life-threatening:
all of the following	any of the following sitting hunched forward ('tripoding') tiring	any of the following
breathing		
respiratory distress is not severe	increased work of breathing with use of accessory muscles (eg tracheal tug, intercostal or subcostal recession, marked abdominal breathing, chest wall recession in children)	severe respiratory distress or poor respiratory effort
skin colour		
normal	may be the same as mild to moderate and does not determine severity	cyanosis (not always present)
respiratory rate [NB1]		
normal	tachypnoea	tachypnoea bradypnoea (indicates respiratory exhaustion)
heart rate [NB1]		
normal	tachycardia	cardiac arrhythmia or bradycardia (may occur just before respiratory arrest)
chest auscultation		
wheeze persistent cough (not always present)	may be the same as mild to moderate and does not determine severity	'silent chest' due to reduced air entry
oxygen saturation (pulse oximetry)		
SpO_2 more than 94%	SpO_2 90 to 94%	SpO_2 less than 90% or clinical cyanosis
arterial blood gas analysis (only applicable to adults)		
not indicated	may be indicated if not improving as expected [NB2]	PaO_2 lower than 60 mmHg on room air $PaCO_2$ higher than 45 mmHg or $PaCO_2$ within normal range [NB2] pH less than 7.35 [NB3]
lung function tests (only applicable to adults)		
FEV_1 or PEF more than 40% predicted or personal best	FEV_1 or PEF less than 40% predicted or personal best	not indicated (usually not able to be performed)
asthma history		
assess risk factors for asthma-related death; see Figure 9.7		
chest X-ray		
not usually required; indicated if pneumonia, atelectasis, pneumothorax or pneumomediastinum is suspected, or if sudden deterioration		

FEV_1 = forced expiratory volume in 1 second; $PaCO_2$ = partial pressure of carbon dioxide; PaO_2 = partial pressure of oxygen; PEF = peak expiratory flow; SpO_2 = oxygen saturation measured by pulse oximetry

Mild to moderate:	Severe:	Life-threatening:
all of the following	any of the following	any of the following

NB1: Normal values for heart rate and respiratory rate in children vary with age; see The Royal Children's Hospital (Melbourne) website.

NB2: Do not be reassured by a normal $PaCO_2$ in a patient with an elevated respiratory rate. The presence of hypercapnia or normocapnia indicates that the patient is tiring and may need ventilatory support.

NB3: Metabolic acidosis (often associated with hypokalaemia) may occur with increased work of breathing and with high-dose salbutamol.

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Figure 9.7 Risk factors for potentially fatal asthma

Risk factors for potentially fatal asthma include:

- previous ventilation or admission to an intensive care unit for asthma
- hospital admission for asthma in the last year
- repeated emergency-department attendances in the last year
- frequent short-acting $beta_2$ agonist use (eg more than one canister per month)
- requirement for three or more classes of asthma maintenance medication
- poor lung function
- history of 'brittle asthma' (ie sudden and severe exacerbations)
- confirmed food allergy
- current or recent requirement for oral corticosteroid
- rural or remote location.

The above factors often coexist with adverse psychosocial or behavioural factors, such as:

- poor adherence to drug therapy
- poor attendance at follow-up appointments
- depression or other psychiatric illness
- substance misuse, including smoking
- denial of the serious nature of asthma or the need for regular treatment
- social isolation
- learning difficulties
- financial or domestic problems.

Treatment of mild to moderate acute asthma

Treatment of mild to moderate acute asthma

To determine the severity of acute asthma, see Assessing severity of acute asthma. Figure 9.6 provides a summary of management of acute asthma according to severity.

For a patient with mild to moderate acute asthma according to the initial rapid assessment, start treatment with salbutamol. Use:

salbutamol 100 micrograms per actuation, 1 actuation at a time via pMDI with spacer: *asthma, acute: mild to moderate*

child 1 to 5 years: 2 to 6 actuations; repeat as required.

adult or child 6 years or older: 4 to 12 actuations; repeat as required.

Immediately after starting treatment, perform a secondary severity assessment to determine ongoing treatment.

All adults and some children with moderate acute asthma should also receive oral corticosteroid therapy as soon as practical (and at least within the first hour of presentation). See Corticosteroid therapy for acute asthma for indications and doses.

If symptoms improve or resolve, salbutamol can be used less frequently or stopped. Monitor the patient for at least an hour after symptom resolution in case symptoms recur.

If the patient worsens or does not have a rapid and marked response to treatment, escalate treatment to that recommended for severe acute asthma. If the patient is being managed in primary care, arrange transfer to a hospital.

Treatment of severe acute asthma

Treatment of severe acute asthma

Overview

Overview

To determine the severity of severe acute asthma, see Assessing severity of acute asthma. Figure 9.6 provides a summary of management of acute asthma according to severity.

For a patient with severe acute asthma according to the initial rapid assessment, start treatment with both salbutamol and ipratropium.

If oxygen saturation measured by pulse oximetry (SpO_2) is less than 92%, also start supplemental oxygen therapy. Titrate oxygen to a target SpO_2 of 92 to 96%. For more detailed advice on supplemental oxygen administration, see Acute oxygen therapy.

Immediately after starting treatment, perform a more detailed secondary severity assessment to determine ongoing treatment.

All patients should also receive oral corticosteroid (or intravenous, if oral intake is not possible) therapy as soon as practical (and at least within the first hour of presentation). See Corticosteroid therapy for acute asthma for indications and doses.

If symptoms improve or resolve, bronchodilator treatment can be used less frequently or stopped. Monitor the patient for at least an hour after symptom resolution in case symptoms recur.

If the patient worsens or does not have a rapid and marked response to treatment, consider escalating treatment to that used for life-threatening acute asthma. Intravenous magnesium sulfate may be required. If the patient is being managed in primary care, arrange transfer to a hospital.

Bronchodilator therapy

Bronchodilator therapy

For bronchodilator therapy in a child 1 to 5 years old with severe acute asthma, use:

salbutamol 100 micrograms per actuation, 6 actuations (1 at a time) via pMDI with spacer (and mask, if required); repeat every 20 minutes for the first hour (or sooner if needed) *asthma, acute: severe (child 1 to 5 years)* _

PLUS

ipratropium 21 micrograms per actuation, 4 actuations (1 at a time) via pMDI with spacer (and mask, if required); repeat every 20 minutes for the first hour (or sooner if needed). *asthma, acute: severe (child 1 to 5 years)*

For bronchodilator therapy in an adult or child 6 years or older with severe acute asthma, use:

salbutamol 100 micrograms per actuation, 12 actuations (1 at a time) via pMDI with spacer; repeat every 20 minutes for the first hour (or sooner if needed) *asthma, acute: severe (adult, child 6 years or older)*

PLUS

ipratropium 21 micrograms per actuation, 8 actuations (1 at a time) via pMDI with spacer; repeat every 20 minutes for the first hour (or sooner if needed). *asthma, acute: severe (adult, child 6 years or older)*

Bronchodilator therapy can be administered by intermittent nebulisation if the patient can't breathe through a spacer. Mix the nebuliser solutions and drive the nebuliser with air unless oxygen is required.

For a child 1 to 5 years old, use:

salbutamol 2.5 mg via intermittent nebulisation every 20 minutes for the first hour (or sooner if needed)

PLUS

ipratropium 250 micrograms via intermittent nebulisation every 20 minutes for the first hour (or sooner if needed).

For an adult or child 6 years or older, use:

salbutamol 5 mg via intermittent nebulisation every 20 minutes for the first hour (or sooner if needed)

PLUS

ipratropium 500 micrograms via intermittent nebulisation every 20 minutes for the first hour (or sooner if needed).

Treatment of life-threatening acute asthma

Treatment of life-threatening acute asthma

Overview

Overview

To determine the severity of life-threatening acute asthma, see Assessing severity of acute asthma. Figure 9.6 provides a summary of management of acute asthma according to severity.

Consider anaphylaxis as a differential diagnosis—see Anaphylaxis and acute asthma for more information.

For a patient with life-threatening acute asthma according to the initial rapid assessment, arrange immediate transfer to a critical care or high-dependency facility. Early involvement of senior staff is desirable for very sick patients.

Start immediate treatment with nebulised bronchodilator therapy (both salbutamol and ipratropium). Supplemental oxygen therapy is almost always required in these patients—use to drive the nebuliser.

Give intravenous corticosteroid therapy as soon as possible (and at least within the first hour). See Corticosteroid therapy for acute asthma for indications and doses.

Immediately after starting treatment, perform a more detailed secondary severity assessment. Depending on the response to initial treatment, intravenous magnesium sulfate may be required. Additional therapy or ventilatory support may be required in difficult cases.

Continuously reassess severity and response to treatment to determine ongoing management.

If the patient is unresponsive, has poor respiratory effort, and cannot inhale bronchodilators, or is considered to be peri-arrest, consider adrenaline (epinephrine).

Oxygen therapy

Oxygen therapy

If oxygen saturation measured by pulse oximetry (SpO_2) is less than 92%, start supplemental oxygen (use oxygen to drive the nebulised bronchodilator therapy). Supplemental oxygen is almost always required for patients with life-threatening acute asthma.

Titrate oxygen to a target SpO_2 of 92 to 96%. For more detailed advice on supplemental oxygen administration, see Acute oxygen therapy.

Bronchodilator therapy

Bronchodilator therapy

Start immediate treatment with nebulised salbutamol and ipratropium. Use oxygen to drive the nebuliser.

For bronchodilator therapy in a child 1 to 5 years old with life-threatening acute asthma, use:

salbutamol 2.5 mg at a time via continuous nebulisation *asthma, acute: life-threatening (child 1 to 5 years)*

PLUS

ipratropium 250 micrograms added to nebulised solution every 20 minutes for the first hour. *asthma, acute: life-threatening (child 1 to 5 years)*

For an adult or child 6 years or older, use:

salbutamol 10 mg at a time via continuous nebulisation *asthma, acute: life-threatening (adult, child 6 years or older)*

PLUS

ipratropium 500 micrograms added to nebulised solution every 20 minutes for the first hour. *asthma, acute: life-threatening (adult, child 6 years or older)*

Hypokalaemia and hypomagnesaemia are likely with repeated high doses of salbutamol—anticipate and manage early. Cardiovascular effects (eg myocardial ischaemia, prolonged QT interval predisposing to arrhythmias) can also occur.

If the patient shows a marked improvement with initial treatment, consider switching delivery of bronchodilator therapy to intermittent nebulisation or pMDI with spacer. For doses, see Treatment of severe acute asthma.

If severe or life-threatening acute asthma persists after starting treatment, give intravenous magnesium sulfate.

Intravenous magnesium sulfate

Intravenous magnesium sulfate

If the patient worsens or does not have a rapid and marked response to bronchodilator and oxygen therapy, add intravenous magnesium sulfate (not suitable for children younger than 2 years).

Magnesium sulfate may have bronchodilator effects; it can improve lung function and reduce hospital admissions. The sickest patients appear to be the most likely to benefit.

For severe or life-threatening acute asthma that has not responded to initial treatment use:

magnesium sulfate 10 mmol (child 2 years or older: 0.1 to 0.2 mmol/kg up to 10 mmol) diluted to 100 mL in a compatible fluid, by slow intravenous injection over 20 minutes. *asthma, acute: life-threatening* _

The safety of repeated doses or infusions of magnesium sulfate has not been assessed. Seek expert advice if considering further administration. Hypermagnesaemia can cause loss of deep tendon reflexes and muscle weakness, including respiratory muscle weakness. Comprehensive monitoring in a critical care or high-dependency environment is required.

Additional treatment for persistent life-threatening acute asthma

Additional treatment for persistent life-threatening acute asthma
Adrenaline (epinephrine)

If the patient is unresponsive, has poor respiratory effort, and cannot inhale bronchodilators, or is considered to be peri-arrest, consider adrenaline (epinephrine). Give:

adrenaline (epinephrine) 1 mg/mL (1:1000, 0.1%) solution, 0.01 mg/kg up to 0.5 mg (0.5 mL) intramuscularly; repeat after 3 to 5 minutes if required. *asthma, acute* _

In life-threatening situations adrenaline (epinephrine) can also be administered intravenously or by continuous infusion—seek expert advice before administration.

Intravenous salbutamol

Intravenous salbutamol is reserved for the sickest patients with life-threatening acute asthma and for those in whom nebulisation is impractical. The potential harm versus benefit is not favourable compared to nebulised salbutamol, and there is no evidence of increased efficacy. Comprehensive monitoring (blood electrolytes, heart rate, blood lactate) in a critical care or high-dependency environment is required. Seek expert advice before administration.

Intravenous aminophylline

The potential harms of aminophylline outweigh the expected benefits in most situations.

The occasional patient with life-threatening acute asthma who is not responding to other therapy, may respond to aminophylline. Comprehensive monitoring in a critical care or high-dependency environment is required. Seek expert advice before administration.

Ventilatory support

Ventilatory support may be required for patients with persistent life-threatening acute asthma.

Consider noninvasive positive pressure ventilation for patients who continue to show no improvement with treatment and are starting to tire or show signs of respiratory failure. Evidence for its use is limited, particularly in children; however, it may avoid the need for intubation. High-flow nasal cannula oxygen therapy is used in some centres, but evidence is limited. Adequately trained staff are needed to administer and monitor acute noninvasive ventilation, usually in a critical care environment or a high-dependency unit; seek expert advice before administration.

If the patient doesn't improve with noninvasive ventilation, intubate and start mechanical ventilation. Intubation and ventilation of these patients is difficult and has significant associated risks. Ideally, it should only be undertaken by an experienced critical care or emergency physician.

Corticosteroid therapy for acute asthma

Corticosteroid therapy for acute asthma

Corticosteroid therapy hastens symptom resolution and prevents relapse in acute asthma.

It is recommended for:

- all cases of acute asthma in adults and children 6 years or older, except the mildest of cases (eg mild symptoms that respond quickly and completely to bronchodilator therapy)
- all cases of **severe** acute wheezing in children 1 to 5 years; in a child with only a mild to moderate wheeze corticosteroids may be of no benefit so can be withheld to reduce corticosteroid exposure.

If indicated, start corticosteroid therapy as soon as practical, and at least within the first hour of presentation.

For oral corticosteroid therapy in adults, use:

1 prednis(ol)one 37.5 to 50 mg orally, within 1 hour of presentation; continue once daily for a total of 5 to 10 days *asthma, acute (adult)* _

OR

2 dexamethasone 16 mg orally, within 1 hour of presentation; repeat dose once the next day. *asthma, acute (adult)* _

If oral therapy is not tolerated in adults, use:

hydrocortisone 100 mg intravenously, 6-hourly for up to 24 hours; switch to an oral corticosteroid once tolerated. If intravenous therapy is still required after 24 hours, reduce frequency to 12-hourly. *asthma, acute (adult)* _

For oral corticosteroid therapy in children, use:

1 prednis(ol)one 1 mg/kg (up to 50 mg) orally, within 1 hour of presentation; continue once daily for a total of 3 days *asthma, acute (child)* _

OR

2 dexamethasone 0.6 mg/kg (up to 16 mg) orally, within 1 hour of presentation; repeat dose once the next day if required. *asthma, acute (child)* _

If oral therapy is not tolerated in children, use:

1 hydrocortisone 4 mg/kg (up to 100 mg) intravenously, 6-hourly for up to 24 hours; switch to an oral corticosteroid once tolerated. If intravenous therapy is still required after 24 hours, reduce frequency to 12-hourly *asthma, acute (child)* _

OR

1 methylprednisolone 1 mg/kg (up to 60 mg) intravenously, 6-hourly for up to 24 hours; switch to an oral corticosteroid once tolerated. If intravenous therapy is still required after 24 hours, reduce frequency to 12-hourly. *asthma, acute (child)* _

Postacute care and discharge following an episode of acute asthma

Postacute care and discharge following an episode of acute asthma

Patients who had any feature of acute life-threatening asthma, or any feature of acute severe asthma that persisted after initial treatment, should be admitted to hospital.

No single physiological measurement can define whether a patient is safe for discharge.

No single factor or physiological measurement can define the extent of ongoing care required, or whether the patient is safe for discharge. Consider the patient's:

- response to therapy during the episode of acute asthma
- ongoing frequency of short-acting $beta_2$ agonist (SABA) requirement—do not discharge a patient who still requires SABA more than every 4 hours
- ability to lie flat without dyspnoea
- history of exacerbations
- current circumstances such as the time of day, distance from medical help, access to phone, and home environment
- treatment adherence
- comorbidities
- risk factors for potentially fatal asthma (see Figure 9.7).

In addition to the above, consider spirometry or peak expiratory flow (PEF) findings (these can often be performed after 1 hour of management); a low forced expiratory volume in 1 second (FEV_1) or PEF may indicate a need for hospital admission.

Patients with severe asthma and adverse psychosocial factors are at increased risk of asthma-related death (see Figure 9.7).

Patients with severe asthma and adverse psychosocial factors are at increased risk of asthma-related death.

The National Asthma Council website includes links to asthma discharge plans for adults and children.

Figure 9.8 outlines reviews that should be completed before discharge.

Figure 9.8 Reviews required before discharging a patient after an episode of acute asthma

Once the episode of acute asthma has resolved, review the patient's:

- inhaler technique
- adherence to prescribed asthma therapy
- asthma triggers; discuss avoidance measures if necessary
- preventer therapy and dose; adjust therapy if necessary (see Maintenance management for asthma in adults and adolescents or Maintenance management of asthma in children)
- written asthma action plan (see Written asthma action plans for adults or Written asthma action plans for children); educate the patient about the action plan.

On discharge, ensure therapy can be continued at home (eg switch nebulised therapy to pMDI with spacer). Continue oral corticosteroids for a total treatment course of 5 to 10 days for adults, or 3 days for children.

Many children presenting with acute asthma may only ever have one such episode. However, a small number of children are at risk of recurrent, potentially fatal acute asthma. Consider whether regular preventer therapy is required. Base assessment on both the pattern of asthma symptoms between exacerbations, and the severity of symptoms during the exacerbation. See Maintenance management of asthma in children.

Any adult or adolescent with an episode of acute asthma severe enough to require emergency-department care, and who is not already using an inhaled corticosteroid (ICS), should be started on ICS therapy to reduce the risk of another episode. See Maintenance management of asthma in adults and adolescents.

Follow-up after an episode of acute asthma

Follow-up after an episode of acute asthma

Any patient who experiences an episode of acute asthma of any severity must be encouraged to seek follow-up medical advice and care. Advise the patient to follow-up with their general practitioner or specialist within 2 or 3 days of discharge from hospital and 2 weeks after the acute episode. Provide a discharge summary to the patient's general practitioner, including details of the:

- severity of the episode
- spirometry findings, if performed
- treatment given
- treatment prescribed at discharge; all adults or adolescents who have had an episode of acute severe asthma require a regular inhaled corticosteroid (ICS)
- written asthma action plan (see Written asthma action plans for adults or Written asthma action plans for children).

Every person with asthma should have a written asthma action plan.

Consider specialist referral for any first presentations of asthma and for all episodes of acute asthma requiring hospital admission. Also consider specialist referral for patients with ongoing poorly controlled asthma.

Patients with near-fatal or 'brittle asthma' (ie sudden and severe exacerbations) should have ongoing specialist review for life. Patients who experienced a severe exacerbation should have specialist review for at least 1 year.

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Introduction to domiciliary oxygen therapy

Introduction to domiciliary oxygen therapy

The purpose of long-term domiciliary oxygen therapy is to prolong life.

Domiciliary oxygen therapy is prescribed for patients with chronic hypoxaemia, most commonly caused by chronic obstructive pulmonary disease (COPD) in adults, and chronic neonatal lung disease in children (see here for information on domiciliary oxygen therapy in children).

Domiciliary oxygen therapy is usually prescribed by specialists; eligible prescribers, funding and clinical criteria for subsidised domiciliary oxygen therapy vary between Australian states and territories and, in some cases, from region to region within a state or territory. See Access to and funding for domiciliary oxygen therapy in Australia for more information.

The Thoracic Society of Australia and New Zealand (TSANZ) guidelines provide recommendations for when domiciliary oxygen is prescribed based on clinical criteria.

Domiciliary oxygen therapy should not be prescribed to treat breathlessness in the absence of hypoxaemia.

Domiciliary oxygen therapy is not prescribed in smokers because there is a potential risk of fire (see Contraindications to domiciliary oxygen therapy in adults).

Indications for domiciliary oxygen therapy in adults

Indications for domiciliary oxygen therapy in adults

Long-term continuous oxygen therapy

Long-term continuous oxygen therapy

Assess the need for long-term continuous oxygen therapy only when patients are clinically stable, have had treatment for their condition optimised and have stopped smoking for at least 1 month. Consider performing arterial blood gas analysis if oxygen saturation measured by pulse oximetry (SpO_2) is less than 90%. Arterial blood gas analysis on room air is required to determine eligibility for domiciliary oxygen therapy.

Long-term continuous oxygen therapy has been shown to prolong survival in patients with stable chronic obstructive pulmonary disease (COPD) who have:

- consistent partial pressure of oxygen (PaO_2) of 55 mmHg or less when breathing air at rest and awake
- evidence of complications of hypoxaemia (eg polycythaemia, pulmonary hypertension, right-sided heart failure) and a PaO_2 of 56 to 59 mmHg.

Results from studies in patients with COPD have been extrapolated to recommend long-term oxygen therapy for patients suffering from any illness where chronic hypoxaemia is an important feature.

Prescribe domiciliary oxygen at an initial flow of 2 litres per minute (this is the flow required by most patients). Some patients may need their flow titrated depending on severity of disease (the usual flow is 1 to 3 litres per minute, but can be higher).

Consider increasing the flow by 1 litre per minute overnight and during activity or exercise (including for everyday physical activities such as showering), if required.

Long-term continuous oxygen therapy should be used for at least 15 hours (preferably 18 hours or more) per day, including hours asleep.

Long-term continuous oxygen therapy should be supplied from an oxygen concentrator. A portable oxygen device (portable concentrator or oxygen cylinder) (see Oxygen delivery systems and devices used in domiciliary oxygen therapy) may be considered, particularly for patients who demonstrate an objective improvement in exercise endurance (eg measured using a treadmill, cycle ergometer, 6-minute walk test or shuttle walk test).

Regularly review patients receiving long-term continuous oxygen therapy (see Monitoring domiciliary oxygen in adults).

Intermittent oxygen therapy

Intermittent oxygen therapy

Evidence for the benefit of intermittent oxygen therapy is equivocal.

Intermittent oxygen therapy may be used in patients:

- starting long-term continuous oxygen therapy who wish to supplement stationary concentrator use with portable oxygen for physical activities outside the home
- during air travel if they have known lung disease and fulfil certain criteria; see Fitness to fly for patients with respiratory disease for more information on assessment for in-flight oxygen therapy
- with obstructive or fibrotic lung diseases who do not meet the criteria for long-term continuous oxygen therapy and whose ability to exercise is limited by hypoxaemia
- with severe asthma or COPD who live in isolated areas for use during acute exacerbations while awaiting medical attention
- with acute cluster headache; see Acute treatment for cluster headache for dosing information.

Intermittent oxygen therapy may be used in patients with dyspnoea due to hypoxaemia in terminal illness (including pulmonary vascular, interstitial or neoplastic lung disease); however, treatment of hypoxaemia with intermittent oxygen therapy may not relieve dyspnoea.

Although domiciliary oxygen therapy is often prescribed for patients with chronic heart failure with intractable breathlessness, there is no supporting evidence that it reduces breathlessness or hospitalisation, or improves survival.

Nocturnal oxygen therapy

Nocturnal oxygen therapy

Nocturnal oxygen therapy can be used in patients with chronic hypoxaemia who do not meet the criteria for long-term continuous oxygen therapy.

Before considering nocturnal oxygen therapy, perform a sleep study (polysomnogram) to identify or exclude sleep-disordered breathing (eg obstructive sleep apnoea or obesity hypoventilation syndrome). Hypoxaemia at night may be related to sleep-disordered breathing and may require use of continuous positive airway pressure (CPAP).

In patients unlikely to have sleep-disordered breathing, perform overnight pulse oximetry to detect nocturnal hypoxaemia.

Nocturnal oxygen therapy can be considered if SpO_2 is 88% or less for more than one-third of sleep duration, particularly in patients with complications of hypoxaemia (eg pulmonary hypertension, polycythaemia).

Contraindications to domiciliary oxygen therapy in adults

Contraindications to domiciliary oxygen therapy in adults

Domiciliary oxygen therapy is not indicated for patients:

- whose main complaint is dyspnoea but who maintain partial pressure of oxygen (PaO_2) higher than 60 mmHg
- who continue to smoke (because of risk of fire)
- who have not received adequate therapy for their underlying disease.

Monitoring domiciliary oxygen therapy in adults

Monitoring domiciliary oxygen therapy in adults Monitoring is vital for all patients prescribed oxygen therapy.

Monitoring is vital for all patients prescribed domiciliary oxygen therapy to ensure treatment:

- is still indicated (38% of patients who meet the criteria for domiciliary oxygen therapy when discharged from hospital no longer had a clinical requirement for therapy at follow-up 4 to 8 weeks later)
- is being effectively adhered to.

Domiciliary oxygen therapy is often prescribed before discharge from hospital; however, there is no evidence to support this practice. If prescribed on discharge, clinicians must emphasise that it is short-term therapy and timely follow-up is especially important.

Specialist review is needed for ongoing domiciliary oxygen therapy within 4 months of starting therapy when the patient is stable; do not assess the patient if they are unstable in order to avoid inappropriately continuing long-term oxygen therapy. Review includes repeat arterial blood gas analysis on room air to assess ongoing need for oxygen therapy, and pulse oximetry to assess adequacy of oxygen delivery. Also assess smoking status and impact of domiciliary oxygen therapy on patient's quality of life.

Patients are reviewed annually thereafter, or more frequently if the patients' condition warrants it. Annual review may involve the general practitioner or specialist.

Incorporate patient education into assessments to help maximise the patient's understanding and adherence, and the effectiveness of domiciliary oxygen therapy. Comprehensive patient education material on domiciliary oxygen therapy is available from the Lung Foundation Australia website.

If domiciliary oxygen therapy is no longer needed, explain to the patient that this is because they have responded well to therapy; telling the patient they are no longer eligible for funding may cause anxiety.

Oxygen delivery systems and devices used in domiciliary oxygen therapy

Oxygen delivery systems and devices used in domiciliary oxygen therapy

Overview

Overview

Oxygen is usually delivered by oxygen concentrators or cylinders. Choice of delivery system depends on cost and the number of hours per day oxygen is needed.

Long-term oxygen therapy is usually delivered by oxygen concentrators; large oxygen cylinders may be used as backup for possible electricity supply failure or if supply of electricity is too unreliable for oxygen concentrator use. Portable oxygen concentrators and small oxygen cylinders may be suitable for ambulatory use. Oxygen conservation devices may be used to increase life of oxygen cylinders.

Low-flow devices are usually used for domiciliary oxygen therapy. Standard nasal cannula is usually used; however, choice of device depends on the patient's clinical condition, partial pressure of oxygen (PaO_2), partial pressure of carbon dioxide ($PaCO_2$), comfort, as well as funding and equipment available.

Oxygen concentrators

Oxygen concentrators

Oxygen concentrators are cost-effective in delivering oxygen to patients needing long-term continuous oxygen therapy.

Oxygen concentrators are mobile, floor-standing, electrically driven machines that extract nitrogen from room air in molecular sieves and generally deliver 90 to 95% oxygen to the machine outlet. These machines do not store oxygen; they must be turned on continuously to deliver oxygen. They do not produce the pressure needed to drive jet nebulisers and cannot be used with Venturi masks. Up to 30 metres of tubing can be used with these machines to allow mobility within the home.

Portable oxygen concentrators are also available. These rechargeable, battery-driven devices may be suitable for ambulatory use, and some models have been approved for use by commercial airlines.

Oxygen cylinders

Oxygen cylinders

Oxygen cylinders deliver 100% oxygen and are used to maximise delivery of oxygen over a 24-hour period. Additionally, oxygen cylinders are used when:

- ambulatory patients need oxygen away from home
- patients are receiving intermittent oxygen therapy
- supply of electricity is too unreliable for oxygen concentrator use, or backup is needed for possible electricity supply failure.

The limited duration of oxygen supply, and cost of refills and delivery are major drawbacks of portable oxygen cylinders.

Oxygen cylinders come in a range of sizes; see Table 9.25. Patients are usually supplied a pull-along trolley or shoulder bag to transport the oxygen cylinder.

Oxygen conservation devices (eg Oxymizer, Oximatic) increase the life of oxygen cylinders substantially by enabling a pulse of oxygen to be delivered on inspiration only; however, evidence of their effectiveness in correcting hypoxaemia is limited.

Oxygen supply companies can arrange oxygen at travel destinations. For information about oxygen use in-flight, see In-flight oxygen therapy.

Table 9.25 Oxygen cylinder size and capacity

Size	Volume (m^3) (1 m^3 = 1000 litres)	Duration of oxygen supply at flow rate 2 litres per minute
G	7.6 to 8.8	hospital use only
E	3.8 to 5.2	about 30 hours
D	1.5	about 11 hours

Size	Volume (m^3) (1 m^3 = 1000 litres)	Duration of oxygen supply at flow rate 2 litres per minute
C	0.55	about 3 hours
Traveller	0.257 to 0.682	depends on size

Adapted with permission from McDonald CF, Whyte K, Jenkins S, Serginson J, Frith P, Pretto J. Clinical practice guideline: Adult domiciliary oxygen therapy. Sydney: The Thoracic Society of Australia and New Zealand; 2014. https://www.thoracic.org.au/journal-publishing/area?command=record&id=6

Adverse effects of domiciliary oxygen therapy

Adverse effects of domiciliary oxygen therapy

Domiciliary oxygen therapy is associated with the risk of fire propagation. Patients should not smoke and must follow procedures for safe storage of oxygen cylinders to avoid fire hazard and personal injury.

Hypercapnia can occur with domiciliary oxygen therapy; however, this is rare.

Nasal symptoms from oxygen delivery (eg nasal stuffiness, dryness or bleeding) are common and may be alleviated by using saline nasal sprays (sodium chloride solution) or water-based lubricants, or by placing the cannulae in the mouth, which may be practical at night.

Nasal cannulae may cause pressure area marks behind the ears or on the cheeks, which can be avoided and alleviated by using soft foam pads, cotton wool or gauze.

The equipment supplier may be able to advise on the availability of extra devices or attachments that would help solve some of these problems.

Access to and funding for domiciliary oxygen therapy in Australia

Access to and funding for domiciliary oxygen therapy in Australia

Eligible prescribers, funding and clinical criteria for subsidised domiciliary oxygen therapy vary between Australian states and territories and, in some cases, from region to region within a state or territory. Obtain details from the relevant state or territory Health Department. Some websites with information on domiciliary oxygen therapy include:

- Queensland Health Medical Aids Subsidy Scheme (MASS)
- New South Wales EnableNSW Home Respiratory Program
- Victoria State-wide Equipment Program (SWEP)
- South Australia Health Home Oxygen Therapy Policy Guideline
- Western Australia Health Respiratory Health Network

Oxygen therapy for patients admitted to a high-level residential care facility is federally subsidised; a social worker may need to organise funding.

Oxygen therapy for patients who receive a Department of Veterans' Affairs pension is subsidised through the Department of Veterans' Affairs.

For patients who pay for their own oxygen therapy, any registered medical practitioner can prescribe treatment.

Domiciliary oxygen therapy in children

Domiciliary oxygen therapy in children

Domiciliary oxygen therapy in children should be prescribed and managed by a specialist.

Domiciliary oxygen therapy is recommended for children with severe chronic hypoxaemia who are unable to maintain oxygen saturation measured by pulse oximetry (SpO_2) at 93% or greater on room air (although children with cyanotic congenital heart disease usually have lower target oxygen saturation levels, as determined by their treating specialists).

The largest group of children with severe chronic hypoxaemia are infants with chronic neonatal lung disease, which is a sequela to severe hyaline membrane disease (caused by a deficiency of pulmonary surfactant). The terms chronic neonatal lung disease, chronic lung disease of prematurity and bronchopulmonary dysplasia are used interchangeably in practice. Domiciliary oxygen in these children aims to maintain SpO_2 in a minimum mean target range of 93 to 95%. Treatment also aims to avoid SpO_2 falling below 90% for more than 5% of the total recording time, as measured by overnight pulse oximetry; prolonged SpO_2 below 90% has been associated with adverse clinical outcomes. A lower target oxygen saturation may be used in children with cyanotic congenital heart disease.

Most infants needing domiciliary oxygen therapy require a low flow of oxygen, between 0.125 and 0.5 litres per minute. Oxygen is usually delivered through an oxygen concentrator via a low-flow meter, lightweight plastic tubing and nasal cannulae. Small cylinders can be used for portability.

All infants born prematurely with oxygen-dependent chronic lung disease should be monitored by a respiratory paediatrician every 4 to 6 weeks following discharge from the neonatal unit. Feeding, weight gain and SpO_2 (measured at the time of clinic visits) are used to determine the rate of weaning from oxygen treatment.

Oxygen desaturation during sleep continues for longer than daytime desaturation in these infants, particularly during rapid eye movement (REM) sleep. Before stopping therapy, it is essential that continuous overnight pulse oximetry without supplemental oxygen shows a minimum mean SpO_2 of 93 to 95%. Temporary reintroduction of low-flow oxygen may be required if the infant develops respiratory illness in the months after stopping oxygen therapy.

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Key references: Domiciliary oxygen therapy

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Definition and causes of allergic rhinitis

Definition and causes of allergic rhinitis

Rhinitis is an inflammation of the mucosal lining of the nose. Rhinitis is classified as:

- allergic rhinitis
- infectious rhinitis—see Acute rhinosinusitis for management
- nonallergic rhinitis (also called vasomotor rhinitis)—no identifiable allergic trigger or infective cause
- occupational rhinitis—caused by workplace irritants (eg cleaning chemicals, foods)
- drug-induced rhinitis—causes include aspirin, nonsteroidal anti-inflammatory drugs (NSAIDs), vasodilator drugs (eg some antihypertensives), intranasal decongestants (causing rhinitis medicamentosa) and estrogen-containing preparations (including combined oral contraceptives).

Allergic rhinitis is the most common form of rhinitis; it affects around 19% of the population in Australia. Common symptoms of allergic rhinitis include rhinorrhoea, sneezing, nasal blockage, nasal itch and, occasionally, altered sense of smell. Allergic conjunctivitis often coexists with allergic rhinitis.

Allergic rhinitis is associated with an immunoglobulin E (IgE)-mediated immune response to environmental allergens. The allergens can be seasonal (eg grass, weed and tree pollens) or perennial (eg dust mites, cat and dog dander). Symptoms can be further aggravated by chemical irritants (eg smoking, including exposure to second-hand smoke).

Allergic rhinitis and asthma commonly coexist (sometimes referred to as 'United Airway Disease')—asthma occurs in 30% of patients with allergic rhinitis, and allergic rhinitis occurs in more than 80% of patients with allergic asthma. Always assess patients with rhinitis for coexisting asthma (see Asthma diagnosis).

Allergic rhinitis also commonly coexists with sinusitis (see Chronic rhinosinusitis) and atopic dermatitis.

Patients with allergic rhinitis and rye grass sensitisation are at increased risk of thunderstorm asthma. Always assess patients with allergic rhinitis who live in an area with high rye grass pollen levels for risk of thunderstorm asthma—see here for more information.

While most rhinitis is allergic, a patient history can help identify other possible types of rhinitis before starting treatment for allergic rhinitis. Features that suggest an alternative diagnosis include unilateral symptoms, nasal obstruction without other symptoms, pain, purulent discharge, recurrent epistaxis and loss of sense of smell.

Classification of allergic rhinitis

Classification of allergic rhinitis

Allergic rhinitis is classified in terms of symptom frequency and duration (intermittent or persistent) and severity (mild, or moderate to severe). Table 9.12 outlines these classifications. Previous classifications referred to seasonal allergic rhinitis (hay fever) or perennial allergic rhinitis, according to the allergens involved; however, as most patients are sensitised to both seasonal and perennial allergens, these classifications are less useful.

Table 9.12 Classification of allergic rhinitis

Frequency and duration of symptoms	
Intermittent	**Persistent**

symptoms present: • on fewer than 4 days a week OR • for fewer than 4 consecutive weeks	symptoms present: • on more than 4 days a week AND • for more than 4 consecutive weeks
Severity of symptoms	
Mild all of the following: • symptoms present but not troublesome • no sleep disturbance • no impairment of daily activities, leisure or sport • no impairment of school or work performance	**Moderate to severe** one or more of the following: • troublesome symptoms • sleep disturbance • impairment of daily activities, leisure or sport • impairment of school or work performance

Approach to management of allergic rhinitis

Approach to management of allergic rhinitis

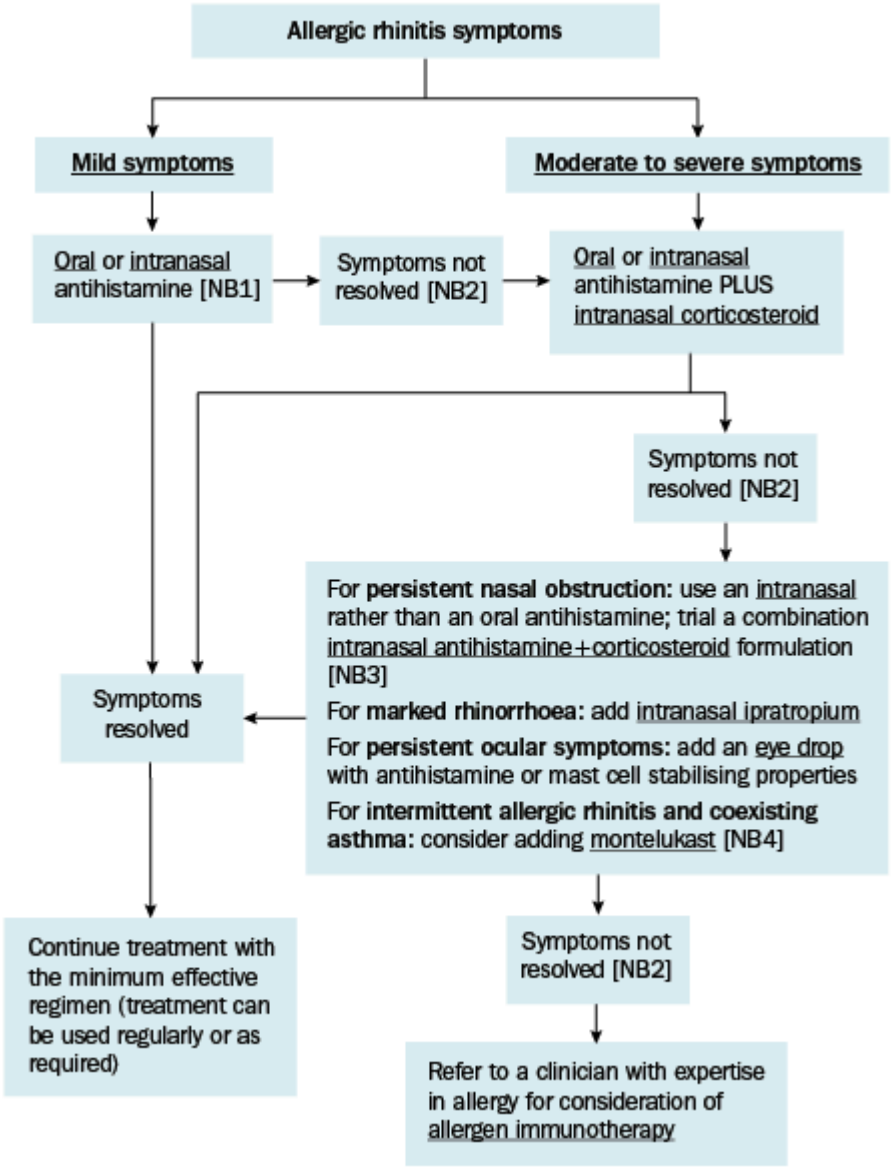
In patients with allergic rhinitis caused by a clinically obvious allergen, minimise exposure to the allergen if possible. Exclude other causes of rhinitis, such as rhinitis medicamentosa caused by overuse of intranasal decongestants.

In patients with allergic rhinitis caused by a clinically obvious allergen, minimise exposure to the allergen if possible.

Figure 9.9 outlines the approach to management of allergic rhinitis.

Figure 9.9 Approach to management of allergic rhinitis

Printable figure



NB1: Combining oral and intranasal antihistamine therapy does not confer additional benefit compared with using either one alone.

NB2: Trial new treatments for around 4 weeks before assessing response. Before escalating treatment, assess adherence and, if using a nasal spray, assess technique (see Figure 9.10 for patient instructions for using a nasal spray). Also consider alternative diagnoses, particularly if the patient has no response to standard therapy.

NB3: Oral and intranasal decongestants have no role in allergic rhinitis and should be avoided.

NB4: Triple therapy with an antihistamine, an intranasal corticosteroid and montelukast can be trialled before referral, but this is usually less effective than allergen immunotherapy.

Once symptoms have resolved, continue treatment with the minimum effective regimen; treatment can be used regularly or as required. Tailor the duration of treatment to the patient's symptoms. Patients with intermittent symptoms that occur seasonally may only require treatment for a few months of the year, while others may require long-term treatment.

For patients who do not have an adequate response to treatment, check the patient's adherence and nasal spray technique (see Figure 9.10). Also consider the possibility of an alternative diagnosis, particularly in patients who have no response to treatment. Features that suggest an alternative diagnosis include unilateral symptoms, nasal obstruction without other symptoms, pain, purulent discharge, recurrent epistaxis and loss of sense of smell.

If the patient does not have any features that indicate an alternative diagnosis, refer them to a clinician with expertise in allergy for consideration of allergen immunotherapy.

Computed tomography (CT) scans are not recommended for uncomplicated rhinitis as they are costly and expose the patient to radiation. If an alternative diagnosis is suspected, or if the patient has complications of rhinitis, consider a CT scan of the sinuses and referral to an ear, nose and throat surgeon for consideration of surgery.
Figure 9.10 Patient instructions for using a nasal spray

Printable box

For videos demonstrating correct use of nasal sprays, see the National Asthma Council website.

To use a nasal spray effectively and safely, follow these instructions:

1. If the spray device is new or has not been used for more than a few days, prime the device according to the manufacturer's instructions.
2. Shake the bottle.
3. Clear the nasal passages first by gently blowing your nose (or by using a saline rinse to clear nasal obstruction and then waiting for 10 minutes before using the nasal spray).
4. Bend your neck forward and look down.
5. Put the nozzle just inside the nose, aiming towards the outer wall of the nose and the ear (away from the middle or the top of the nose). Use your right hand for the left nostril and left hand for the right nostril. This reduces the amount of drug deposited onto the wall that separates your nostrils (septum).
6. Press to spray and sniff gently at the same time—sniffing hard can make the liquid go straight down the throat.

If you are using two different nasal sprays, wait 10 minutes between sprays.

Antihistamines for allergic rhinitis

Antihistamines for allergic rhinitis

Oral antihistamines

Oral antihistamines

The less-sedating oral antihistamines are effective for most symptoms of allergic rhinitis, including sneezing, rhinorrhoea, ocular symptoms and itch (including at sites other than the nose, such as conjunctiva, palate and skin). They are less effective than intranasal antihistamines or intranasal corticosteroids for nasal obstruction.

Oral antihistamines have a fast onset of action, so can be used as required for intermittent symptoms; for persistent symptoms, they should be used regularly.

Currently available less-sedating antihistamines appear to be equally effective, but response can vary between patients. Consider trialling an alternative oral antihistamine if response is inadequate.

For an adult, use:

1 cetirizine 10 mg orally, daily [Note 1] *allergic rhinitis*

OR

1 desloratadine 5 mg orally, daily *allergic rhinitis*

OR

1 fexofenadine 120 to 180 mg orally, daily as a single dose or in divided doses *allergic rhinitis*

OR

1 loratadine 10 mg orally, daily. *allergic rhinitis*

For a child, use:

1 cetirizine orally [Note 1] *allergic rhinitis*

child 1 to 2 years: 0.25 mg/kg (up to 2.5 mg) twice daily

child 2 to 5 years: 5 mg daily as a single dose or in divided doses

child 6 years or older: 10 mg daily as a single dose or in divided doses

OR

1 desloratadine orally *allergic rhinitis*

child 1 to 5 years: 1.25 mg once daily

child 6 to 11 years: 2.5 mg once daily

child 12 years or older: 5 mg once daily

OR

1 fexofenadine orally *allergic rhinitis*

child 2 to 11 years: 30 mg twice daily

child 12 years or older: 120 to 180 mg daily as a single dose or in divided doses

OR

1 loratadine orally *allergic rhinitis*

child 1 to 2 years: 2.5 mg once daily

child 2 years or older, weight 30 kg or less: 5 mg once daily

child 2 years or older, weight more than 30 kg: 10 mg once daily.

Higher doses are unlikely to be of additional benefit, and combining oral and intranasal antihistamine therapy does not confer additional benefit.
Combining oral and intranasal antihistamine therapy does not confer additional benefit.

Sedating antihistamines are not routinely recommended for treatment of allergic rhinitis, particularly in children, in whom the sedative properties can affect school performance.

Note 1: Of the less-sedating antihistamines, cetirizine is the most likely to cause sedation.

Intranasal antihistamines

Intranasal antihistamines

Intranasal antihistamines are more effective than oral antihistamines for nasal obstruction caused by allergic rhinitis, and have a faster onset of action. However, they are less effective for other symptoms of allergic rhinitis (eg itch at sites other than the nose), and require good technique to be effective. Instruct patients on how to use nasal sprays correctly; see Figure 9.10.

Intranasal antihistamines have a fast onset of action, so can be used as required for intermittent symptoms; for persistent symptoms, they should be used regularly.

Use:

1 azelastine (adult or child 5 years or older) 1 mg/mL nasal spray, 1 spray into each nostril, twice daily *allergic rhinitis* _

OR

1 levocabastine (adult or child 6 years or older) 0.5 mg/mL nasal spray, 2 sprays into each nostril, 2 to 4 times daily. *allergic rhinitis* _

Combining oral and intranasal antihistamine therapy does not confer additional benefit.

Intranasal corticosteroids for allergic rhinitis

Intranasal corticosteroids for allergic rhinitis

Intranasal corticosteroids are particularly useful for moderate to severe allergic rhinitis. They are more effective than oral antihistamines and are especially effective for nasal obstruction. They also reduce ocular symptoms. However, intranasal corticosteroids require good technique and adherence to be effective.

It is important to explain to patients that intranasal corticosteroids do not provide immediate relief of symptoms. Symptom relief usually starts within a few days, but a minimum trial of 4 weeks of consistent use is needed to properly establish efficacy.

For intranasal corticosteroid therapy, use a high dose for 4 weeks, then reduce to a maintenance dose. Available intranasal corticosteroid formulations for allergic rhinitis are summarised in Table 9.13. Use:

1 beclometasone 100 micrograms (child 6 years or older: 50 to 100 micrograms) into each nostril, twice daily for 4 weeks, then 50 micrograms twice daily *allergic rhinitis* _

OR

1 budesonide (adult or child 6 years or older) 128 micrograms into each nostril, daily (in 1 or 2 divided doses) for 4 weeks, then 32 to 64 micrograms daily *allergic rhinitis* _

OR

1 ciclesonide (adult or child 6 years or older) 100 micrograms into each nostril, daily [Note 2] *allergic rhinitis* _

OR

1 fluticasone furoate 55 micrograms (child 2 to 11 years: 27.5 to 55 micrograms) into each nostril, daily for 4 weeks, then 27.5 micrograms daily *allergic rhinitis* _

OR

1 fluticasone propionate (adult or child 12 years or older) 100 micrograms into each nostril, daily for 4 weeks, then 50 micrograms daily *allergic rhinitis* _

OR

1 mometasone 100 micrograms (child 3 to 11 years: 50 micrograms) into each nostril, daily for 4 weeks, then 50 micrograms daily. *allergic rhinitis* _

Table 9.13 Intranasal corticosteroid formulations for allergic rhinitis

Drug	Dose per spray	Initial dose (for 4 weeks) (into each nostril)	Maintenance dose [NB1] (into each nostril)
beclometasone	50 micrograms	adults: 2 sprays, twice daily children 6 years and older: 1 to 2 sprays twice daily	1 spray twice daily
budesonide	32 micrograms	adults and children 6 years and older: 2 sprays twice daily, or 4 sprays once daily	1 to 2 sprays once daily
	64 micrograms	adults and children 6 years and older: 1 spray twice daily, or 2 sprays once daily	1 spray once daily
ciclesonide	50 micrograms	adults and children 6 years and older: 2 sprays once daily	2 sprays once daily [NB2]
fluticasone furoate	27.5 micrograms	adults: 2 sprays once daily children 2 to 11 years: 1 to 2 sprays once daily	1 spray once daily
fluticasone propionate	50 micrograms	adults and children 12 years and older: 2 sprays once daily	1 spray once daily
mometasone	50 micrograms	adults: 2 sprays once daily children 3 to 11 years: 1 spray once daily	1 spray once daily

NB1: Maintenance dose is the same for adults and children.

NB2: Based on lack of available clinical data, the manufacturer does not recommend decreasing the initial dose of ciclesonide.

Instruct patients on how to use nasal sprays correctly; see Figure 9.10. Using a crossover technique (right hand to left nostril, left hand to right nostril) reduces deposition of the corticosteroid directly onto the nasal septum, and reduces the likelihood of causing nasal septal perforation.

To reduce the likelihood of systemic adverse effects, reduce to the maintenance dose after 4 weeks of initial therapy and tailor the duration of treatment to the patient's symptoms. Patients with intermittent symptoms that occur seasonally may only require treatment for a few months of the year, while others may require long-term treatment.

For severe symptoms occurring seasonally (eg in spring) and related to pollen exposure, consider starting an intranasal corticosteroid at least 2 weeks before the onset of the pollen season to avoid the priming effect of initial re-exposure to the allergen.

Note 2: Based on lack of available clinical data, the manufacturer does not recommend decreasing the initial dose of ciclesonide.

Intranasal antihistamine+corticosteroid for allergic rhinitis

Intranasal antihistamine+corticosteroid for allergic rhinitis

Combination intranasal formulations containing an antihistamine and a corticosteroid can be useful for patients with allergic rhinitis who have moderate to severe symptoms or those with mild symptoms not responding to antihistamines. They are particularly useful if their primary symptom is nasal obstruction.

If the patient is already taking an oral antihistamine, it should be stopped before starting the combination nasal spray. Combining oral and intranasal antihistamine therapy does not confer additional benefit.

If appropriate, for adults and children 12 years and older, use:

1 azelastine+fluticasone propionate 125+50 micrograms per spray, 1 spray into each nostril, twice daily *allergic rhinitis*

OR

1 olopatadine+mometasone 665+25 micrograms per spray, 2 sprays into each nostril, twice daily. *allergic rhinitis*

Instruct patients on how to use nasal sprays correctly; see Figure 9.10.

Montelukast for allergic rhinitis

Montelukast for allergic rhinitis

Montelukast is a leukotriene receptor antagonist that is usually only used in combination with an antihistamine and an intranasal corticosteroid. It may have a role in patients with intermittent allergic rhinitis that occurs seasonally who also have asthma, because it is beneficial for both conditions. In children with asthma, it may be first-line therapy before intranasal corticosteroids. Montelukast can be trialled in patients who do not respond adequately to other treatments; however, progressing to allergen immunotherapy is more likely to be effective in these patients.

If considered appropriate, use:

montelukast : *allergic rhinitis*

adult: 10 mg orally, once daily

child 2 to 5 years: 4 mg orally, once daily

child 6 to 14 years: 5 mg orally, once daily.

Montelukast was the subject of an Australian Therapeutic Goods Administration (TGA) alert regarding neuropsychiatric adverse effects (nightmares, sleep disturbance, agitation, depression and, rarely, suicidal thinking and behaviour). Counsel parents and carers about these effects—they usually occur in the first 2 weeks of treatment and subside within a few days of stopping treatment. Stop treatment if the effects occur. See the TGA website for more information.

Intranasal ipratropium for allergic rhinitis

Intranasal ipratropium for allergic rhinitis

Ipratropium is an antimuscarinic drug that is useful for patients with allergic rhinitis who have marked rhinorrhoea. Intranasal ipratropium has a rapid onset of action and a prolonged effect (4 to 12 hours). It is usually used in combination with an intranasal corticosteroid and an antihistamine.

Use:

ipratropium (adult or child 12 years or older) 44 micrograms per spray, 2 sprays into each nostril, up to 3 times daily initially, reducing as rhinorrhoea improves [Note 3]. *allergic rhinitis*

Note 3: Ipratropium is also available as a 22 micrograms per spray formulation, which can be used for a lower maintenance dose.

Eye drops for allergic conjunctivitis

Eye drops for allergic conjunctivitis

Allergic conjunctivitis can be the predominant symptom in allergic rhinitis (also known as allergic rhinoconjunctivitis). Therapy with oral antihistamines or intranasal corticosteroids and saline eye drops or eye washes is effective for allergic conjunctivitis; eye drops can be used if symptoms do not respond.

Drugs used in eye drops for allergic conjunctivitis include:

- antihistamines (levocabastine [Note 4]), which provide rapid relief of symptoms
- mast cell stabilisers (cromoglycate, lodoxamide), which have a delayed onset (around 2 weeks) but provide longer-term relief of symptoms
- drugs with both antihistamine and mast cell stabilising properties (azelastine, ketotifen, olopatadine), which provide both short- and long-term relief of symptoms.

Drugs with both antihistamine and mast cell stabilising properties appear to be more effective than drugs with only antihistamine or mast cell stabilising properties. Use:

1 azelastine 0.05% eye drops, 1 drop into both eyes, 2 to 4 times daily *allergic conjunctivitis* _

OR

1 ketotifen 0.025% eye drops, 1 drop into both eyes, twice daily *allergic conjunctivitis* _

OR

1 olopatadine 0.1% eye drops, 1 drop into both eyes, twice daily. *allergic conjunctivitis* _

If an antihistamine eye drop is preferred, use:

1 levocabastine 0.05% eye drops, 1 drop into both eyes, 2 to 4 times daily. *allergic conjunctivitis* _

If a mast cell stabiliser eye drop is preferred, use:

1 cromoglycate 2% eye drops, 1 drop into both eyes, 4 to 6 times daily *allergic conjunctivitis* _

OR

1 lodoxamide 0.1% eye drops, 1 drop into both eyes, 4 times daily. *allergic conjunctivitis* _

If ocular symptoms do not respond, consider referral to an optometrist or ophthalmologist. Anti-inflammatory eye drops, including ketorolac and corticosteroids, should only be used to treat allergic conjunctivitis under specialist advice.

Vasoconstrictor eye drops (eg naphazoline, tetryzoline) are not recommended for allergic conjunctivitis. Extended use causes rebound ocular redness, which can in turn lead to overuse.

Note 4: The antihistamines pheniramine and antazoline are only available in an eyedrop formulation in combination with a vasoconstrictor, so are not recommended for allergic conjunctivitis.

Decongestants and allergic rhinitis

Decongestants and allergic rhinitis

Oral and intranasal decongestants have no role in allergic rhinitis. Although they are effective at reducing congestion, they should not be used for more than 3 to 5 days. Prolonged use of intranasal decongestants causes rebound congestion (rhinitis medicamentosa), which can take several weeks to reverse. Oral decongestants can increase blood pressure, and increase the risk of arrhythmias in people with cardiovascular disease.

Oral and intranasal decongestants are also not recommended in children younger than 6 years because of the lack of evidence for benefit and the risk of adverse effects.

Allergen immunotherapy for allergic rhinitis

Allergen immunotherapy for allergic rhinitis

Allergen immunotherapy can be very effective in the management of allergic rhinitis; it is the only treatment that alters the course of the condition. Its use is largely limited to patients with moderate to severe symptoms that are incompletely or poorly controlled with drug treatment and allergen avoidance.

Specific allergen sensitivities must be identified by *in vivo* skin testing or *in vitro* serum testing. These tests are usually carried out and interpreted by a clinician with expertise in allergy. Allergen immunotherapy is more successful for patients who have a single sensitivity, but patients with multiple sensitivities can still achieve good results.

The treatment course of subcutaneous or sublingual immunotherapy is around 3 years. Both sublingual and subcutaneous immunotherapy are effective for patients with allergic rhinitis who are sensitised to grass pollen or dust mites; subcutaneous immunotherapy is also available for other allergens. Relief of symptoms may be delayed, but reassess the diagnosis if the patient shows no improvement after 6 months.

Subcutaneous immunotherapy is always given under medical supervision because it can cause both immediate- and slower-onset systemic reactions. These range from mild urticaria and rhinitis, through to angioedema, severe asthma and anaphylactic shock. Systemic adverse effects occur in 0.13% of patients and local adverse effects occur in 50% of patients.

Sublingual immunotherapy should be given under medical supervision for the first dose, but subsequent doses can be taken at home. Local adverse reactions to sublingual immunotherapy occur in 20 to 30% of patients, but systemic adverse effects are rare.

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Introduction to bronchiectasis

Introduction to bronchiectasis

Bronchiectasis is increasingly recognised as an important cause of chronic cough and recurrent chest infections.

Bronchiectasis is a disease characterised morphologically by the abnormal dilatation of bronchi and bronchioles, and clinically by recurrent bronchial infection, and chronic cough (often with sputum). The pathogenesis of bronchiectasis is related to chronic airway infection and inflammation resulting in airway damage. Bronchiectasis may be localised to one lobe or segment, or generalised in both lungs.

Bronchial dilatation in bronchiectasis was traditionally thought to be permanent; however, there is emerging evidence, particularly in children, that dilatation is potentially reversible with early diagnosis and intervention.

Bronchiectasis is classified under chronic suppurative lung disease. Cystic fibrosis is an important cause of bronchiectasis. Information covered in this topic relates to bronchiectasis **not** associated with cystic fibrosis.

There is increasing recognition of bronchiectasis not associated with cystic fibrosis occurring in children. Prompt referral to a paediatric specialist for diagnosis and management is recommended in children with suspected bronchiectasis.

The Lung Foundation Australia website publishes fact sheets on bronchiectasis for patients and health professionals.

Causes of bronchiectasis

Causes of bronchiectasis

An underlying disease or reversible cause of bronchiectasis is often not easy to identify. The majority of bronchiectasis cases are idiopathic or are a result of previous infection. Pneumonia, often in childhood, is the most common cause of bronchiectasis. For more causes of and contributors to bronchiectasis, see Table 9.21.

Table 9.21 Causes of and contributors to bronchiectasis

[NB1]

Common causes and contributors
severe respiratory infection
asthma
COPD
cystic fibrosis [NB2]
Less common causes and contributors
common variable immunodeficiency (CVID)
gastro-oesophageal reflux or aspiration

radiotherapy for breast cancer

connective tissue disease

allergic bronchopulmonary aspergillosis

primary ciliary dyskinesia

inflammatory bowel disease

nontuberculous mycobacterial infection (including *Myobacterium avium* complex infection)

Rare causes and contributors

alpha-1 antitrypsin deficiency

diffuse panbronchiolitis

pink disease

yellow nail syndrome

bronchial obstruction

congenital malformations

inhaled foreign body

COPD = chronic obstructive pulmonary disease

NB1: The main causes of bronchiectasis are the same in adults and children; however, certain conditions (eg rheumatoid arthritis, COPD) are not causes of bronchiectasis in children because they have onset in adulthood.

NB2: Information covered in this topic relates to bronchiectasis not associated with cystic fibrosis; see Cystic fibrosis for more information.

Adapted with permission from Morgan L, Visser S, Stroil-Salama E, Abbott A. Bronchiectasis [How to treat]. Sydney: Australian Doctor Group; 2020. https://www.ausdoc.com.au/howtotreat

Bronchiectasis frequently coexists with asthma, chronic obstructive pulmonary disease (COPD), sinusitis, gastro-oesophageal reflux disease (GORD), anxiety or depression.

Clinical features of bronchiectasis

Clinical features of bronchiectasis

Most patients with bronchiectasis have a chronic productive cough and recurrent bronchial infection; the sputum is usually purulent and may be intermittently bloodstained. Other symptoms of bronchiectasis may include fatigue, breathlessness and pleuritic chest pain. Coarse crackles are commonly heard on chest auscultation. A small proportion of patients (less than 5%) have clubbing of the fingers.

Always consider bronchiectasis in patients presenting with coarse crackles, chronic productive cough and recurrent or difficult-to-treat chest infections. Also consider bronchiectasis if *Pseudomonas aeruginosa* or *Haemophilus influenzae* is found on sputum culture.

Some patients present with life-threatening haemoptysis requiring urgent hospitalisation.

Bronchial dilatation in bronchiectasis is potentially reversible in children with early diagnosis and intervention. Promptly refer children with suspected bronchiectasis to a paediatric specialist for assessment; see Figure 9.17 for clinical features suggestive of bronchiectasis in children.

Figure 9.17 Indications for paediatric referral for investigation of bronchiectasis

Refer to a paediatric specialist for investigation of bronchiectasis if a child has any of the following:

- clinical features suggestive of bronchiectasis, including children with
  - recurrent episodes of chronic productive (wet or moist) cough, with each episode lasting for more than 4 weeks
  - clubbing
  - hyperinflation or chest wall deformity
  - persistent auscultatory findings (eg crackles)
- productive (wet or moist) cough persisting for more than 4 weeks despite appropriate antibiotics
- recurrent pneumonia or recurrent hospitalisations for lower respiratory tract infections
- persistent parenchymal changes on X-ray over time.

Investigations for and diagnosis of bronchiectasis

Investigations for and diagnosis of bronchiectasis

High-resolution computed tomography (HRCT) is the gold standard for diagnosis of bronchiectasis. Clinically significant bronchiectasis is diagnosed on HRCT when the bronchial diameter exceeds that of the adjacent vessel in a patient with symptoms of bronchiectasis. Children are more sensitive to ionising radiation; if an HRCT scan is considered in a child, consult with a paediatric specialist.

If an HRCT scan is considered in a child, consult with a paediatric specialist.

Chest X-ray is important for investigating causes of chronic cough, but is usually not adequate to diagnose bronchiectasis. Chest X-ray may be normal in bronchiectasis.

Pulmonary function testing in bronchiectasis often reveals airflow obstruction; however, 48% of patients with bronchiectasis have normal spirometry and only 34% of patients have airflow obstruction.

Consider specific diagnostic testing for conditions associated with bronchiectasis, directed by the clinical findings (patient history and physical examination) and radiological appearances. If there are no clinical clues to the cause of bronchiectasis, the following investigations are useful in determining a cause:

- full blood count and differential white cell count
- serum total IgE, specific IgG and IgE to *Aspergillus* (with or without *Aspergillus* skin-prick testing)
- serum IgG, IgM and IgA
- sputum culture and susceptibility testing (including testing for mycobacteria)
- cystic fibrosis (CF) sweat chloride test in children, and in adults with symptoms of CF (see Cystic fibrosis)
- screening for autoimmune disorders, if appropriate (eg rheumatoid factor [RF], antinuclear antibodies [ANA]).

Specific testing for primary ciliary dyskinesia (PCD), alpha-1 antitrypsin deficiency and complex immunodeficiencies may be ordered by specialists.

Severity, morbidity and mortality of bronchiectasis can be estimated using the FACED score, or the Bronchiectasis Severity Index (BSI), which also estimates hospitalisation admissions, exacerbations and quality of life.

Management of bronchiectasis

Management of bronchiectasis

Overview

Overview

The aims of managing bronchiectasis are to improve symptoms and quality of life, minimise exacerbations and limit disease progression.

Management of bronchiectasis associated with cystic fibrosis differs from management of bronchiectasis associated with other causes.

Key components of bronchiectasis management in adults include:

- exercise and pulmonary rehabilitation
- airway clearance
- general measures (eg developing action plans, smoking cessation, immunisation, nutrition, managing causes and comorbidities, spirometry testing)
- treating infective exacerbations
- managing haemoptysis.

Very rarely, surgical removal of a severely damaged section of lung may be helpful.

Bronchodilators and corticosteroids have a limited role in the treatment of bronchiectasis.

Stable bronchiectasis in adults can be managed in primary care. Refer to a respiratory physician in patients with:

- rapid progression of disease or symptoms
- disease requiring hospitalisation
- severe respiratory symptoms
- lack of response to treatment
- recurrent exacerbations (more than three per year)
- resistant or unusual organisms isolated in sputum (eg nontuberculous mycobacteria, *Pseudomonas aeruginosa*)
- haemoptysis.

Bronchiectasis in children should be managed by a specialist. Treatment involves airway clearance, exercise, antibiotic therapy, immunisations and optimisation of nutrition and growth.

The Lung Foundation Australia website publishes fact sheets on bronchiectasis for patients and health professionals, including stepwise management of stable bronchiectasis.

Exercise and pulmonary rehabilitation

Exercise and pulmonary rehabilitation

It is important for patients with bronchiectasis to maintain weight, muscle strength and muscle mass through exercise. Exercise may be useful in promoting airway clearance, and may improve quality of life and lung function; encourage regular exercise in adults and children with bronchiectasis.

In adults with bronchiectasis and impaired exercise capacity, refer to a pulmonary rehabilitation service in addition to encouraging regular exercise.

Airway clearance

Airway clearance

Keeping the airways as free of secretions as possible is an important part of bronchiectasis management. Airway clearance methods include physical techniques and drug treatment.

Refer to a respiratory physiotherapist with expertise in bronchiectasis to develop an individualised airway clearance program. Physical methods may include various breathing and coughing techniques, and the use of

aids for sputum mobilisation (eg mechanical devices). Information and videos on different airway clearance techniques can be found on the Bronchiectasis Toolbox website.

Inhaled and nebulised mucolytic agents that may assist with airway clearance include normal and hypertonic saline (sodium chloride solution). Nebulised hypertonic saline may cause bronchospasm in susceptible patients; refer to a specialist respiratory laboratory for hypertonic saline challenge before starting. Bronchodilators are sometimes used as pretreatment before mucolytics to prevent bronchoconstriction and improve pulmonary deposition.

General measures

General measures

All patients should have a **written bronchiectasis action plan** that outlines usual treatment, how to recognise worsening of symptoms, and how to adjust treatment in response to deterioration. Templates are available for download from the Lung Foundation Australia website.

Immunisation with pneumococcal vaccine and annual influenza vaccine is recommended. For details, see the *Australian Immunisation Handbook* .

Smoking cessation and **cigarette smoke avoidance** is recommended. For details on smoking cessation, see Smoking cessation.

Monitor and manage **causes and comorbidities**. Consider referral to psychological support services in patients with depression or anxiety.

Optimise **nutrition;** dietician referral may be needed for patients presenting with poor appetite, cachexia or nutritional deficiency.

Spirometry should be performed annually as part of routine monitoring of stable patients. It can be performed more often if clinically indicated (eg investigating suspected changes in airflow obstruction, increased cough, breathlessness or chest tightness).

Managing exacerbations

Managing exacerbations

All patients should have a written bronchiectasis action plan that outlines usual treatment, how to recognise worsening of symptoms, and how to adjust treatment in response to deterioration. Templates are available for download from the Lung Foundation Australia website.

Patients with severe exacerbation of bronchiectasis need close clinical review and usually require hospital admission; see Clinical features of severe exacerbations of bronchiectasis for clinical features of severe exacerbations.

Antibiotic therapy should only be used for **exacerbations** of bronchiectasis if the patient has all three of the following clinical features suggestive of bacterial infection:

- increased sputum volume or change in sputum viscosity
- increased sputum purulence
- increased cough, which may be associated with wheeze, breathlessness or haemoptysis.

For assessment and antibiotic management of exacerbations of bronchiectasis, see Antibiotic management of bronchiectasis.

Long-term oral or inhaled antibiotic therapy (eg low-dose macrolides) may be used by specialists to reduce the frequency of exacerbations in patients with bronchiectasis. Long-term antibiotic therapy is only appropriate for patients with bronchiectasis who have more than three exacerbations per year when other aspects of management (eg airway clearance, exercise, treatment of causes) are optimised. The reduction in

exacerbation frequency may be due in part to the anti-inflammatory effect of macrolides. For more information, see The role of long-term antibiotic therapy for bronchiectasis.

Management of haemoptysis

Management of haemoptysis

If a patient with bronchiectasis has massive haemoptysis, arrange immediate transfer to a hospital with appropriate specialist services. Investigations are generally aimed at localising the site of haemorrhage; they may include computed tomography (CT) scan of the chest with angiography, selective bronchial artery angiography and bronchoscopy. Bronchial artery embolisation or lobectomy may be required.

If a patient with bronchiectasis has recurrent small volume, bright haemoptysis, refer for assessment by a specialist.

Minor haemoptysis (small volume streaky blood mixed with purulent sputum) is common in patients with bronchiectasis. This may be an indication of infection but does not necessarily require further investigation. Assess the patient for signs of bacterial infection—see Assessment of exacerbations of bronchiectasis. Review the use of drugs that may worsen haemorrhage (eg nonsteroidal anti-inflammatory drugs [NSAIDs], anticoagulants).

Bronchodilators and corticosteroids

Bronchodilators and corticosteroids

Do not routinely prescribe bronchodilators unless the patient has other indications for use (eg asthma, chronic obstructive pulmonary disease [COPD]). However, long-acting beta$_2$ agonists may provide some symptomatic benefit in patients with bronchiectasis and significant breathlessness. Bronchodilators may be used before performing airway clearance techniques, and as premedication to prevent bronchospasm from inhaled mucolytic agents and inhaled antibiotics.

Do not routinely prescribe corticosteroids unless the patient has other indications for use (eg inhaled corticosteroids for asthma or COPD, oral corticosteroids for allergic bronchopulmonary aspergillosis [ABPA] or inflammatory bowel disease).

Do not routinely prescribe bronchodilators or corticosteroids for bronchiectasis unless the patient has other indications for use.

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Classification and diagnosis of pneumothorax

Classification and diagnosis of pneumothorax

Pneumothorax is the presence of air between the parietal and visceral pleura, and is classified as:

- **spontaneous pneumothorax**, which occurs without a precipitating external event and can be subdivided into
  - primary—no evidence of underlying lung disease
  - secondary—lung disease is present (most commonly chronic obstructive pulmonary disease [COPD], but also asthma, interstitial lung disease or cystic fibrosis)
- **traumatic pneumothorax**, which is caused by blunt or penetrating thoracic trauma. Iatrogenic pneumothorax is a traumatic pneumothorax induced by a medical procedure.

Spontaneous pneumothorax usually presents with sudden onset of pleuritic chest pain and breathlessness, and is diagnosed primarily on history and inspiratory chest X-ray. Expiratory chest X-ray is not recommended because it may exaggerate the size of pneumothorax. Computed tomography (CT) scan may be required for patients unable to sit upright because pneumothorax may be difficult to see on chest X-ray taken in the supine position. CT scan may also be required for patients with coexisting lung disease.

Specific chest signs depend on the size of the pneumothorax and may be difficult to detect. In a large pneumothorax, physical signs include absent breath sounds, tachypnoea, decreased chest wall movement, hyperresonance to percussion, decreased vocal resonance and tracheal deviation to the opposite side.

Decompensated (tension) pneumothorax

Decompensated (tension) pneumothorax

Decompensated (tension) pneumothorax is a rapid onset large pneumothorax occurring in a clinically unstable patient (eg with symptoms including severe breathlessness, hypoxaemia, hypotension and cardiovascular collapse). It is a medical emergency and requires urgent needle decompression followed by intercostal catheter drainage.

Decompensated (tension) pneumothorax usually occurs in patients with underlying lung disease or trauma. It is extremely rare in patients with primary spontaneous pneumothorax.

The concept that the effects of a decompensated (tension) pneumothorax relate to supra-atmospheric intrapleural pressure has been questioned; the term decompensated pneumothorax may be preferred over tension pneumothorax.

Diagnosis of decompensated (tension) pneumothorax is clinical, not radiological. Mediastinal shift is often seen in patients with a large pneumothorax; however, in the absence of clinical features of instability, mediastinal shift does not indicate a need for decompression.

Patients on positive pressure ventilation (including continuous positive airway pressure [CPAP] or bilevel positive airway pressure [BPAP]) may develop intrathoracic pressures exceeding atmospheric pressure and deteriorate rapidly. If a patient on positive pressure ventilation deteriorates rapidly, consider decompensated (tension) pneumothorax as a potential cause.

Primary spontaneous pneumothorax

Management of primary spontaneous pneumothorax

Management of primary spontaneous pneumothorax

Primary spontaneous pneumothorax is a pneumothorax that occurs without a precipitating external event in a patient without underlying lung disease.

For management of primary spontaneous pneumothorax in **children**, seek specialist advice. Information on the management of primary spontaneous pneumothorax in children is available from The Royal Children's Hospital (Melbourne) website.

Spontaneous pneumothorax is diagnosed primarily on history and inspiratory chest X-ray; see Classification and diagnosis of pneumothorax for more information.

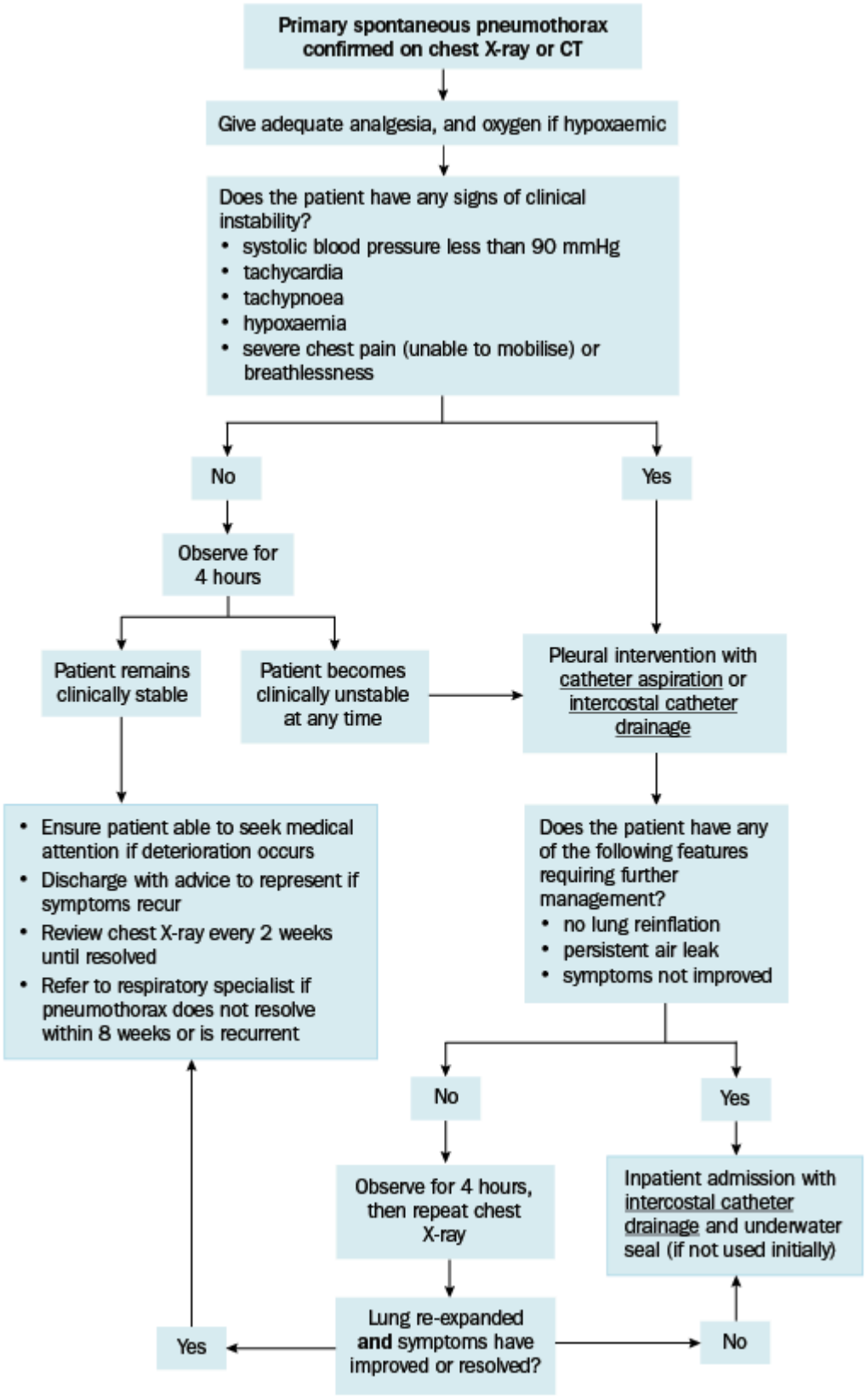
Primary spontaneous pneumothorax is usually not dangerous. Symptoms commonly resolve within 24 to 48 hours without specific treatment. Before treating primary spontaneous pneumothorax, exclude secondary spontaneous pneumothorax.

The approach to managing spontaneous primary pneumothorax is summarised in Figure 9.19.

All primary spontaneous pneumothoraces, regardless of size, should initially be managed conservatively with analgesia, and oxygen if the patient is hypoxaemic. A large multicentre randomised controlled trial showed that conservative management was not inferior to pleural intervention with regard to radiological and symptom resolution in otherwise healthy patients. Compared to pleural intervention, conservative management reduced hospitalisation days, time off work, need for prolonged chest drainage and surgery, risk of early recurrence and adverse events [Note 1].

Figure 9.19 Approach to managing primary spontaneous pneumothorax

Printable figure



CT = computed tomography

For patients with primary spontaneous pneumothorax, give adequate **analgesia**; this often substantially improves breathlessness, which may be largely related to the pain of breathing. For information on managing acute pain with analgesics, see Using analgesics to manage acute pain.

Give **oxygen** if the patient is hypoxaemic. Titrate flow of oxygen to target SpO_2 levels; see here for more advice.

Pleural intervention (catheter aspiration or intercostal catheter drainage) should be considered in any patient who is clinically unstable, as outlined in Figure 9.19. Drainage of a pneumothorax is often painful and carries risks (including damage to internal organs, bleeding and infection); it should not be attempted by inexperienced practitioners.

Note 1: Brown SGA, Ball EL, Perrin K, Asha SE, Braithwaite I, Egerton-Warburton D, et al. Conservative versus Interventional Treatment for Spontaneous Pneumothorax. N Engl J Med 2020;382(5):405-15. [URL]

Recurrence of primary spontaneous pneumothorax

Recurrence of primary spontaneous pneumothorax

The risk of recurrence of primary spontaneous pneumothorax is estimated to be 30 to 50%. Continuing smokers have higher risk of recurrence; smoking cessation should be recommended.

If pneumothorax recurs in the same lung, the risk of further recurrences rises sharply and referral for pleurodesis is recommended. Pleurodesis techniques include medical thoracoscopy with talc insufflation, surgical video-assisted thoracoscopy with pleural abrasion, and injection of talc slurry through an intercostal catheter.

Secondary spontaneous pneumothorax

Secondary spontaneous pneumothorax

Secondary spontaneous pneumothorax is a pneumothorax that occurs without a precipitating external event in a patient with lung disease (most commonly chronic obstructive pulmonary disease [COPD], but also asthma, interstitial lung disease or cystic fibrosis).

Secondary spontaneous pneumothorax is initially managed with analgesia, and oxygen if the patient is hypoxaemic. Titrate flow of oxygen to target SpO_2 levels; see here for more advice. Early pleural intervention and hospitalisation for observation are more likely to be required for secondary spontaneous pneumothorax compared with primary spontaneous pneumothorax. Intercostal catheter drainage is usually recommended. Catheter aspiration is less likely to be successful.

Patients with untreated pneumothorax should not be put on positive pressure ventilation (eg continuous positive airway pressure [CPAP], bilevel positive airway pressure [BPAP]).

Iatrogenic pneumothorax

Iatrogenic pneumothorax

Iatrogenic pneumothorax is a traumatic pneumothorax induced by a medical procedure. Iatrogenic pneumothoraces may occur following pleural aspiration, or transbronchial or percutaneous lung biopsy. They are usually small and resolve spontaneously, but catheter aspiration may be considered.

Pleural intervention for pneumothorax

Pleural intervention for pneumothorax

Urgent needle decompression

Urgent needle decompression

Urgent needle decompression is used for patients with decompensated (tension) pneumothorax. Sterile procedures and local anaesthetic are desirable, but do not delay decompression if these are not immediately available.

For urgent needle decompression of a pneumothorax:

- insert a cannula above the third rib in the midclavicular line
- remove the needle from the cannula
- insert a thoracostomy tube as soon as possible.

Catheter aspiration

Catheter aspiration

For a guide to catheter aspiration (sometimes termed thoracocentesis) of a pneumothorax, see Figure 9.20.

Figure 9.20 Guide to catheter aspiration of a pneumothorax

[NB1]

Use a small-bore catheter, such as a venous catheter with a 3-way valve or a pigtail catheter, or a single-lumen central line.

Infiltrate local anaesthetic (5 to 10 mL of 1% lidocaine) subcutaneously in an intercostal space above the fifth rib in the midaxillary line. Infiltrate local anaesthetic into deeper layers of tissue down to the pleural space (confirmed by aspiration of air into the syringe). Withdraw needle.

Connect catheter to the needle and puncture skin at the same landmark used for the local anaesthetic. Continue until reaching the pleural space (confirmed by aspiration of air into the syringe). Remove the needle and syringe, and leave the catheter *in situ*.

Aspirate until no more air is returned.

Leave the catheter *in situ* and immediately repeat the chest X-ray.

Repeat the chest X-ray again in 4 hours.

- If the pneumothorax has reaccumulated, perform intercostal catheter drainage (insert chest tube and connect to an underwater seal or a Heimlich valve).
- If the pneumothorax has not reaccumulated, remove the catheter. Discharge the patient. Follow up every 2 weeks until the pneumothorax has resolved, and advise the patient to return promptly if symptoms recur.

NB1: Detailed information on catheter aspiration of a pneumothorax can be found in the British Thoracic Society guidelines

Intercostal catheter drainage

Intercostal catheter drainage

Intercostal catheter drainage (tube thoracostomy) is indicated for:

- primary spontaneous pneumothorax that was initially treated with catheter aspiration but did not respond
- secondary spontaneous pneumothorax, unless the pneumothorax is small and the patient is clinically stable
- traumatic pneumothorax, unless the pneumothorax is small and the patient is stable
- decompensated (tension) pneumothorax, following urgent needle decompression.

Intercostal catheter drainage is a specialised procedure and should only be performed by experienced clinicians; for detailed information see British Thoracic Society guidelines [Note 2].

A small-bore catheter (10 to 14 gauge), connected either to a Heimlich valve or to an underwater seal, is preferred for simple pneumothorax (ie if only air is present and there is no blood). Suction is not indicated. A large-bore catheter is used in traumatic pneumothorax to allow blood to drain.

Note 2: Havelock T, Teoh R, Laws D, Gleeson F, Group BTSPDG. Pleural procedures and thoracic ultrasound: British Thoracic Society Pleural Disease Guideline 2010. Thorax 2010;65 Suppl 2:ii61-76. [URL] and MacDuff A, Arnold A, Harvey J, Group BTSPDG. Management of spontaneous pneumothorax: British Thoracic Society Pleural Disease Guideline 2010. Thorax 2010;65 Suppl 2:ii18-31. [URL]

Persistent air leak after pneumothorax

Persistent air leak after pneumothorax

A persistent air leak (bronchopleural fistula) develops in about one-third of pneumothorax cases treated with intercostal drains. It is more common in secondary spontaneous pneumothorax.

Early surgical intervention is sometimes advised, but there is no evidence to support this. One study has shown that all persistent air leaks in primary spontaneous pneumothorax resolved in 15 days and up to 80% of persistent air leaks in secondary spontaneous pneumothorax resolved in 14 days [Note 3].

An alternative to surgical intervention is insertion of a small catheter attached to a lightweight one-way valve (Heimlich valve), which allows outpatient management.

Note 3: Chee CB, Abisheganaden J, Yeo JK, Lee P, Huan PY, Poh SC, et al. Persistent air-leak in spontaneous pneumothorax: clinical course and outcome. Respir Med 1998;92(5):757-61. [URL]

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Introduction to interstitial lung disease

Introduction to interstitial lung disease

The interstitial lung diseases (ILDs) are a diverse group of conditions characterised by varying degrees of inflammation or fibrosis, predominantly affecting the lung interstitium. In many ILDs, the airways, parenchyma and pulmonary vasculature are also involved.

The terms ILD and pulmonary fibrosis are often used interchangeably.

ILD can develop in both adults and children; for information about childhood interstitial lung disease, see here.

Causes and classification of interstitial lung disease in adults

Causes and classification of interstitial lung disease in adults

A classification of the major interstitial lung diseases (ILDs) in adults is shown in Figure 9.21.

The aetiology of ILDs is wide-ranging and may be associated with environmental and occupational exposures (eg smoking, drugs, radiation, asbestos), systemic autoimmune disease (eg systemic sclerosis, rheumatoid arthritis) and genetic disorders. A definite cause has not been identified in some ILDs (eg idiopathic pulmonary fibrosis, sarcoidosis).

Figure 9.21 Classification of major interstitial lung diseases in adults

Idiopathic interstitial pneumonias

- idiopathic pulmonary fibrosis
- idiopathic nonspecific interstitial pneumonia
- cryptogenic organising pneumonia

Multisystem disorders

- connective tissue disease
- sarcoidosis
- inflammatory bowel disease

Environmental or lifestyle exposures

- smoking-related interstitial lung disease (eg respiratory bronchiolitis–interstitial lung disease, Langerhans cell histiocytosis, desquamative interstitial pneumonia)
- hypersensitivity pneumonitis
- occupational lung disease (eg asbestosis, silicosis, coal worker's pneumoconiosis, mixed dust pneumoconiosis)
- drug-induced interstitial lung disease (eg caused by amiodarone, leflunomide, methotrexate, nitrofurantoin, or some oncology and immunomodulatory drugs [NB1])
- radiation-induced interstitial lung disease

Genetic

- familial idiopathic pulmonary fibrosis

- short telomere syndromes

Other

- lymphangioleiomyomatosis
- pulmonary alveolar proteinosis
- eosinophilic pneumonia

NB1: A comprehensive list of drugs associated with interstitial lung disease is available on the Drug-induced Respiratory Disease website.

Presentation of interstitial lung disease in adults

Presentation of interstitial lung disease in adults

Patients with interstitial lung disease (ILD) usually present with nonspecific symptoms such as dyspnoea and dry cough, often resulting in delayed diagnosis.

There may be crackles on chest auscultation; however, crackles can also occur with pulmonary oedema, bronchiectasis or pneumonia. Clubbing of the fingers or toes may also be present.

Advanced disease presents with tachypnoea, tachycardia and low oxygen saturation as measured by pulse oximetry (SpO_2).

If ILD is suspected, see Assessment of interstitial lung disease in adults.

Assessment of interstitial lung disease in adults

Assessment of interstitial lung disease in adults

Introduction to assessment

Introduction to assessment

Accurate diagnosis is important because disease behaviour, response to therapy and prognosis varies between the different interstitial lung diseases (ILDs). The rate of clinical progression from initial symptoms to end-stage disease can range from a few months to many years.

Specialist assessment is required to ensure diagnosis is accurate and not delayed; diagnosis usually involves discussion by an ILD multidisciplinary team. Access to specialised therapy, enrolment in clinical trials or referral to a lung transplantation service can also be facilitated by the ILD multidisciplinary team, if required.

Initial assessment to determine urgency of specialist referral should include:

- detailed clinical history
- physical examination
- initial investigations (eg pulse oximetry, spirometry, blood tests, chest X-ray).

Also consider investigations to exclude other causes of dyspnoea (eg full blood count [FBC] to exclude anaemia, echocardiogram to assess for heart failure).

If ILD is suspected, refer the patient to a specialist to ensure diagnosis is accurate and not delayed.

Specialists may conduct further investigations to confirm diagnosis of ILD. These may include additional blood tests, complex pulmonary function testing (eg static lung volumes [including total lung capacity], diffusing capacity of the lung for carbon monoxide [DLCO]) or bronchoscopy (eg bronchoalveolar lavage [BAL] fluid analysis, transbronchial lung biopsy, endoscopic bronchial ultrasound [EBUS]–guided

transbronchial lymph node biopsy). Occasionally, a tissue biopsy is required and a referral for video-assisted thoracoscopic surgery (VATS) biopsy will be made.

Detailed clinical history

Detailed clinical history

A detailed clinical history may assist in determining the likely cause of ILD (eg drug-induced, occupational exposure, concomitant autoimmune disease).

If ILD is suspected, take a detailed clinical history consisting of the following:

- age—idiopathic pulmonary fibrosis occurs more frequently in older people (typically older than 65 years of age); connective tissue disease–associated interstitial lung disease (CTD–ILD) and sarcoidosis are more common in younger people
- sex—idiopathic pulmonary fibrosis is more common in men, while CTD–ILD is more common in women. Pulmonary lymphangioleiomyomatosis only occurs in women. Most other ILDs are not strongly associated with sex
- family history—ILD occurring in families is increasingly recognised, and may present at a younger age compared to cases without a familial predisposition
- drug history—over 350 drugs have been associated with ILD including amiodarone, leflunomide, methotrexate, nitrofurantoin, and some oncology and immunomodulatory drugs [Note 1]
- occupational history—especially exposure to dusts such as coal, asbestos and silica; coal workers, miners and stonemasons are some examples of occupations at risk of developing occupational lung disease
- environment—exposure to birds, compost, manure, spas, and other antigens associated with hypersensitivity pneumonitis
- smoking history—acute eosinophilic pneumonia, respiratory bronchiolitis–ILD and idiopathic pulmonary fibrosis are more common in smokers
- history of connective tissue disease—ILD may be associated with conditions including rheumatoid arthritis, systemic sclerosis and polymyositis
- history of gastro-oesophageal reflux—may cause ILD, as well as acute exacerbations of established ILD
- history of receiving radiotherapy.

Note 1: A comprehensive list of drugs associated with ILD is available on the Drug-induced Respiratory Disease website.

Physical examination

Physical examination

Physical signs that may suggest the presence of ILD include:

- fine ‘velcro-like’ crackles on chest auscultation—crackles may also be present with pulmonary oedema or pneumonia (although often with a more acute presentation); more coarse crackles are usually present in bronchiectasis
- ‘squeaks’ or ‘squawks’ (short duration, high-pitched sounds similar to a wheeze) on chest auscultation—may indicate small airways narrowing in hypersensitivity pneumonitis
- clubbing of the fingers or toes—present in a minority of patients (particularly in idiopathic pulmonary fibrosis)
- skin and musculoskeletal signs of connective tissue disease—including Raynaud phenomenon, sclerodactyly, skin rash, telangiectasia, skin thickening, arthritis, arthralgias and myalgias
- other findings such as premature greying of hair can be associated with short telomere syndromes and familial ILD.

Initial investigations

Initial investigations

Pulmonary function testing

If ILD is suspected, perform spirometry and pulse oximetry.

Patients with ILD typically develop a restrictive defect in pulmonary function, characterised by reduced forced vital capacity (FVC), normal or reduced forced expiratory volume in 1 second (FEV_1), and normal or increased FEV_1/FVC ratio.

Complex pulmonary function testing (eg static lung volumes [including total lung capacity], diffusing capacity of the lung for carbon monoxide [DLCO]) may be ordered by the specialist.

Changes in pulmonary function tests over time can also be used to monitor ILD progression. A 10% decline in FVC or a 15% decline in DLCO is highly suggestive of progressive ILD.

Blood tests

Blood tests can help determine the cause of ILD. Initial blood tests may include full blood count (FBC) with eosinophil count, antinuclear antibodies (ANA), extractable nuclear antigens (ENA), double-stranded DNA (dsDNA), serum calcium and rheumatoid factor (RF).

Additional tests may be ordered by the specialist depending on the clinical scenario, such as antineutrophil cytoplasmic antibodies (ANCAs) if pulmonary vasculitis is suspected, or precipitins against environmental antigens (eg avian or mould precipitins) if hypersensitivity pneumonitis is suspected.

Imaging

Chest X-rays are often ordered to assess breathlessness and are useful in detecting a range of respiratory diseases, including ILD. However, in patients with early or mild ILD, chest X-ray may appear normal.

HRCT is a pivotal diagnostic test in ILD and is usually ordered if chest X-ray and spirometry reveal abnormalities. The clinical question or indication for ordering the HRCT scan should be clearly described in the request form for consideration by the radiology team. Consider the dose of radiation exposure to the patient from HRCT, especially as the specialist may need to repeat the scan for additional clarity. If there is any uncertainty about ordering HRCT, consult the radiologist. See also CT of the chest.

Sometimes prone HRCT images can help distinguish early or mild ILD from causes of gravity-dependent opacity (eg atelectasis).

While HRCT scans of the chest are usually performed at full inspiration, occasionally expiratory phase images are also performed to assess for small airways involvement and gas trapping that can be a feature of chronic hypersensitivity pneumonitis.

The HRCT pattern and distribution are important in distinguishing between the different ILDs. Upper-zone predominant diseases include sarcoidosis and chronic hypersensitivity pneumonitis, while lower-zone distribution diseases include idiopathic pulmonary fibrosis and nonspecific interstitial pneumonia. Specific features on HRCT, such as honeycombing, nodules or ground-glass opacity, can help define the ILD diagnosis. Examples of HRCT patterns that can be suggestive of specific ILDs include usual interstitial pneumonia pattern, nonspecific interstitial pneumonia pattern, organising pneumonia, pulmonary nodules and pulmonary cysts.

A **usual interstitial pneumonia (UIP)** pattern is the term used to describe a specific pattern on HRCT, and also a specific histological pattern on a lung biopsy specimen.

A UIP pattern can be seen in several conditions including idiopathic pulmonary fibrosis, rheumatoid arthritis–associated ILD, asbestosis, chronic hypersensitivity pneumonitis and drug-induced ILD.

A UIP pattern on HRCT is characterised by:

- honeycombing, with or without traction bronchiectasis
- subpleural, basal predominant reticulation
- absence of or minimal ground-glass opacity
- absence of nodules, cysts and other features (eg pleural plaques).

The histological features of a UIP pattern include:

- marked fibrosis and honeycombing in a subpleural distribution
- patchy involvement of lung parenchyma with fibrosis
- presence of fibroblastic foci.

A **nonspecific interstitial pneumonia (NSIP)** pattern is the most frequently observed pattern in connective tissue disease–associated ILD, but may also occur in drug-induced lung injury or from unknown causes (idiopathic NSIP).

An NSIP pattern on HRCT is characterised by bilateral, often lower-zone ground-glass opacities with reticular changes (with or without traction bronchiectasis). Histological features include varying amounts of interstitial inflammation and fibrosis.

Assess for connective tissue disease and drug exposure if NSIP is identified on HRCT or lung biopsy.

Idiopathic pulmonary fibrosis

Idiopathic pulmonary fibrosis

Introduction to idiopathic pulmonary fibrosis

Introduction to idiopathic pulmonary fibrosis

Idiopathic pulmonary fibrosis is a specific form of chronic, progressive fibrosing lung disease of unknown cause.

It typically occurs in people older than 65 years of age and is more common in males with a history of smoking.

A family history of interstitial lung disease (ILD) (not necessarily only idiopathic pulmonary fibrosis) may be present in around 10% of patients; the exact pattern of inheritance and genes involved is not well understood.

The natural history of idiopathic pulmonary fibrosis is variable and unpredictable. If untreated, progressive deterioration and death generally occur within 3 to 5 years of diagnosis.

Disease progression is characterised by worsening dyspnoea and cough, deteriorating pulmonary function tests and worsening fibrosis on high-resolution computed tomography (HRCT). Antifibrotic drugs (nintedanib, pirfenidone) may slow disease progression; see Treatment of idiopathic pulmonary fibrosis for more information.

Patient and carer information sheets on idiopathic pulmonary fibrosis are available from the Lung Foundation Australia website.

Diagnosis of idiopathic pulmonary fibrosis

Diagnosis of idiopathic pulmonary fibrosis

The diagnosis of idiopathic pulmonary fibrosis requires:

- the presence of a usual interstitial pneumonia (UIP) pattern on HRCT; see Imaging
- exclusion of other known causes of ILD (eg environmental exposures, drug exposure, connective tissue disease)

- integration of clinical, radiological and pathological findings (if lung biopsy is performed) at a multidisciplinary meeting.

HRCT has a high specificity for diagnosing idiopathic pulmonary fibrosis; surgical lung biopsy is not required in most cases and is generally reserved for patients with either an atypical history or nonclassical radiology.

Treatment of idiopathic pulmonary fibrosis

Treatment of idiopathic pulmonary fibrosis

Antifibrotic drugs, nintedanib and pirfenidone, can slow progression of mild to moderate idiopathic pulmonary fibrosis. They are available for patients with idiopathic pulmonary fibrosis who meet specific eligibility criteria [Note 2]. Choice of drug depends on patient preference, potential adverse effects and drug interactions; see the Thoracic Society of Australia and New Zealand and the Lung Foundation Australia position statement on treatment of idiopathic pulmonary fibrosis for more information on nintedanib and pirfenidone.

Combination therapy with prednisolone, azathioprine and N-acetylcysteine is no longer recommended for treatment of idiopathic pulmonary fibrosis because it is associated with increased morbidity and mortality.

Other therapies that may be beneficial for idiopathic pulmonary fibrosis include:

- smoking cessation
- pulmonary rehabilitation
- drugs for symptom control, such as opioids and anxiolytics for dyspnoea
- long-term oxygen therapy for patients with resting hypoxaemia; however, oxygen may not improve breathlessness
- early referral for lung transplantation assessment in appropriate patients
- referral to palliative care services for symptom control, psychological care and end-of-life planning (including advance care planning).

Several comorbidities may contribute to worsening of symptoms in idiopathic pulmonary fibrosis. Comorbidities that can be treated include gastro-oesophageal reflux disease, cardiovascular disease, pulmonary hypertension and sleep-disordered breathing.

Note 2: See the Pharmaceutical Benefits Scheme website for subsidised indications for nintedanib and pirfenidone

Acute exacerbations of idiopathic pulmonary fibrosis

Acute exacerbations of idiopathic pulmonary fibrosis

Acute exacerbations of idiopathic pulmonary fibrosis are defined as periods of acute clinically significant respiratory deterioration, accompanied by new radiological abnormalities on HRCT (ie bilateral ground-glass opacification or consolidation) on a background of a UIP pattern.

The annual incidence of acute exacerbations in patients with idiopathic pulmonary fibrosis may be up to 15%, although estimates vary. Risk factors include advanced disease, younger age and a history of previous acute exacerbations. Patients presenting with an acute exacerbation of idiopathic pulmonary fibrosis and associated respiratory failure have high mortality (greater than 50%).

The cause of acute exacerbations is unknown; potential triggers include infection, aspiration, thoracic surgical procedures, mechanical ventilation and drugs. Exclusion of respiratory infection and cardiac failure is important.

There are no proven effective therapies for acute exacerbations. Supportive measures include oxygen for hypoxaemia and management of dyspnoea. Although evidence to support corticosteroid therapy is lacking, it

is often trialled given lack of alternative treatment options.

Nonspecific interstitial pneumonia in adults

Nonspecific interstitial pneumonia in adults

Introduction to nonspecific interstitial pneumonia in adults

Introduction to nonspecific interstitial pneumonia in adults

Nonspecific interstitial pneumonia (NSIP) is characterised by specific high-resolution computed tomography (HRCT) and histological features; see Imaging for more information. NSIP pattern is the most frequently observed pattern in connective tissue disease–associated ILD, but may also occur in drug-induced lung injury or from unknown causes (idiopathic NSIP).

The clinical course of NSIP is highly variable, ranging from indolent nonprogressive disease to rapidly progressive disease. Survival in NSIP is significantly better than that seen in idiopathic pulmonary fibrosis.

If NSIP is suspected, refer to a specialist to identify the cause and whether treatment is required. Duration and intensity of treatment is tailored to clinical, physiological and radiological response. Smoking cessation is recommended; see Smoking cessation.

Connective tissue disease–associated interstitial lung disease in adults

Connective tissue disease–associated interstitial lung disease in adults

ILD occurs in most connective tissue diseases, generally as a consequence of abnormal immune system overactivity and immune-mediated lung damage. ILD is most often seen in systemic sclerosis, rheumatoid arthritis and idiopathic inflammatory myopathy (including polymyositis and dermatomyositis).

The most common HRCT patterns in connective tissue disease–associated interstitial lung disease (CTD–ILD) are nonspecific interstitial pneumonia pattern and organising pneumonia, although a usual interstitial pneumonia pattern predominates in rheumatoid arthritis. Overlap patterns (particularly nonspecific interstitial pneumonia/organising pneumonia overlap) are not uncommon.

If CTD–ILD is suspected, refer to a specialist to identify patients who require treatment (generally corticosteroids, with or without steroid-sparing drugs). Treatment of CTD–ILD depends on several factors including severity, disease behaviour and patient factors (eg age, comorbidities, frailty, other drugs). Smoking cessation is recommended; see Smoking cessation. For more information on diagnosis and management of CTD–ILD, see the Thoracic Society of Australia and New Zealand position statement.

Idiopathic nonspecific interstitial pneumonia in adults

Idiopathic nonspecific interstitial pneumonia in adults

Radiologically, idiopathic nonspecific interstitial pneumonia is indistinguishable from nonspecific interstitial pneumonia due to other causes (eg connective tissue disease or drug exposure).

Treatment is generally reserved for patients with severe or progressive disease. First-line therapy includes corticosteroids, with or without steroid-sparing drugs. Smoking cessation is recommended; see Smoking cessation.

Pulmonary sarcoidosis in adults

Pulmonary sarcoidosis in adults

Sarcoidosis is a chronic, multiorgan granulomatous disorder of unknown aetiology. Pulmonary involvement occurs in up to 90% of patients with sarcoidosis, ranging from asymptomatic mediastinal/hilar lymphadenopathy (often detected incidentally) through to progressive pulmonary fibrosis, which may result in respiratory failure and death.

Symptoms related to pulmonary sarcoidosis include dyspnoea on exertion and cough. Pulmonary sarcoidosis is not associated with many clinical signs; finger clubbing is not a feature. Pulmonary infiltration is usually bilateral with nodular shadowing typically in the mid-zones. More dense infiltration leading to reticulonodular shadowing and fibrosis of the upper lobes is seen in advanced cases. Nodules may be present along the pleural surfaces, but pleural effusion is rare.

The natural course of pulmonary sarcoidosis is variable. In many patients (particularly those with isolated mediastinal/hilar lymph node involvement), spontaneous resolution occurs without treatment.

The role of corticosteroids in pulmonary sarcoidosis is controversial. Patients are often observed for a period before starting therapy, because spontaneous resolution may occur. Oral corticosteroids may be beneficial in some situations (eg asymptomatic pulmonary disease with persistent infiltrates or progressive loss of lung function, or progressive symptomatic pulmonary disease).

Other therapy is primarily targeted to extrapulmonary disease, which is common and may involve the skin (see sarcoidosis in skin), eyes, nervous system, heart or kidneys. Magnetic resonance imaging (MRI) may be required to identify cardiac sarcoidosis. Hypercalcaemia and hypercalciuria may occur. Ophthalmological assessment should also be considered.

Smoking-related interstitial lung disease in adults

Smoking-related interstitial lung disease in adults

Respiratory bronchiolitis–interstitial lung disease, Langerhans cell histiocytosis and desquamative interstitial pneumonia are strongly associated with smoking.

Smoking cessation is the principal recommendation for management because quitting smoking can lead to clinical and physiological improvements. Corticosteroids can be used in refractory or progressive cases, although evidence for their use is limited. Lung transplantation may need to be considered in advanced cases.

Many patients with idiopathic pulmonary fibrosis have a history of smoking. Patients with combined pulmonary fibrosis and emphysema (CPFE), characterised by upper lobe emphysema and lower lobe interstitial fibrosis, have a high incidence of associated pulmonary hypertension and a poor prognosis.

Hypersensitivity pneumonitis in adults

Hypersensitivity pneumonitis in adults

Hypersensitivity pneumonitis (also known as extrinsic allergic alveolitis) is a granulomatous condition associated with interstitial lung disease (ILD). Pathology is linked to repeated inhaled exposure to a sensitising antigen. Common forms of chronic hypersensitivity pneumonitis include bird fancier's lung (exposure to proteins found in feathers or droppings) and hot tub lung (exposure to *Mycobacterium avium* complex).

A detailed history to identify potential exposures in both the work and home environment is recommended; measurement of specific circulating immunoglobulin G (IgG) antibodies may provide further information on the causative exposure. However, in approximately 40% of cases the causative exposure will not be identified.

The key to management is avoidance of the inciting environmental exposure because continued antigen exposure is associated with chronic disease and progression to ILD. Corticosteroids are recommended in acute, severe and progressive disease.

Occupational lung disease

Occupational lung disease

Occupational exposure to a variety of inhaled substances may be associated with the development of interstitial lung disease (ILD). Enquiring about current and previous employment is an important part of clinical assessment. Coal workers, miners and stonemasons are some examples of occupations at risk of developing occupational lung disease.

Asbestosis, coal worker's pneumoconiosis and **mixed dust pneumoconiosis** can occur following exposure to asbestos, coal dust, and a mix of coal and silica dust, respectively. Historically, these have been the most prevalent occupational lung diseases and stringent workplace safety measures have been established to minimise the risk of developing these diseases. For information on malignant pleural mesothelioma associated with asbestos exposure, see Malignant pleural mesothelioma.

Silicosis results from exposure to crystalline silica, now most commonly encountered during the manufacturing of artificial stone bench tops. Cutting of these products, particularly without water suppression or adequate respiratory protection, results in exposure to very high concentrations of respirable silica.

Silicosis ranges from asymptomatic, multiple small pulmonary nodules and calcified lymph nodes, through to progressive massive fibrosis. Deaths from silicosis have been reported in Australia.

Due to the increasing awareness and case numbers of silicosis, government workplace safety organisations have developed online resources for potentially affected individuals, including health screening. Online resources are available at:

- Safe Work Australia (National)
- WorkCover Queensland
- WorkSafe Victoria
- SafeWork New South Wales
- SafeWork South Australia
- WorkCover Western Australia
- WorkSafe ACT
- Northern Territory WorkSafe
- WorkSafe Tasmania.

The Lung Foundation Australia website also publishes patient information on silica and silicosis.

Childhood interstitial lung disease

Childhood interstitial lung disease

The estimated prevalence of childhood interstitial lung disease (approximately 1.5 cases per million) is lower than in adults. However, with advances in classification and identification, the estimated prevalence of childhood interstitial lung disease may increase.

Common clinical features of childhood interstitial lung disease include cough, tachypnoea, crackles and hypoxaemia. Diffuse infiltrates on chest X-ray are commonly seen. If interstitial lung disease is suspected, refer to a paediatric respiratory specialist.

As in adult interstitial lung disease, some forms of interstitial lung disease in children respond to corticosteroids. The response to therapy and overall prognosis is better than in most adult forms of interstitial

lung disease. The majority of children recover and most can lead normal lives. However, some subgroups, particularly those with genetic abnormalities of surfactant function, have poor prognoses.

The Lung Foundation Australia website publishes information and fact sheets for parents and carers of children diagnosed with childhood interstitial lung disease.

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Introduction to noninvasive ventilation

Introduction to noninvasive ventilation

Noninvasive ventilation (NIV), also known as noninvasive positive pressure ventilation, is ventilatory support given by a mask (most commonly an oro-nasal mask, but can also be a nasal or total face mask, or a helmet) rather than by endotracheal intubation.

Noninvasive ventilation may be given acutely or long term. It may consist of continuous positive airway pressure (CPAP), or bilevel positive airway pressure (BPAP), in which a higher pressure is given during inspiration (inspiratory positive airway pressure [IPAP]) and a lower pressure is given during expiration (expiratory positive airway pressure [EPAP]), often with a backup respiratory rate. IPAP provides pressure support for inspiration, which increases alveolar ventilation and assists in reducing carbon dioxide. EPAP improves aeration of the lungs.

Noninvasive ventilation is supportive therapy, used only in addition to first-line therapy directed at the underlying condition.

Acute noninvasive ventilation has approximately 20% failure rate. Before starting any form of ventilatory support, a decision should be made as to whether intubation and invasive mechanical ventilation will be undertaken if noninvasive ventilation fails.

Adequately trained staff are needed to administer and monitor acute noninvasive ventilation, usually in a critical care environment or a high-dependency unit.

Noninvasive ventilation is an aerosol-generating procedure, which has implications for infection control; consider use of:

- devices, circuits and masks that reduce aerosol dispersion (eg single-limb device with filtered vented mask, dual-limb device with nonvented mask)
- increased personal protective equipment
- appropriate ward setting (eg single room with negative pressure ventilation).

Indications for noninvasive ventilation

Indications for noninvasive ventilation

Acute and long-term noninvasive ventilation can be used for various indications.

Acute noninvasive ventilation can be used in an acute exacerbation of chronic obstructive pulmonary disease (COPD), acute cardiogenic pulmonary oedema, hypoxaemic respiratory failure, life-threatening acute asthma, and to wean high-risk patients from invasive ventilation. See Table 9.26 for more details on indications for acute noninvasive ventilation.

Acute noninvasive ventilation is usually administered in critical care or high-dependency units, where staff are adequately trained and close observation is possible, because risk of treatment failure, complications and subsequent need for mechanical intubation is high.

Long-term noninvasive ventilation can be used in chronic hypercapnia of any cause, obstructive sleep apnoea, obesity hypoventilation syndrome, neuromuscular disease (eg motor neurone disease), diaphragm palsy, chest wall disorders (eg kyphoscoliosis) and end-stage respiratory failure. See Table 9.26 for more details on indications for long-term noninvasive ventilation.

Continuous positive airways pressure (CPAP) is usually preferred when treating acute cardiogenic pulmonary oedema, obstructive sleep apnoea and obesity hypoventilation syndrome. Bilevel positive airways pressure (BPAP) is usually preferred when treating hypercapnic respiratory failure due to COPD, neuromuscular or chest wall disorders, and to wean high-risk patients from invasive ventilation.

Table 9.26 Common indications for acute and long-term noninvasive ventilation

Indications	Benefits or details of noninvasive ventilation use
Acute noninvasive ventilation	
Acute exacerbation of COPD	Can avoid the need for intubation, and reduce length of hospital stay and mortality. Recommended for COPD exacerbations associated with hypercapnic respiratory failure and acidosis, defined as pH below 7.35, and a $PaCO_2$ above 45 mmHg, despite optimal therapy (including oxygen therapy). BPAP is usually preferred.
Acute cardiogenic pulmonary oedema	Can improve respiratory distress and metabolic disturbance. CPAP is usually preferred. Reserve BPAP for patients failing to improve on CPAP, particularly if there is carbon dioxide retention.
Weaning high-risk patients from invasive ventilation	Useful in patients with a high risk of postextubation respiratory failure, including those with myopathy (eg prolonged stay in ICU, often recovering from a sudden medical or surgical event), pre-existing respiratory or cardiac disease, or morbid obesity. BPAP is usually preferred.
Hypoxaemic respiratory failure	High-flow nasal cannula oxygen therapy may be preferred, although evidence is limited. Consider trial of noninvasive ventilation if patient does not respond to high-flow nasal cannula oxygen therapy, although some hospitals may use noninvasive ventilation first line. Start in critical care or high-dependency unit because risk of treatment failure and subsequent need for mechanical intubation is high. Either BPAP or CPAP can be used. Some patients require invasive ventilation without first trialling noninvasive ventilation.
Life-threatening acute asthma	BPAP is usually preferred. Close observation in emergency department, critical care or high-dependency unit is recommended.
Long-term noninvasive ventilation	
Chronic hypercapnia of any cause	Manage reversible factors (eg sedatives, excessive oxygen, electrolyte imbalance, endocrine abnormalities such as hypothyroidism) and optimise underlying medical condition(s) (eg COPD, heart failure) before starting noninvasive ventilation. Particularly effective for patients with COPD who remain hypercapnic several weeks following hospital admission for acute exacerbation. BPAP is usually preferred.
Obstructive sleep apnoea	Consider long-term nocturnal CPAP for patients with: • severe obstructive sleep apnoea

Indications	Benefits or details of noninvasive ventilation use • symptoms of daytime dysfunction and moderate obstructive sleep apnoea • obstructive sleep apnoea and hypertension. See here for more information on CPAP for obstructive sleep apnoea.
Obesity hypoventilation syndrome	CPAP is usually preferred as initial therapy because it has similar long-term effectiveness as BPAP but is lower in cost and complexity. BPAP can be considered in patients who do not respond to CPAP.
Neuromuscular disease (eg motor neurone disease) Diaphragm palsy Chest wall disorders (eg kyphoscoliosis)	BPAP is usually preferred.
End-stage respiratory failure with hypercapnia in airway disease (eg COPD, cystic fibrosis)	Patients generally have nocturnal hypoventilation associated with a rise in $PaCO_2$ of more than 5 mmHg. They tolerate and demonstrate a physiological benefit with noninvasive ventilation. BPAP is usually preferred. See End-stage respiratory failure for more advice.

BPAP = bilevel positive airway pressure, COPD = chronic obstructive pulmonary disease, CPAP = continuous positive airway pressure, ICU = intensive care unit, $PaCO_2$ = partial pressure of carbon dioxide

Contraindications to noninvasive ventilation

Contraindications to noninvasive ventilation

Use of noninvasive ventilation is contraindicated in the following situations:

- immediate need for tracheal intubation
- cardiorespiratory arrest
- haemodynamic instability (eg hypotension)
- life-threatening hypoxaemia in patients who are candidates for intubation
- upper airway surgery
- impaired consciousness with inability to protect the airway
- fixed upper airway obstruction
- copious secretions or vomiting
- pneumothorax
- facial injuries, including fractured base of skull
- recent upper gastrointestinal surgery
- following transphenoidal resection of a pituitary tumour
- uncooperative patient or patient intolerant of the mask
- insufficiently trained staff to administer and monitor noninvasive ventilation.

Before using acute noninvasive ventilation

Before using acute noninvasive ventilation

Before using acute noninvasive ventilation:

- measure arterial blood gases, if possible, to determine whether a patient is hypercapnic or hypocapnic

- obtain informed consent and discuss whether intubation and invasive mechanical ventilation will be undertaken if noninvasive ventilation fails
- develop and document a management plan that is reviewed regularly and updated as required
- document baseline observations such as arterial blood gases, respiratory rate, oxygen saturation measured by pulse oximetry (SpO_2), level of breathlessness and consciousness, pain score, cardiac monitoring, blood pressure, heart rate, skin integrity at mask contact points, and other parameters relevant to the patient's comorbidities
- set up and check the appropriate ventilator device and circuit.

Initial equipment settings and monitoring for acute noninvasive ventilation

Initial equipment settings and monitoring for acute noninvasive ventilation

Suggested initial equipment settings and monitoring for acute noninvasive ventilation are listed in Figure 9.26.

Choose a suitable mask interface (oro-nasal, nasal, total face or helmet).

Once the machine is attached and switched on, hold the mask to the patient's face to familiarise them with it. After a few minutes, secure the mask. Do not overtighten the mask because breakdown of the skin at the mask contact point can occur very rapidly. Show the patient how to remove the mask and how to ask for help if needed.

Figure 9.26 Suggested initial equipment settings and monitoring for acute noninvasive ventilation

Suggested initial equipment settings for acute noninvasive ventilation:

- Suggested initial settings for BPAP (eg in COPD) are IPAP 10 to 12 cmH_2O and EPAP 4 to 6 cmH_2O [NB1].
- If a spontaneous/time mode ventilator is used, set this with a backup rate of 15 breaths per minute and I:E ratio of 1:3.
- Set triggers at maximum sensitivity.
- Suggested initial settings for CPAP (eg in acute pulmonary oedema) are 5 to 15 cmH_2O (approximately 10% of body weight in kilogram).

Suggested monitoring for acute noninvasive ventilation:

- Monitor SpO_2 continuously.
- Reassess the patient within a few minutes and adjust ventilator settings and oxygen therapy to target oxygen saturation levels; see also Ventilator adjustment for acute noninvasive ventilation and oxygen therapy.
- Repeat clinical assessment and arterial blood gases in 1 hour; if there is no improvement, review and adjust ventilator settings (see Ventilator adjustment for acute noninvasive ventilation and oxygen therapy). Observations should include respiratory rate, heart rate, blood pressure, level of consciousness, pain score, patient comfort, skin integrity at mask contact points, chest wall movement, ventilator synchrony and accessory muscle use.
- Repeat clinical assessment and arterial blood gases after 4 hours or as clinically indicated. If there is improvement, consider monitoring using venous blood gases if access to arterial blood gases is difficult [NB2].
- Regularly review management plan (at least every 24 hours and with a change in patient's condition) and update as required.

BPAP = bilevel positive airway pressure; COPD = chronic obstructive pulmonary disease; CPAP = continuous positive airway pressure; I:E ratio = inspiratory to expiratory ratio; IPAP = inspiratory positive airway pressure; EPAP = expiratory positive airway pressure; SpO_2 = oxygen saturation measured by pulse oximetry

NB1: IPAP provides pressure support for inspiration, which increases alveolar ventilation and assists in reducing carbon dioxide. EPAP improves aeration of the lungs.

NB2: Venous blood gas values do not correlate directly with arterial blood gas values. See Venous blood gas analysis for more information.

Ventilator adjustment for acute noninvasive ventilation and oxygen therapy

Ventilator adjustment for acute noninvasive ventilation and oxygen therapy

For patients receiving acute noninvasive ventilation, adequacy of ventilation is assessed by chest expansion, repeat arterial blood gases and readings on the noninvasive ventilation device.

Generally, inspiratory positive airway pressure (IPAP) is increased in 2 to 5 cmH_2O increments every 10 minutes (or as clinically indicated) to reduce carbon dioxide until pH is corrected. Expiratory positive airway pressure (EPAP) is increased in similar increments to overcome upper airway collapse (snoring) or restrictive lung volume.

In general, maximum settings are 20 cmH_2O for continuous positive airway pressure (CPAP), 30 cmH_2O for IPAP, and 20 cmH_2O for EPAP; however, maximum settings vary, and depend on patient size and weight. There should always be a difference of at least 6 cmH_2O between IPAP and EPAP.

See Inadequate ventilation for considerations in patients who have not responded adequately to ventilation.

Give oxygen to maintain target oxygen saturation measured by pulse oximetry (SpO_2) levels; see Pulse oximetry to monitor acute oxygen therapy for target SpO_2 levels. For information on considerations in acute oxygen therapy, see Principles of oxygen therapy and Potential harms of oxygen therapy.

Management of problems with acute noninvasive ventilation

Management of problems with acute noninvasive ventilation

Inadequate ventilation

Inadequate ventilation

If there is persistent elevation of partial pressure of carbon dioxide ($PaCO_2$) and continued acidosis after starting acute noninvasive ventilation:

- check inspired oxygen concentration and oxygen saturation measured by pulse oximetry (SpO_2), and reduce oxygen if necessary; ensure target SpO_2 levels are being maintained
- check circuit for leaks, including mask leaks
- check patient's synchronisation with ventilator and adjust backup rate
- check ventilator trigger is set at maximum sensitivity
- consider increasing expiratory positive airway pressure (EPAP) to reduce the possibility of rebreathing
- observe chest expansion and, if inadequate, consider increasing inspiratory positive airway pressure (IPAP). If this is not tolerated or chest expansion is adequate, consider increasing respiratory rate or inspiratory to expiratory (I:E) ratio to increase expiratory time.

If there is persisting hypoxaemia despite improvement in $PaCO_2$, consider increasing EPAP (while maintaining difference of at least 6 cmH_2O between IPAP and EPAP) or increasing supplemental oxygen. Also review the need for intubation and mechanical ventilation.

Treatment failure

Treatment failure

Treatment failure with noninvasive ventilation may be indicated by clinical deterioration, increasing distress or deteriorating arterial blood gas results.

If treatment failure occurs, consider:

- need for intubation and mechanical ventilation
- whether medical treatment for underlying condition has been optimised
- chest X-ray to exclude pneumothorax or aspiration pneumonia
- ventilation perfusion isotope (V/Q) lung scan or computed tomography pulmonary angiography (CTPA) to exclude pulmonary embolus
- chest physiotherapy for airway clearance.

Adverse effects

Adverse effects

Some adverse effects associated with noninvasive ventilation are:

- skin breakdown at mask contact point (especially at the nasal bridge when using oro-nasal masks)—this should not occur with appropriate mask fitting. Do not overtighten mask. A prophylactic hydrocolloid dressing may be used
- rhinorrhoea—may be reduced by the use of ipratropium nasal spray and by incorporating a heated humidifier in the circuit
- retention of secretions—may be overcome by humidification of air, bronchodilators and regular chest physiotherapy
- gastric distension—may cause discomfort. Consider lowering both IPAP and EPAP.

Stopping noninvasive ventilation

Stopping noninvasive ventilation

Acute noninvasive ventilation usually produces rapid improvement.

For patients with exacerbations of chronic obstructive pulmonary disease (COPD), noninvasive ventilation is usually applied throughout the first 24 hours (with breaks for meals) and then overnight for 1 to 2 nights.

For patients with acute cardiogenic pulmonary oedema, continuous positive airway pressure (CPAP) is usually only required for approximately 6 to 12 hours.

Patients can usually be weaned from noninvasive ventilation once dyspnoea has resolved (particularly in patients with acute cardiogenic pulmonary oedema) and arterial blood gases have normalised (particularly in patients with acute hypercapnic COPD).

Most patients admitted to hospital with acute-on-chronic respiratory failure present severely sleep deprived. Following acute noninvasive ventilation, consider assessing ventilation during sleep (eg using pulse oximetry) to determine whether overnight noninvasive ventilation should be continued for extra nights to restore sleep quality.

Long-term noninvasive ventilation can be ceased following end-of-life discussions and palliative care team involvement. For information on withdrawal of noninvasive ventilation in patients with end-stage respiratory failure, see Withdrawal of noninvasive ventilation. Long-term noninvasive ventilation may also be ceased following improvement of the underlying condition (eg extreme weight loss in morbid obesity).

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Key references: Noninvasive ventilation

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Overview of allergic bronchopulmonary aspergillosis

Overview of allergic bronchopulmonary aspergillosis

This topic covers management of allergic bronchopulmonary aspergillosis (ABPA) in patients with asthma and cystic fibrosis (CF). For management of aspergillosis in pneumonia, see Invasive pulmonary aspergillosis and Chronic pulmonary aspergillosis.

ABPA is characterised by a marked inflammatory reaction in the airways to lung colonisation with *Aspergillus fumigatus*. *A. fumigatus* is a common environmental fungus; culture of *A. fumigatus* from the sputum is common and is not necessarily associated with clinical disease.

ABPA predominantly occurs in patients with asthma or CF. It affects approximately 1 to 2% of people with asthma, and around 10% of people with CF, although estimates vary. In children, most cases of ABPA are related to CF rather than asthma.

The typical presentation of ABPA differs between asthma and CF, and diagnosis is difficult. Management of ABPA is similar regardless of the cause. Diagnosis and management require specialist advice.

Chronic or recurrent ABPA can cause bronchiectasis or lung fibrosis.

Presentation and diagnosis of allergic bronchopulmonary aspergillosis in asthma

Presentation and diagnosis of allergic bronchopulmonary aspergillosis in asthma

Allergic bronchopulmonary aspergillosis (ABPA) can be difficult to detect and the diagnosis is often delayed because the presentation is nonspecific.

Consider the possibility of ABPA in a patient with:

- unexplained shadowing on chest X-ray
- segmental collapse on chest X-ray
- difficult-to-control asthma (despite management of comorbidities such as allergic rhinitis)
- a productive cough of sticky mucous plugs or blood
- recurrent asthma exacerbations
- haemoptysis.

ABPA should also be considered in a patient who appears to have pneumonia on X-ray but is reasonably well. Although a computed tomography (CT) scan is not a routine diagnostic test for ABPA, if it was performed because pneumonia was a presumed diagnosis and the scan shows mucous plugging, bronchiectasis, bronchial dilatation or airspace change, this may indicate ABPA.

If ABPA is suspected in a patient with asthma, or if a patient with asthma displays any of the above features without an alternative cause, consider referral to a respiratory physician for diagnosis and management. Features that are of particular concern are haemoptysis and transient pulmonary infiltrates on chest X-ray.

Diagnosis of ABPA requires specialist advice; it involves chest X-ray and serum-specific immunoglobulin E (IgE) tests ('RAST' tests). See Figure 9.18 for diagnostic criteria.

Figure 9.18 International Society for Human and Animal Mycology (ISHAM) diagnostic criteria for allergic

bronchopulmonary aspergillosis

[NB1]

Obligatory criteria (both must be present):

- positive type 1 *Aspergillus* skin test (immediate cutaneous hypersensitivity to *Aspergillus* antigen) or elevated IgE levels against *Aspergillus fumigatus*
- elevated total IgE levels greater than 1000 IU/mL [NB2]

Additional criteria (at least two must be present):

- presence of precipitating or IgG antibodies against *A. fumigatus* in serum
- radiographic pulmonary opacities consistent with ABPA (eg transient pulmonary infiltrates)
- total eosinophil count more than 500 cells/microlitre in steroid-naive patients

ABPA = allergic bronchopulmonary aspergillosis; IgE = immunoglobulin E; IgG = immunoglobulin G

NB1: Diagnosis is complex and usually requires specialist input.

NB2: If the patient meets all other criteria, an IgE value less than 1000 IU/mL may be acceptable.

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Presentation and diagnosis of allergic bronchopulmonary aspergillosis in cystic fibrosis

Presentation and diagnosis of allergic bronchopulmonary aspergillosis in cystic fibrosis

Early identification and management of allergic bronchopulmonary aspergillosis (ABPA) in patients with cystic fibrosis (CF) is critical, because ABPA can cause significant and rapid structural changes in the lungs. Approximately 10% of patients with CF have coexisting ABPA. Patients with CF have annual serological screening for ABPA, but clinicians should also be alert to signs of ABPA in between screenings.

In patients with CF, ABPA usually presents as acute or subacute clinical deterioration (eg wheezing, decreased exercise tolerance and reduced lung function). Differentiating between ABPA and a CF exacerbation can be difficult; see exacerbations of cystic fibrosis lung disease. ABPA may be associated with a dryer or 'tighter' cough than the wet cough that is usually seen in infective exacerbations of CF.

Diagnosis of ABPA requires specialist advice; it involves chest X-ray and serum-specific immunoglobulin E (IgE) tests ('RAST' tests). See Figure 9.18 for diagnostic criteria.

If ABPA is suspected in a patient with CF, refer the patient to their CF physician for confirmation and early management.

Management of allergic bronchopulmonary aspergillosis

Management of allergic bronchopulmonary aspergillosis

The management of allergic bronchopulmonary aspergillosis (ABPA) is similar regardless of the cause. Treatment requires specialist advice; it can include systemic corticosteroid and antifungal therapy.

In patients with cystic fibrosis (CF), pharmacokinetic monitoring by a specialist centre is required because the pharmacokinetics of antifungal drugs in patients with CF are complex.

Key references: Allergic bronchopulmonary aspergillosis

Key references: Allergic bronchopulmonary aspergillosis

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Principles of oxygen therapy

Processing
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Potential harms of oxygen therapy

Processing
rsg c rsg6-c31-s2

Patients at risk of hypercapnia

Processing
rsg c rsg6-c31-s3

Indications for acute oxygen therapy

Processing
rsg c rsg6-c31-s4

Oxygen delivery systems used in acute oxygen therapy

Processing
rsg c rsg6-c31-s5

Monitoring acute oxygen therapy

Processing
rsg c rsg6-c31-s6

Pulse oximetry to monitor acute oxygen therapy

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Arterial blood gas analysis to monitor acute oxygen therapy

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Key references: Acute oxygen therapy

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Overview of fitness to fly

Overview of fitness to fly

Medical emergencies during flights are uncommon (they occur in 1 of every 604 flights). The most common in-fight medical problems reported are syncope or presyncope (37.4%), respiratory symptoms (12.1%), nausea or vomiting (9.5%), and cardiac symptoms (7.7%). Physicians may be asked to assess and provide care to a passenger having a medical emergency on a commercial flight. Few in-flight medical emergencies result in diversion of the aircraft or patient death. The final decision to redirect the flight lies with the captain of the aircraft and is made after considering advice from the medical provider on board or clinicians at ground-based medical consultation services.

Air travel can pose significant risks to people with certain medical conditions. Medical clearance is usually required by the airline if the passenger:

- suffers from any disease that is believed to be actively contagious and communicable
- is likely to be a hazard or cause discomfort to other passengers because of their physical or behavioural condition
- is considered to be a potential risk to the safety or punctuality of the flight including the possibility of diversion or an unscheduled landing
- is incapable of caring for themselves and requires special assistance
- has a medical condition which may be adversely affected by the flight environment.

Passengers who do not fall into the above categories usually do not need medical clearance; however, consult the airline if there is any doubt about whether medical clearance is required. It is advisable to contact the relevant airline well in advance of travel.

Requirements for medical clearance can differ between airlines; airlines produce their own travel clearance guidelines, which are available online. An example of information available online can be found on the Qantas website.

Further information can be found in the International Air Transport Association (IATA) medical manual, available here.

Commercial aircrafts usually cruise at altitudes between 10 000 and 13 500 metres (32 800 and 44 300 feet). Pressurisation of the cabin ensures that the pressure corresponds to an altitude of no more than 2438 metres (8000 feet), which generates a cabin air pressure of 565 mmHg. In this environment, haemoglobin oxygen saturation normally remains above 90% in the average healthy person, and partial pressure of inspired oxygen (PiO_2) falls to the equivalent of breathing 15.1% oxygen at sea level (normally 20.8%). These changes create a mild hypoxia, which is usually well tolerated by a healthy person. The reduced cabin pressure also causes expansion of gas by about one-third, which can be important if there is trapped gas in closed body cavities (eg sinuses, middle ear, pleural cavity).

Other features of commercial air travel that might cause problems are:

- dryness of air in cabin
- reduced mobility of travellers, potentially causing venous thromboembolism (see VTE prophylaxis for long-distance travel)
- close proximity to other people and consequent risk of respiratory tract infections
- disturbance of circadian rhythms on longer flights (see Jet lag).

Risk of sinus or middle ear barotrauma during flight

Risk of sinus or middle ear barotrauma during flight

There is a potential risk of sinus or middle ear barotrauma in those with risk factors (mucosal oedema, bacterial infection, thick mucus).

Upper airway infections can impair the ability to equalise pressures between the middle ear and oropharynx via the eustachian tube. This can result in barotrauma to the tympanic membrane, particularly at the time of descent. If travel is necessary, and the patient has lost their usual ability to equalise the pressure with the Valsalva manoeuvre at sea level, consider an intranasal or oral decongestant. Use at least 10 minutes (for intranasal decongestants) or 30 minutes (for oral decongestants) before ascent or descent to allow onset of action. Anecdotal evidence suggests that semipermeable earplugs may be helpful; earplugs are available from pharmacies. In patients with chronic rhinosinusitis, using saline nasal sprays and nasal irrigation may be helpful.

Children are especially at risk of middle ear barotrauma. Parents and carers should be advised to encourage their children to blow their nose, drink water, or chew or suck (eg on a lolly or dummy), particularly during descent. In infants, breastfeeding may help equalise pressures between the middle ear and oropharynx via the eustachian tube.

Any patient who experiences deafness, vertigo or bleeding from the external auditory meatus after flying must be examined by a doctor.

Assessment of specific respiratory conditions before flying

Assessment of specific respiratory conditions before flying

Overview

Overview

No further investigation is needed for patients whose respiratory disease is stable when assessed, who have not had a previous in-flight problem, and whose resting oxygen saturation measured by pulse oximetry (SpO_2) is 95% or greater.

For patients with unstable respiratory disease, spirometry and pulse oximetry do not reliably predict in-flight complications. Aim to optimise control of respiratory disease before flying. Some patients with respiratory conditions require assessment for supplemental oxygen; see Patients needing assessment.

Infants and young children who have had chronic neonatal lung disease (even if they no longer require supplemental oxygen), and children who are oxygen dependent require specialist assessment before air travel. For adults currently using supplemental oxygen, refer to or discuss with a respiratory specialist to determine changes to oxygen therapy.

Asthma and COPD

Asthma and COPD

Bronchodilator inhalers may be kept in emergency aircraft kits; however, advise patients to carry their own bronchodilator inhaler as part of their hand luggage in case of an acute exacerbation.

For patients with severe asthma or COPD (forced expiratory volume in 1 second [FEV_1] less than 30% predicted), refer for assessment by a respiratory specialist.

Lung bullae

Lung bullae

Patients with large lung bullae are usually safe to travel; reports of problems during air travel are rare. Pressure changes during commercial flights happen slowly, allowing time for equilibration, so the presence of bullae is not a contraindication to air travel.

Pneumothorax and thoracic surgery

Pneumothorax and thoracic surgery

Patients who have a current pneumothorax should not travel by air because the volume of air in the pleural space expands by about one-third at cabin altitude. However, if travel is necessary, patients with an intercostal drain with a one-way valve (Heimlich valve) in place may be able to travel with a suitable escort (doctor or nurse).

For patients with recently resolved pneumothorax, delay air travel:

- by 1 week after full radiological resolution of spontaneous pneumothorax
- by 2 weeks after full radiological resolution of pneumothorax after thoracic surgery or trauma.

Respiratory infections and pulmonary tuberculosis

Respiratory infections and pulmonary tuberculosis

Consider risk of transmission to other passengers for airborne infections.

Consult the latest online guidelines for advice on travel restrictions for those with respiratory viral infections of high mortality, including for outbreaks of emerging respiratory infections. Updates are available on the World Health Organization (WHO) website.

Patients with pulmonary tuberculosis must not travel by air until they are noninfectious (usually after at least 2 weeks of effective treatment)—seek specialist advice.

In-flight oxygen therapy

In-flight oxygen therapy

Patients needing assessment

Patients needing assessment

Although there is no trial evidence for the benefit of in-flight supplemental oxygen, consider in-flight supplemental oxygen for patients:

- with a history of respiratory problems during air travel (eg breathlessness, chest pain, confusion, syncope)
- with severe asthma or severe chronic obstructive pulmonary disease (COPD) (forced expiratory volume in 1 second [FEV_1] less than 30% predicted)
- with severe restrictive lung disease (forced vital capacity [FVC] less than 1 Litre)
- with oxygen saturation measured by pulse oximetry (SpO_2) less than 95%
- within 6 weeks of hospital discharge for acute severe or acute-on-chronic respiratory illness
- with a comorbidity that is worsened by hypoxaemia (eg cerebrovascular disease, coronary artery disease, heart failure)
- with a pre-existing requirement for supplemental oxygen or ventilator support, including noninvasive ventilation.

Clinical assessment and tests

Clinical assessment and tests
Clinical assessment

Clinical assessment to determine the need for in-flight oxygen therapy includes cardiorespiratory history and examination, spirometry, pulse oximetry and review of previous air travel experience.

Hypoxic challenge test

The hypoxic challenge test (also known as the high-altitude simulation test) is used to assess the need for in-flight oxygen. Consider a hypoxic challenge test in patients with SpO_2 less than 95%.

The hypoxic challenge test simulates the cabin pressure by exposing the person to the reduced inspired oxygen partial pressure (PiO_2) at 2438 metres (8000 feet). The test is performed in a specialist respiratory laboratory over a 20- to 30-minute period, either with special low-oxygen gas cylinders or with the person breathing air while wearing a 40% Venturi mask with 100% nitrogen as the driving gas.

In-flight oxygen is usually indicated if SpO_2 falls below 85% or if the patient becomes distressed during the hypoxic challenge test.

Walk test

Walk tests are only recommended if hypoxic challenge testing is unavailable. However, some airlines still include the 50 metre walk test in their medical clearance form.

Patients unable to walk 50 metres on level ground should be considered unfit to fly.

Oxygen delivery

Oxygen delivery

The usual flow rate for in-flight oxygen is 2 L per minute via nasal cannulae. In patients currently using supplemental oxygen, refer to or discuss with a respiratory specialist to determine changes to oxygen therapy. Those needing oxygen at flow rates of 4 L per minute or more at sea level are not fit to fly.

The requirement for in-flight oxygen must be communicated to the airline before travel, often by the completion of a medical travel clearance form, which can be found on the airline website.

Consider the need for oxygen at the airport (including for stopovers) because most airlines only provide oxygen during flight. Some airlines allow passengers to carry and use their own small oxygen cylinders on board.

In-flight continuous positive airway pressure

In-flight continuous positive airway pressure

Continuous positive airway pressure (CPAP) may be required by some patients with severe obstructive sleep apnoea on long-haul flights. Consider the possibility of worsening hypoxaemia when asleep.

If CPAP is necessary, the airline should be consulted before booking; airlines may have a list of approved CPAP devices allowable in-flight. Information on carrying CPAP machines on a flight can be found on the Qantas website. A doctor's letter outlining the diagnosis and necessary equipment may be needed. The letter should state that the CPAP machine should travel in the cabin as extra hand luggage. Dry cell battery–powered CPAP can be used during the flight but must be switched off before take-off and landing.

During the flight, patients with obstructive sleep apnoea should avoid factors that worsen their apnoea, such as alcohol or sedatives.

Key references: Fitness to fly for patients with respiratory disease

Key references: Fitness to fly for patients with respiratory disease

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Definition and symptoms of obstructive sleep apnoea in adults

Definition and symptoms of obstructive sleep apnoea in adults

Obstructive sleep apnoea is the most common form of sleep-disordered breathing in adults. Patients with obstructive sleep apnoea experience apnoeas and hypopnoeas during sleep, which reduce the restfulness of sleep and can cause daytime dysfunction (predominantly excessive daytime sleepiness).

The typical patient with obstructive sleep apnoea is overweight, middle-aged and male, and often has a short thick neck and a history of alcohol and tobacco consumption. However, women and thin young people can also develop sleep apnoea, especially those with abnormal anatomy (eg high arched palate, narrow anteroposterior diameter of the pharynx).

In addition to daytime sleepiness, untreated obstructive sleep apnoea is associated with:

- hypertension
- arrhythmias, such as paroxysmal atrial fibrillation
- cardiovascular mortality
- cerebrovascular mortality
- pregnancy-related hypertension and pre-eclampsia
- motor vehicle accidents, especially single-vehicle accidents at night.

Clinical assessment of obstructive sleep apnoea in adults

Clinical assessment of obstructive sleep apnoea in adults

In patients with suspected obstructive sleep apnoea, take a history of symptoms and coexisting conditions; ask both the patient and their sleeping partner about symptoms. Symptoms suggestive of obstructive sleep apnoea and common comorbidities are outlined in Figure 9.22.

Figure 9.22 Symptoms suggestive of obstructive sleep apnoea and common comorbidities

[NB1]

Symptoms suggestive of obstructive sleep apnoea:

- snoring—frequency, loudness and whether the partner needs to leave the bedroom
- waking through the night with a sensation of choking
- nocturnal interruption of breathing recognised by the partner (‘witnessed apnoeas’)
- nocturia
- nocturnal sweating
- daytime sleepiness and irritability
- poor concentration or attention span
- morning headache
- gastro-oesophageal reflux
- erectile dysfunction

Common comorbidities:

- hypertension, more suggestive in younger patients
- cardiovascular disease, especially atrial fibrillation and heart failure
- cerebrovascular disease

- diabetes
- thyroid disease
- obesity
- Down syndrome [NB2]

NB1: A family history of continuous positive airway pressure (CPAP) use or sleep apnoea increases the likelihood of obstructive sleep apnoea.

NB2: People with Down syndrome are at increased risk of obstructive sleep apnoea, with the prevalence estimated at close to 100% by adulthood. Consider the possibility of obstructive sleep apnoea in all people with Down syndrome, including those without overt symptoms.

The Berlin, STOP-Bang and OSA50 questionnaires can help to identify patients likely to have symptomatic moderate to severe sleep apnoea. Links to these questionnaires can be found on the American Thoracic Society website.

The Epworth Sleepiness Scale can be completed by the patient to give an indication of daytime sleepiness. Patients may deny or be unaware of the severity of their daytime sleepiness; their partner may give a better indication of symptoms. Daytime sleepiness can also be a marker of other conditions, such as depression.

These questionnaires form part of the criteria to access subsidised sleep studies (polysomnograms) through the Medicare Benefits Schedule (MBS). See Diagnosis of obstructive sleep apnoea for more information.

Diagnosis of obstructive sleep apnoea in adults

Diagnosis of obstructive sleep apnoea in adults

The standard diagnostic test for obstructive sleep apnoea is an overnight sleep study (polysomnogram), which can be either home-based (unattended) or in-laboratory (attended). Sleep studies involve detailed monitoring of body position, sleep stage and breathing. They calculate the number and severity of obstructive apnoeas and hypopnoeas, oxygen desaturations and arousals.

The severity of obstructive sleep apnoea is defined by the apnoea–hypopnoea index (the number of apnoeas or hypopnoeas per hour), which is provided by the laboratory. Significant obstructive sleep apnoea is indicated by an apnoea–hypopnoea index of more than five events per hour. More than 30 events per hour indicates severe obstructive sleep apnoea.

Hypoxic burden is a metric of oxygen desaturation recorded by sleep studies that can also be used to determine the severity of obstructive sleep apnoea. Hypoxic burden can be reported as the total sleep time or the percentage of sleep time during which oxygen saturation measured by pulse oximetry (SpO_2) is below 90% (T90 or P90 respectively). A P90 of approximately 1 to 5% may indicate moderate sleep apnoea; a P90 above 5% may indicate severe sleep apnoea.

For information about which patients should have a sleep study, whether it should be home-based or in-laboratory, and an outline of Medicare Benefits Schedule (MBS) subsidy criteria, see Figure 9.23.

Figure 9.23 Indications for sleep study for suspected obstructive sleep apnoea

Who can order a sleep study based on MBS criteria? [NB1]

A sleep study can be ordered by a specialist (a respiratory or sleep physician), or directly by a GP, for patients with:

- an Epworth Sleepiness Scale score of at least 8
- plus one of the following [NB2]:
    - a STOP-Bang score of at least 4
    - an OSA50 score of at least 5
    - a high-risk score on the Berlin questionnaire.

A sleep study can also be ordered by a specialist based on other factors—consider specialist referral for patients who do not meet the above criteria if there is a strong clinical suspicion of obstructive sleep apnoea (see Figure 9.22).

Should the sleep study be home-based or in-laboratory?

A home-based sleep study, accompanied by clinical assessment by an experienced clinician, is suitable for most patients.

Consider an in-laboratory sleep study in patients with:

- an intellectual or physical disability
- a comorbidity that could complicate diagnosis (eg neuromuscular disease, heart failure, respiratory disease)
- suspected respiratory failure (additional measurements indicated [eg $PaCO_2$])
- suspected parasomnia or seizure disorder
- previously failed home-based study
- an unsuitable home environment
- a strong preference for an in-laboratory sleep study.

If an in-laboratory sleep study is ordered, document the reason on the referral to the sleep laboratory.

GP = general practitioner; MBS = Medicare Benefits Schedule; $PaCO_2$ = partial pressure of carbon dioxide

NB1: See the MBS website for comprehensive and current information.

NB2: Links to these questionnaires are available on the American Thoracic Society website.

The results of a sleep study should be considered in the context of the patient's clinical presentation and symptoms.

If the sleep study shows that the patient has obstructive sleep apnoea, refer to an experienced practitioner for management (eg to start continuous positive airway pressure). See Treatment of obstructive sleep apnoea for more information.

A sleep study can also identify alternative or coexisting sleep disorders requiring specific management, including central sleep apnoea, and restless legs syndrome (which can worsen sleep independently of sleep-disordered breathing).

Treatment of obstructive sleep apnoea in adults

Treatment of obstructive sleep apnoea in adults

General measures

General measures

For all adults with obstructive sleep apnoea, consider the general treatment measures outlined in Figure 9.24. In some patients—especially those with mild disease with no daytime sleepiness, no impairment to daytime functioning, and no hypertension—these interventions may be sufficient. They can also be trialled before testing for sleep apnoea.

Figure 9.24 General measures for adults with obstructive sleep apnoea

Consider the following general measures for all adults with obstructive sleep apnoea:

- Weight reduction—many patients with obstructive sleep apnoea are overweight, and weight reduction is beneficial.

- Smoking cessation (recommended for all patients)—in addition to other health benefits, smoking cessation can also reduce nasal resistance.
- Improved sleep practices (see Good sleep practices for adults)—sleep deprivation increases the likelihood of daytime dysfunction.
- Avoidance of alcohol and drugs that can affect sleep.
- Intranasal corticosteroid to reduce nasal resistance.
- Positional therapy—for patients with predominantly supine obstructive sleep apnoea (identified by sleep study), suggest:
    - sleeping on the side; consider simple measures to keep the patient on their side (eg pillows behind the back, a tennis ball attached to the back of a pyjama top)
    - vibratory alarms that sound if the patient adopts the supine position
    - raising the head of the bed by 5 to 8 cm to help reduce rostral fluid shift [NB1]
    - sleeping with the neck extended and mouth closed can also help.

NB1: Rostral fluid shift is a phenomenon in which extravascular fluid shifts from the lower limbs and abdomen to the thorax, head and neck while the patient is supine overnight.

Many complementary treatments (eg nasal strips, nasal dilators, snore-stop drops, 'snore-easy' pillows) are marketed for snoring and mild sleep apnoea, but they have little supporting data. Nasal expiratory valves have proven benefit, but are usually poorly tolerated.

Increased sleepiness increases the likelihood of motor vehicle accidents. Advise patients with obstructive sleep apnoea causing severe daytime sleepiness to stop driving vehicles and operating machinery until their condition is stabilised on treatment.

The individual driving risk should not be based solely on the severity of symptoms; consider factors such as acute sleep deprivation, circadian misalignment (eg shift work, jet lag), narcolepsy, alcohol consumption, comorbidities and other drugs. See the Austroads website for general information about fitness to drive. If there is concern about the patient's fitness to drive, seek expert advice.

Continuous positive airway pressure

Continuous positive airway pressure

The most effective therapy for obstructive sleep apnoea is continuous positive airway pressure (CPAP). CPAP works by splinting the upper airway open. It can significantly reduce the number of apnoea and hypopnea events, and reduce daytime sleepiness. With good adherence, it can also improve mental health outcomes.

Consider CPAP for patients with:

- severe obstructive sleep apnoea—apnoea–hypopnoea index of more than 30 events per hour or hypoxic burden (percentage of sleep time during which oxygen saturation measured by pulse oximetry [SpO_2] is less than 90%) of more than 5%
- symptoms of daytime dysfunction and moderate obstructive sleep apnoea (apnoea–hypopnoea index of more than 5 events per hour or hypoxic burden of approximately 1 to 5%)
- obstructive sleep apnoea and hypertension—CPAP appears to produce a clinically significant reduction in blood pressure. Patients without significant sedation may prefer to manage hypertension with lifestyle modifications or drug therapy (see Blood pressure reduction). If blood pressure remains elevated despite lifestyle modifications or drug therapy, reassess whether the patient may benefit from CPAP.

The effect of CPAP on cardiovascular events and mortality in patients with coexisting obstructive sleep apnoea and cardiovascular disease is unclear. Benefit has been shown in some observational studies, but a randomised controlled trial did not find any benefit [Note 1].

For a patient with mild to moderate obstructive sleep apnoea without daytime dysfunction, with or without cardiovascular disease, a 'watch and wait' approach is reasonable. Consider general measures (eg weight loss) to improve sleep and prevent progression to symptomatic disease.

CPAP is usually started in a specialist clinic or by a general practitioner with expertise in CPAP. The clinic can assist with optimising the mask interface, controlling leaks and fitting chin straps. Table 9.22 summarises some common problems that occur with CPAP. CPAP machines are expensive; therefore, patients may prefer to trial the treatment by renting a CPAP machine, if possible, before purchasing one.

The airway pressure required to prevent obstructive apnoea and hypopnoea varies between patients. The pressure can be titrated during a second sleep study (the CPAP titration study), or using an automatic titrating CPAP machine. In symptomatic patients, do not delay starting treatment to await a titration study. Consider starting the patient on either a standard rate of 10 cmH_2O, or a rate based on 10% of the patient's body weight (eg start a 60 kg patient on 6 cmH_2O) until a titration study can be performed.

In patients who remain symptomatic with CPAP treatment, consider a repeat sleep study to identify leaks, changes in pressure requirements, or other disorders requiring independent treatment (eg restless legs syndrome).

Patient information brochures about CPAP are available from the Sleep Health Foundation website.

Table 9.22 Managing common problems with long-term CPAP

Problem	Management strategies
nasal symptoms due to relatively dry air of CPAP machine	intranasal saline or corticosteroid, pressure reduction, inbuilt or add-on humidifiers to CPAP machine
mouth leak	trial chin straps
dry mouth	usually indicates significant mouth leak; trial chin straps (humidification of the CPAP machine will not relieve dry mouth while a mouth leak exists) consider reducing CPAP pressure
skin ulceration over the nasal bridge	mask may not be fitted properly or may be applied too tightly—refit mask or trial a new mask
ear discomfort	intranasal corticosteroid
adherence	ensure: • mask is comfortable • humidification is operational • there is no anatomic obstruction (eg chronic nasal injury, secondary obstruction) requiring surgical intervention exclude coexisting lifestyle, medical and psychological factors that prevent sleep consider: • using CPAP while distracted (eg while watching TV) • using CPAP on alternate nights • a short course of an anxiolytic drug at night (eg for the first week of CPAP)

CPAP = continuous positive airway pressure

Note 1: McEvoy RD, Antic NA, Heeley E, Luo Y, Ou Q, Zhang X, et al. CPAP for Prevention of Cardiovascular Events in Obstructive Sleep Apnea. N Engl J Med 2016;375(10):919-31. [URL]

Other interventions

Other interventions
Mandibular advancement splints

Mandibular splinting devices are an alternative to continuous positive airway pressure (CPAP) but are only effective in mild to moderate obstructive sleep apnoea. They may also have a role for patients who have 'simple' snoring (snoring with minimal apnoea or hypopnoea on sleep study). These splints can be used either to advance the mandible forward or to widen the maxilla.

Mandibular advancement splints must be professionally fitted, and patients need to be regularly reviewed by a dentist. In the long term, they can cause temporomandibular joint pain, changes to the bite and excessive salivation. Simple mouth guards used without dental guidance may damage the teeth and do not work.
Surgery

Maxillary and mandibular reconstructive surgery may be recommended for patients with a significant craniofacial abnormality.

Adenotonsillectomy or nasal decongestive surgery may be helpful if anatomical abnormalities contribute to the patient's snoring. They alleviate snoring and can improve adherence to other forms of treatment such as CPAP or mandibular advancement splints.

Removal of the soft palate (uvulopalatal pharyngoplasty) and reduction of the tongue base were used in the past, but studies have shown minimal reduction in the apnoea–hypopnoea index. Palatal surgery is now only considered in highly selected cases.

Upper airway pacemaker

Upper airway muscle stimulating pacemakers have been assessed in small short-term studies for sleep apnoea in patients resistant to other forms of treatment. The results have not shown consistent benefit, and long-term adverse effects are not established. At the time of writing, this treatment remains a research tool.

Obstructive sleep apnoea and coexisting respiratory disorders

Obstructive sleep apnoea and coexisting respiratory disorders

Obstructive sleep apnoea may be associated with chronic obstructive pulmonary disease (COPD), asthma or other significant respiratory disorders. For patients with a coexisting respiratory disorder, a sleep study should include measurement of transcutaneous carbon dioxide and arterial blood gases.

Patients with severe COPD and obstructive sleep apnoea can develop nocturnal hypoventilation due to the combination of the COPD and the episodes of apnoea and hypopnoea.

Management of obstructive sleep apnoea in patients with comorbid respiratory disease includes optimisation of daytime respiratory function through weight loss, smoking cessation and drug treatment of the respiratory disorder.

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Key references: Clinical assessment of obstructive sleep apnoea in adults

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Impact of respiratory impairment on procedures

Impact of respiratory impairment on procedures

In this topic, the term ‘procedure’ is used to refer to any operation or procedure requiring general anaesthetic or procedural sedation.

There are risks involved when patients with respiratory disease have a procedure. Specific interventions or precautions may be required before, during and after a procedure.

Patients with respiratory disease need proper assessment before a procedure.

During the procedure, general measures that may reduce the risk of complications include using regional anaesthesia, assisted ventilation, targeted oxygen therapy, effective intra-airway suction to remove secretions, and using opioids and sedatives with caution and only as required.

In the postprocedural period, respiratory-related morbidity and mortality are increased because of:

- increased demand on the respiratory system: demand is increased because postprocedure fever, sepsis and tissue repair cause the basal metabolic rate to increase two- to three-fold, which increases oxygen consumption and carbon dioxide production
- reduced ventilatory capacity of the respiratory system: pain from abdominal or thoracic wounds, the need to remain supine, and the use of opioids and sedatives can contribute to reduced ventilatory capacity. Atelectasis, sputum retention, pneumonia and fluid overload can also reduce ventilatory capacity, as well as adversely affecting gas exchange.

Risk of periprocedural complications in patients with respiratory disease

Risk of periprocedural complications in patients with respiratory disease

The risk of periprocedural complications depends on the type of procedure and the nature of the respiratory disease.

Procedures that put patients with respiratory disease at most risk are:

- procedures involving the throat, thorax and abdomen
- procedures with long operating duration
- procedures requiring high levels of postprocedural analgesia.

Patients with respiratory disease at most risk of postprocedural complications are those:

- who smoke
- with poorly controlled asthma or history of severe exacerbations (especially those requiring intensive care or hospital admissions)
- taking long-term systemic or high-dose inhaled corticosteroids—a brief course of supplementary corticosteroids may be needed periprocedurally
- with limited mechanical ventilatory reserve, including patients with
    - severe airway obstruction
    - interstitial lung disease
    - an oxygen requirement or on domiciliary oxygen therapy

    - obesity
    - diseases associated with weak respiratory muscles (eg neuromuscular disease)
- with mucus hypersecretion, including patients with
    - chronic bronchitis
    - bronchiectasis
    - cystic fibrosis
- with a chest wall disorder causing a rigid chest (eg kyphoscoliosis)
- with reduced ability to protect the upper airway or to clear secretions from the lungs (eg due to neuromuscular disorders affecting the bulbar muscles and cough mechanism)
- with uncontrolled gastro-oesophageal reflux
- with coexisting cardiac disease predisposing to pulmonary oedema
- with significant sleep apnoea or obesity hypoventilation syndrome
- with significant craniofacial abnormalities (who may be difficult to intubate and are more likely to have obstructive sleep apnoea)
- who are prone to respiratory centre depression (eg due to chronic carbon dioxide retention)
- who have difficulty cooperating with instructions (eg with physical or developmental disability).

Acute viral and bacterial infections can temporarily affect mucociliary function and increase mucus production. This can increase the risk of postprocedural complications. In otherwise healthy people, this risk is relatively low, but elective procedures may need to be postponed with consideration of the risks and benefits by the anaesthetist and surgeon.

Preprocedural assessment of patients with respiratory disease

Preprocedural assessment of patients with respiratory disease

Clinical assessment

Clinical assessment

Consult the patient's general and specialist practitioners about their medical conditions, drug therapy, surgical history and functional status; functional status can be assessed using the Duke Activity Status Index (DASI) questionnaire [Note 1]. Optimise drug therapy and management of respiratory conditions before the procedure, including encouraging physical activity if appropriate. See also Periprocedural management of patients with cardiovascular disease and Periprocedural management of adults with diabetes for nonrespiratory considerations.

The potential harms and expected benefits of the procedure must be considered for each patient. Refer to a perioperative specialist if appropriate, particularly for complex patients. Patients waiting for elective procedures will usually have an appointment before the procedure to determine their periprocedural risk.

Consult the anaesthetist to determine if any drugs need to be withheld before the procedure. The patient's usual inhaler therapy is usually continued unless advised otherwise by the specialist or anaesthetist.

Encourage and assist patients to stop smoking before their procedure to improve postprocedural outcomes. Stopping smoking for even one day can lower carboxyhaemoglobin and nicotine levels, and improve the delivery of oxygen to tissues. Longer periods of smoking cessation have additional benefits, including improved wound healing after 3 weeks, reduced sputum volume and improved pulmonary function after 8 weeks, and improved immune function after 6 months. If practical, postpone the procedure until the patient has stopped smoking. See Smoking cessation for suggested strategies.

Before a procedure, consider screening for sleep-disordered breathing (eg obstructive sleep apnoea, obesity hypoventilation syndrome). Questionnaires such as the STOP-Bang questionnaire [Note 2] can be useful to identify patients likely to have sleep apnoea; see Obstructive sleep apnoea in adults for more information.

If preprocedural assessment identifies any undiagnosed respiratory conditions, investigate and manage these conditions before the procedure, if practical.

Patients who use continuous positive airway pressure (CPAP) (eg for sleep-disordered breathing), should usually be instructed to bring their CPAP machines and associated equipment to hospital to be used after the procedure. However, CPAP may be contraindicated after some procedures.

Consider the need for venous thromboembolism (VTE) prophylaxis.

Note 1: For detailed information on the Duke Activity Status Index (DASI) questionnaire, see here.

Note 2: Links to questionnaires that can help to identify patients likely to have sleep apnoea (eg Berlin, STOP-Bang, OSA50 questionnaires) can be found on the American Thoracic Society website.

Pulmonary function testing

Pulmonary function testing

Before a procedure, all patients with clinical evidence of respiratory impairment should have pulmonary function tests such as spirometry and pulse oximetry. Consider measuring diffusing capacity of the lung for carbon monoxide (DLCO) in patients with abnormal spirometry and oxygen saturation levels, and also in high-risk patients and patients undergoing high-risk procedures. If these tests cannot be performed because the patient is physically or developmentally disabled, perform thorough clinical examination, chest X-ray, and blood tests to assess for hypercapnia (partial pressure of carbon dioxide in arterial blood [$PaCO_2$] more than 45 mmHg or serum bicarbonate concentration 27 mmol/L or more) and polycythaemia; monitor patients carefully after the procedure.

For patients using oxygen therapy, monitor for and prevent hyperoxaemia; see Principles of oxygen therapy and Potential harms of oxygen therapy for considerations in oxygen therapy.

Patients with any of the following have a very limited respiratory reserve and need expert preprocedural assessment:

- forced expiratory volume in 1 second (FEV_1) less than 60% of predicted
- DLCO less than 60% of predicted
- $PaCO_2$ higher than 45 mmHg
- moderate or severe pulmonary hypertension
- oxygen saturation measured by pulse oximetry (SpO_2) 90% or less on room air
- a requirement for long-term domiciliary oxygen therapy or noninvasive ventilation.

Patients with untreated obstructive sleep apnoea or obesity hypoventilation syndrome need expert assessment if a procedure cannot be delayed until adequate treatment is in place.

In some cases, additional physiological investigations, including cardiopulmonary cycle exercise testing (VO_2 max) and electrocardiogram (ECG), are performed before procedures involving general anaesthesia.

Lobectomy is associated with a low risk of postprocedural complications if DLCO is greater than 60% of predicted, but risk is usually considered high if VO_2 max is less than 15 mL/min/kg.

Postprocedural management of patients with respiratory disease

Postprocedural management of patients with respiratory disease

The key requirements in the early postprocedural period for patients with respiratory disease are:

- airway clearance techniques—eg Active Cycle of Breathing techniques, bubble positive expiratory pressure (PEP)
- restarting usual drug therapy when tolerated—use an alternative route of administration if usual route is not possible

- adequate analgesia—see General principles of acute pain management for postprocedural pain management advice
- targeted oxygen therapy for hypoxaemic patients—use humidified oxygen for 'mouth breathers' and ensure oxygen therapy is titrated to target oxygen saturation measured by pulse oximetry (SpO_2); see Pulse oximetry to monitor acute oxygen therapy for target oxygen saturation levels
- prevention of atelectasis—by effective deep breathing (eg facilitated by incentive spirometry) and coughing, and prophylactic continuous positive airway pressure (CPAP) or bilevel positive airway pressure (BPAP) in some instances (eg after cardiac surgery, in children with neuromuscular disorders or restrictive lung disease such as kyphoscoliosis)
- consideration of venous thromboembolism (VTE) prophylaxis and early mobilisation.

Monitoring for complications involves:

- frequent clinical examination to detect fever, auscultatory changes (eg inspiratory crackles, reduced air entry, bronchial breath sounds), and disorientation or delirium
- continuous or regular monitoring of SpO_2 and partial pressure of carbon dioxide ($PaCO_2$), if indicated
- early detection of oversedation, vomiting and aspiration, reflux, fluid overload and cardiac arrhythmias
- formal monitoring of pain control
- formal monitoring of ability to cough effectively
- monitoring sputum volume and purulence
- monitoring forced expiratory volume in 1 second (FEV_1) or peak expiratory flow when appropriate.

Abnormal chest findings, fever or hypoxaemia warrant a chest X-ray.

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Key references: Periprocedural management of patients with respiratory disease

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Introduction to sleep-disordered breathing in children

Introduction to sleep-disordered breathing in children

Sleep-disordered breathing in children can be related to either:

- obstructive sleep apnoea—occurs in up to 5% of children
- central sleep apnoea—less common than obstructive sleep apnoea.

Overnight sleep studies (polysomnograms) may be required to diagnose sleep-disordered breathing in children. They are performed in the same way as for adults but should be carried out in a specialised paediatric sleep laboratory. Separate scoring criteria are used for infants and children to account for developmental and maturational changes that occur throughout childhood (including alterations in sleep structure, respiratory rate and breathing patterns).

Obstructive sleep apnoea in children

Obstructive sleep apnoea in children

Causes of obstructive sleep apnoea in children

Causes of obstructive sleep apnoea in children

Obstructive sleep apnoea in children results from an anatomically or functionally narrowed upper airway. The most common cause of obstructive sleep apnoea in children is adenotonsillar hypertrophy. Other causes are listed in Table 9.23.

Table 9.23 Causes of obstructive sleep apnoea in children

Cause	Comments and examples
adenotonsillar hypertrophy	most common cause
anatomical abnormalities	macroglossia and hypertrophy of lingual tonsils in Down syndrome [NB1]
	craniofacial abnormalities (eg Pierre-Robin sequence, Crouzon syndrome, achondroplasia)
	hypotonia of neuromuscular disorders, leading to collapse of upper airway during inspiration
functional abnormalities	hypertonia, commonly seen in cerebral palsy, causing functional narrowing
	decreased or impaired respiratory drive (eg spina bifida, achondroplasia, Prader-Willi syndrome)
obesity	may be associated with obstructive sleep apnoea, with or without tonsillar enlargement
	severely obese children are at risk of developing obesity hypoventilation syndrome

NB1: Children with Down syndrome are at increased risk of obstructive sleep apnoea. The estimated prevalence varies widely between 50 and 100%, compared to 1 to 5% in the standard paediatric population. The risk of obstructive sleep apnoea in children with Down syndrome appears to be high independently of

Cause	Comments and examples
	the presence of other risk factors (eg adenotonsillar hypertrophy, obesity). All children with Down syndrome, including those without symptoms, should be screened for obstructive sleep apnoea.

Clinical assessment of obstructive sleep apnoea in children

Clinical assessment of obstructive sleep apnoea in children

In children, obstructive sleep apnoea typically presents with habitual snoring and observed apnoea during sleep—see Figure 9.25 for other common nocturnal and daytime features. The peak incidence in children is between 2 and 7 years of age; it is less common in the first 6 months of life.

Examination usually reveals adenotonsillar hypertrophy and mouth breathing.

In contrast to adults, children with obstructive sleep apnoea frequently present with hyperactivity, behavioural problems and poor school performance; tiredness may not be present. Poor weight gain—thought to be related to increased work of breathing during sleep—can also be present.

Figure 9.25 Clinical features of obstructive sleep apnoea in children

Snoring or witnessed apnoeas, plus any of the following clinical features, may indicate obstructive sleep apnoea in a child.

Nocturnal symptoms or signs:

- gasping
- increased work of breathing
- restlessness
- sweating
- night waking
- enuresis
- mouth breathing
- neck extension

Daytime symptoms or signs:

- mouth breathing
- hyperactivity
- poor attention
- behavioural problems
- poor school performance
- daytime somnolence
- tiredness

If obstructive sleep apnoea is suspected based on presentation, take a full history. In children with predisposing genetic, anatomical or developmental conditions (see Table 9.23), assess for symptoms and signs of obstructive sleep apnoea routinely.

The OSA-5 questionnaire is a screening tool for obstructive sleep apnoea in children (see Table 9.24); it has high sensitivity and good negative predictive value but low specificity. It can be a useful adjunct to clinical judgement. It is most useful to identify children unlikely to have obstructive sleep apnoea—a score below 5 makes the diagnosis unlikely. For children who score 5 or more, see here for information on treatment and referral.

Table 9.24 OSA-5 screening questionnaire for obstructive sleep apnoea in children

Printable table

During the past 4 weeks, how often has the child had:	None of the time	Some of the time	Most of the time	All of the time	Score
loud snoring?	0	1	2	3	
breath holding spells or pauses in breathing at night?	0	1	2	3	
choking or made gasping sounds while asleep?	0	1	2	3	
mouth breathing because of a blocked nose?	0	1	2	3	
breathing problems during sleep that made you worried they were not getting enough air?	0	1	2	3	
Total score:					

A total score below 5 makes the diagnosis of obstructive sleep apnoea unlikely.

A total score of 5 or higher has good sensitivity but poor specificity for moderate to severe obstructive sleep apnoea.

Reproduced from Soh HJ, Rowe K, Davey MJ, Horne RSC, Nixon GM. The OSA-5: Development and validation of a brief questionnaire screening tool for obstructive sleep apnea in children. Int J Pediatr Otorhinolaryngol 2018;113:62-6. [URL] with permission from Elsevier.

Home overnight pulse oximetry showing multiple clusters of oxygen desaturation is a specific but not sensitive test for obstructive sleep apnoea in children; it can avoid the need for an overnight sleep study in up to 25% of preschool children with a suggestive history. However, a sleep study is required if overnight oximetry is normal in a child with a suggestive history.

Treatment of obstructive sleep apnoea in children

Treatment of obstructive sleep apnoea in children
Overview

Children with features of obstructive sleep apnoea (see Figure 9.25) who are younger than 2 years or have risk factors such as craniofacial abnormalities or Down syndrome should always be referred to a paediatrician with expertise in sleep, or an ear, nose and throat surgeon.

Always refer children with features of obstructive sleep apnoea and risk factors such as craniofacial abnormalities or Down syndrome.

For children 2 years or older with no risk factors, consider referral to an ear, nose and throat surgeon for surgical management if the child has adenotonsillar hypertrophy. If the child does not have adenotonsillar hypertrophy, consider a trial of drug therapy instead of, or while awaiting, specialist referral.

Other interventions for obstructive sleep apnoea in children include noninvasive ventilation (usually continuous positive airway pressure [CPAP]) or craniofacial surgery.

Poorly controlled asthma can worsen obstructive sleep apnoea, and obstructive sleep apnoea can worsen asthma. Optimise management of both conditions in children with coexisting disease. See Asthma maintenance management in children for details about managing asthma in children.

Drug therapy

Consider a trial of drug therapy instead of specialist referral, or while awaiting specialist referral, for children 2 years or older who do not have risk factors (such as craniofacial abnormalities or Down syndrome). Some children experience complete resolution of symptoms with drug therapy and do not require further investigation or referral. Drug therapy may be particularly useful in children with coexisting allergic rhinitis.

Intranasal corticosteroids can reduce nasal obstruction and symptoms of obstructive sleep apnoea. Instruct patients on how to use nasal sprays correctly to minimise drug deposition onto the nasal septum; see Figure 9.10. Use:

1 fluticasone furoate 27.5 micrograms per spray, 1 or 2 sprays into each nostril, once daily *obstructive sleep apnoea (child)*

OR

1 mometasone 50 micrograms per spray, 1 spray into each nostril, once daily. *obstructive sleep apnoea (child)*

Review drug therapy after 4 to 6 weeks. If the child has a good response, continue therapy until symptoms resolve. The optimal duration of treatment has not been studied. Therapy can be restarted if symptoms recur after stopping.

If the child does not respond to intranasal corticosteroid therapy, refer to a paediatric respiratory or sleep physician for assessment, including consideration of a sleep study [Note 1] and surgical management. Consider using combination therapy with an intranasal corticosteroid and montelukast or an oral antihistamine, at the same dosages used for allergic rhinitis, while awaiting referral.

Note 1: Based on the Medicare Benefits Schedule (MBS) criteria, a paediatric sleep study can only be ordered by a sleep physician. See the MBS website for comprehensive and current information.

Surgical management

Adenotonsillectomy is curative in up to 90% of children with obstructive sleep apnoea in the absence of underlying medical problems.

Consider referring children with features of obstructive sleep apnoea (see Figure 9.25) and marked adenotonsillar hypertrophy to an ear, nose and throat surgeon for adenotonsillectomy. Drug therapy can be trialled while awaiting referral.

Adenotonsillectomy can also be considered in children without marked adenotonsillar hypertrophy who do not respond to drug therapy.

If symptoms of obstructive sleep apnoea persist after an adenotonsillectomy, refer the child to a paediatrician with expertise in respiratory or sleep medicine for consideration of a sleep study. [Note 2]

Note 2: Based on the Medicare Benefits Schedule (MBS) criteria, a paediatric sleep study can only be ordered by a sleep physician. See the MBS website for comprehensive and current information.

Central sleep apnoea in children

Central sleep apnoea in children

Central sleep apnoea can occur in children but is far less common than obstructive sleep apnoea. Consider the possibility of central sleep apnoea in children with:

- a history of pauses in breathing but without obstructive symptoms (eg snoring, mouth breathing)
- a history of symptoms associated with poor sleep quality (eg excessive daytime sleepiness, difficulty concentrating, mood changes, morning headaches).

Central sleep apnoea may be related to:

- infancy or prematurity—prolonged apnoeas or periodic breathing during sleep associated with oxygen desaturation or sleep disturbance, usually caused by immaturity of the brainstem
- conditions affecting the nervous system—neurological abnormalities, craniofacial abnormalities, neuromuscular conditions or neuromuscular injury
- conditions affecting chemoreception—congenital central hypoventilation syndrome, obesity hypoventilation syndrome, Prader-Willi syndrome.

Central sleep apnoea can only be diagnosed with a sleep study (polysomnogram [Note 3]). Refer the child to a paediatric respiratory or sleep physician. Screen all children at risk for central sleep apnoea (eg children with Down syndrome or achondroplasia).

Treatment of children with central sleep apnoea is usually by ventilatory support (eg supplemental oxygen or bilevel positive airway pressure [BPAP]) prescribed by a paediatric respiratory or sleep physician. Apnoea of prematurity or infancy may improve as the child gets older and the respiratory centre matures.

Note 3: Based on the Medicare Benefits Schedule (MBS) criteria, a paediatric sleep study can only be ordered by a sleep physician. See the MBS website for comprehensive and current information.

Key references: Obstructive sleep apnoea in children

Key references: Obstructive sleep apnoea in children
Causes of obstructive sleep apnoea in children

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Diagnosis of pleural effusion in adults

Diagnosis of pleural effusion in adults

This topic covers information on the diagnosis of pleural effusion in adults. For diagnosis of pleural effusion and empyema in **children**, seek specialist advice. Information on diagnosis and management of pleural effusion and empyema in children is available from The Royal Children's Hospital (Melbourne) website.

Management of pleural effusion depends on accurate diagnosis of the cause. To help diagnose the cause, determine whether pleural effusions are transudates or exudates using Light's criteria; see the British Thoracic Society guidelines for detailed information on categorisation of pleural effusions. Most transudates occur in patients with heart failure, liver cirrhosis, nephrotic syndrome or those receiving peritoneal dialysis.

Use direct ultrasound guidance to sample pleural fluid by aspiration.

Use direct ultrasound guidance to sample pleural fluid by aspiration. This can be safely undertaken at the bedside using a 21 gauge needle and a syringe. Obtain as large a sample as possible to analyse for biochemistry (which may include pH, lactate dehydrogenase [LDH], protein and glucose), cytology and culture (including for mycobacteria). Note the gross appearance of the fluid (eg colour, clear or cloudy appearance, evidence of blood and clots, purulence). If clinical suspicion of tuberculosis is high, consider a pleural biopsy.

Management of parapneumonic effusion and empyema in adults

Management of parapneumonic effusion and empyema in adults

Introduction to management of parapneumonic effusion and empyema in adults

Introduction to management of parapneumonic effusion and empyema in adults

This topic covers information on the management of parapneumonic effusion and empyema in adults. For management of parapneumonic effusion and empyema in **children**, seek specialist advice. Information on the diagnosis and management of parapneumonic effusion and empyema is available from The Royal Children's Hospital (Melbourne) website.

Parapneumonic effusion is a pleural effusion occurring as a complication of pneumonia; it occurs in up to 50% of pneumonia cases. Parapneumonic effusion is sterile initially, but if not detected and managed appropriately, it may develop into an empyema.

Small parapneumonic effusions (eg incidental small effusions with depth less than 10 mm on lateral decubitus X-ray) do not require pleural fluid sampling and drainage. All clinically significant parapneumonic effusions (eg depth greater than 10 mm on lateral decubitus X-ray or greater than 30 mm on computed tomography [CT], dyspnoea attributable to effusion) require diagnostic pleural fluid sampling, and culture and susceptibility testing of the fluid. For antibiotic management, see Parapneumonic effusion and empyema. Some parapneumonic effusions require drainage; see here for indications.

All **empyemas** require adequate drainage and antibiotic therapy. For antibiotic management, see Parapneumonic effusion and empyema. Intrapleural enzyme therapy or surgery may also be required.

Drainage of parapneumonic effusion and empyema in adults

Drainage of parapneumonic effusion and empyema in adults

Indications for drainage of **parapneumonic effusion** are:

- continued fever and systemic signs of infection despite adequate antibiotic therapy
- large size (more than one-third of the hemithorax)
- loculated pleural effusions
- evidence of continued pleural infection, such as
    - frankly purulent or turbid fluid on sampling
    - presence of bacteria on Gram stain or culture of pleural fluid
    - pleural fluid pH less than 7.2
    - pleural fluid lactate dehydrogenase (LDH) concentration more than 1000 units/L.

Empyema always requires drainage.

Intrapleural enzyme therapy for empyema in adults

Intrapleural enzyme therapy for empyema in adults

Recombinant human DNase (dornase alfa) reduces intrapleural pus viscosity. A randomised controlled study in adults has shown DNase combined with a fibrinolytic (recombinant tissue plasminogen activator [alteplase]), significantly reduces length of hospital stay and the need for surgery, and improves radiographic appearance [Note 1]. Neither drug is registered by the Australian Therapeutic Goods Administration (TGA) for this indication.

Alteplase and dornase alfa can be administered combined in one syringe; although randomised controlled trials of alteplase plus dornase alfa did not combine the two drugs in one syringe, this method has been widely used and has been reported in case series. For adults, use:

alteplase 10 mg *empyema*

PLUS

dornase alfa 5 mg. *empyema*

Combine both drugs in 50 mL sodium chloride 0.9% and inject via intercostal tube; clamp the tube for 2 hours after instillation, then flush it. Give twice daily for 3 days.

Some centres use lower doses of alteplase, longer intervals or shorter courses. Consider stopping treatment before 3 days if empyema has resolved, to reduce risk of bleeding; resolution is indicated by improvement in radiological appearance, reduction in fever, and fall in white cell count and C-reactive protein (CRP).

Intrapleural fibrinolytic enzymes should not be used alone to treat empyema because they do not improve outcomes (mortality, need for surgery, final radiographic appearance) or length of hospital stay.

Note 1: Rahman NM, Maskell NA, West A, Teoh R, Arnold A, Mackinlay C, et al. Intrapleural use of tissue plasminogen activator and DNase in pleural infection. N Engl J Med 2011;365(6):518-26. [URL]

Surgery for empyema in adults

Surgery for empyema in adults

Surgery may be required for patients in whom empyema does not resolve despite adequate antibiotic therapy, intrapleural enzyme therapy and drainage (including the placement of additional catheters under imaging into the other loculations if necessary). Consult a thoracic surgeon for consideration of thoracoscopy, including video-assisted thoracoscopic surgery, or thoracotomy and open drainage.

Persistence of chest X-ray abnormalities in a patient who is clinically well is not an indication for surgery; this usually improves over time.

Management of malignant pleural effusion in adults

Management of malignant pleural effusion in adults

The presence of pleural effusion in malignancy indicates a poor prognosis. Symptomatic malignant pleural effusions usually require drainage. Reaccumulation of fluid after drainage is very common. Treatment with pleurodesis depends on individual patient circumstances and preferences.

Pleurodesis is usually carried out under direct specialist supervision. It can be performed as dry talc poudrage at thoracoscopy, or by instillation of a sclerosant (eg talc slurry) through an intercostal catheter.

Instillation of talc and other sclerosing agents into the pleural space can cause considerable pain, although this is less common in patients with malignant effusion. Pain associated with pleurodesis can be managed with lidocaine before instillation of the sclerosant, and parenteral opioid therapy (both for premedication and for treatment of pain following the procedure).

Placement of a permanent indwelling tunnelled pleural catheter is an alternative to pleurodesis in cases where the lung fails to re-expand (trapped lung) or in the case of patient preference. This is performed in a specialist centre.

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Key references: Pleural effusion in adults

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