Acute exacerbation of chronic obstructive pulmonary disease
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Summary

Acute exacerbation of COPD typically presents with an increased level of dyspnoea, worsening of chronic cough, and/or an increase in the volume and/or purulence of the sputum produced.

May represent the first presentation of COPD, usually associated with a history of tobacco exposure.

Treatment includes bronchodilators, systemic corticosteroids, and antibiotics.

Antibiotics may be reserved for exacerbations thought to be due to bacteria. An acute change in the volume and colour of sputum produced is suggestive of a bacterial trigger.

Definition

Chronic obstructive pulmonary disease (COPD) is "a common, preventable and treatable disease that is characterized by persistent respiratory symptoms and airflow limitation that is due to airway and/or alveolar abnormalities usually caused by significant exposure to noxious particles or gases and influenced by host factors including abnormal lung development."[1]

An exacerbation of COPD may be defined as "an acute worsening of respiratory symptoms that results in additional therapy."[1]
**Epidemiology**

COPD is the fourth leading cause of death worldwide, and the third leading cause of death in the United States.[1] [3] The death rate due to COPD increased over 100% between 1970 and 2002.[4] No other major cause of death in the US has increased at this rate. Globally, COPD has been shown to be responsible for 3.8% of deaths in high-income countries and 4.9% of deaths in low-income countries.[5]

There is significant variability in the prevalence of COPD between countries. [6] [7] [8] This may be due to differing rates of exposure to tobacco smoke and indoor and occupational pollutants.[5] In the UK, the prevalence of COPD diagnosed by physicians between 1990 and 1997 was 2% in men and 1% in women.[9] In the past, men have experienced higher rates of disease due to COPD. This difference has been thought to be due primarily to greater exposure to tobacco smoke and occupational pollutants. Surveys have shown that the prevalence of COPD appears to be becoming more equally distributed between men and women.[7] [10] COPD contributes a significant burden of healthcare costs.[6] Exacerbations are responsible for much of the morbidity and mortality experienced by people with COPD, and the median number per year ranges between 1 and 3.[11] [12] It has been clearly shown that patients with more severe manifestations of COPD have greater rates of mortality over time.[6] However, estimates of mortality may be underestimated, as deaths in this population are often attributed to other aetiologies such as other respiratory disorders, lung cancer, and cardiovascular disease.[6]

Acute exacerbations of COPD are commonly triggered by bacterial or viral pathogens, pollutants, or changes in temperature and humidity, and present with an acute-onset, sustained worsening of the patient's respiratory symptoms, lung function, functional status, and quality of life.[11] [13] [14] [15] [16] [17] [18] Exacerbation rates and all-cause mortality tend to be higher during winter months.[19] Acute exacerbations of COPD, particularly those that are moderate to severe, have significant public health impact, with increased healthcare utilisation and healthcare costs and increased mortality.[20] [21] [22] [23] [24] Early deaths among patients hospitalised with severe COPD exacerbation are often caused by concurrent problems such as pulmonary embolus, pneumonia, or congestive heart failure. [25] Patients may also be at risk of myocardial infarction and stroke in the post-exacerbation period.[26]

**Risk factors**

**Strong bacterial infection**

Bacterial pathogens are thought to be responsible for the majority of acute exacerbations of COPD. Evidence suggests that the presence of purulent sputum is frequently associated with a bacterial lower respiratory tract infection.[58] Because the lower respiratory tract in people with COPD is not sterile, the interpretation of culture results of both upper and lower respiratory tract specimens must be made with caution. There is mixed evidence as to whether greater bacterial colony counts over baseline levels are present in patients with an acute exacerbation of COPD.[59] [60]

The most frequently identified bacterial pathogens include *Haemophilus influenzae*, *Streptococcus pneumoniae*, and *Moraxella catarrhalis*. [31] [51] The role of other gram-positive pathogens such as *Staphylococcus aureus* and gram-negative pathogens such as *Pseudomonas aeruginosa* in the pathogenesis of acute exacerbations of COPD is less certain, but patients with more severe COPD and greater frequency and/or severity of exacerbations, or those who have been hospitalised recently...
or had recent (within 2 weeks) daily use of systemic corticosteroids (i.e., >10 mg/day of prednisolone) are more likely colonised with these pathogens.\[31\] [61]

Of note, it has been shown that acquisition of a new strain of bacteria by people with COPD is a risk for an acute exacerbation.\[62\] Alterations in the innate and/or adaptive immune response may result in cyclical perpetuation of inflammation and infection.\[42\]

Concurrent infection with both bacterial and viral respiratory tract pathogens has been associated with more severe episodes.\[50\] Treatment of moderate to severe exacerbations with antibiotics has been associated with improved outcomes.\[63\] [64\] Influenza vaccination may have protective effect in reducing risk of *Pseudomonas aeruginosa* infection.\[31\]

**gastro-oesophageal reflux and/or swallowing dysfunction**

Gastro-oesophageal reflux and swallowing dysfunction with associated aspiration are common triggers for exacerbations of COPD.\[65\] [66\] Few studies guide whether the treatment of reflux improves exacerbations of COPD. In one observational study of more than 600 patients with stable COPD, treatment with proton pump inhibitors did not decrease the risk for severe exacerbations.\[67\]

**viral infection**

It has been estimated that respiratory viruses are responsible for 22% to 50% of acute exacerbations.\[33\]

The rhinovirus has been isolated from patients with acute exacerbations of COPD more often than other viruses.\[68\]

Influenza, respiratory syncytial virus, parainfluenza, coronavirus, adenovirus, and human metapneumovirus have also been associated with episodes.\[31\] [34\] [35\] [69\]

Exacerbations associated with respiratory viruses have been shown to be more severe and take longer to resolve compared with those attributed to other triggers.\[68\] [70\] Co-infection with viruses and bacterial pathogens is not uncommon.

It has been hypothesised that the chronic presence of respiratory viruses in the lower respiratory tract may play a role in the pathogenesis of COPD.\[71\]

**pollutants**

Increasing levels of pollutants, specifically nitrogen dioxide (NO\textsubscript{2}), sulphur dioxide (SO\textsubscript{2}), ozone (O\textsubscript{3}), and black smoke particulates, including wood smoke, have been associated with a greater rate of acute exacerbations and hospital admissions for people with COPD.\[72\] [73\] [74\] Peaks of air pollution can also increase hospitalisations and mortality.\[75\]

Exposure to many of these pollutants has been found to induce an inflammatory response in the respiratory tract.\[28\]

Short-term exposure to fine particulate matter is associated with increased hospitalisations for acute exacerbations and increased mortality.\[1\]

**Weak**
**Atypical bacterial infection**

Atypical organisms (Mycoplasma pneumoniae, Chlamydia pneumoniae, and Legionella species) have been associated with acute exacerbations though with conflicting results. There is insufficient evidence to suggest that antimicrobial coverage of atypical bacterial pathogens improves outcomes.

**Change in weather**

Changes in temperature and humidity are associated with increased risk for acute exacerbations of COPD. However, it remains unclear whether changes in ambient temperature and/or humidity or changes in risk for infection due to respiratory viruses and/or other pathogens account for this association.

Exacerbation rates and all-cause mortality tend to be higher during winter months.

**Aetiology**

The most common cause of COPD in the developed world is exposure to tobacco smoke. Data have shown that, over time, 50% of chronic smokers develop COPD. The development of COPD is a complex process that is not completely understood. Inflammation, oxidant-antioxidant imbalance, protease-antiprotease imbalance, and several additional processes including recurrent infection, immunosenescence, autoimmunity, altered tissue healing, and other mechanisms are all implicated in the pathogenesis of COPD.

While tobacco smoking is a well-recognised cause of COPD, the risk for developing COPD may also depend on gender, genetic and socioeconomic factors, as well as exposures to dusts, chemicals, or pollutants, and early childhood severe respiratory infection. The genetic risk factor that is best documented is a severe hereditary deficiency of alpha-1 antitrypsin, a major circulating inhibitor of serine proteases.

Acute exacerbations of COPD occur intermittently throughout the course of the disease over the patient's lifetime. Exacerbations vary in severity and are thought to be triggered primarily by infections (both viral and bacterial) and airborne pollutants. In approximately one third of COPD exacerbations, no clear cause can be identified. A careful search for other causes of respiratory decompensation (e.g., congestive heart failure or pulmonary embolus) should be considered in such cases.

During an episode, decreases in the FEV₁, forced vital capacity, and peak expiratory flow may be identified and are due at least in part to airway inflammation. However, exacerbations are diagnosed by the identification of typical signs and symptoms rather than by spirometry.

Bacterial pathogens are thought to be responsible for triggering 50% to 70% of exacerbations. The most common bacterial pathogens include Haemophilus influenzae, Streptococcus pneumoniae, and Moraxella catarrhalis. Atypical bacterial pathogens such as Mycoplasma and Chlamydia pneumoniae are also thought to trigger exacerbations, as are respiratory viruses such as rhinovirus, influenza, respiratory syncytial virus, parainfluenza virus, and human metapneumovirus. The severity of baseline lung function impairment influences the profile of pathogens most likely to be present.

Exacerbations may also be due to environmental pollutants such as smoke particulate matter, sulphur dioxide, nitrogen dioxide, and ozone.
Pathophysiology

Smoking, or other significant exposure to smoke, is noted in most people with COPD. Components of smoke lead to impaired integrity of the tight junctions between lung epithelial cells,[38] stimulate inflammation, and have been shown to decrease respiratory tract mucusciliary clearance, increasing the likelihood of microbial pathogens penetrating the normally sterile lower respiratory tract.[39] [40] [41] The presence of microbial flora leads to antigen presentation and stimulation of the innate and then the adaptive immune response.[42] Over time, chronic irritation by smoke and the inflammatory response leads to emphysema, hypertrophy of airway mucous glands, small airway fibrosis, and a decrease in the elastic recoil of the lung.[43] The decrease in elastic recoil (due to emphysema) and/or obstruction of the small airways due to inflammation, oedema, and hypersecretion of mucus leads to decreased FEV₁ and FEV₁/FVC.[44] Hyperinflation that results from airflow limitation is a main cause of dyspnoea.[45] Unlike asthma, airflow limitation in COPD is not fully reversible with medical therapy.[46] Furthermore, while the pathogenesis of both asthma and COPD is rooted in inflammation, the specific inflammatory process differs between these disorders.[12] However, a substantial number of patients with COPD do have a component of airflow obstruction that is reversible with bronchodilator therapy.[47] Indeed, inhaled bronchodilators (beta-2-agonists and anticholinergics) are one of the primary forms of therapy for all patients with COPD, because, in addition to bronchodilation, they have also been shown to decrease dynamic hyperinflation.[48] [49]

Acute exacerbations of COPD may be defined as an acute worsening of respiratory symptoms (e.g., dyspnoea, cough, sputum production) that results in additional therapy.[1] This worsening appears to result from increases in airway inflammatory cells and proteins that are triggered by an infection, airborne pollutants, and/or other factors.[29] [50] [51] [52] The acute on chronic inflammatory response and/or concurrent bronchoconstriction leads to worsening in expiratory airflow limitation.[14] Worsening of expiratory airflow limitation leads to increased resistive work of breathing, increased ventilation/perfusion mismatch, and gas exchange disturbances. It also results in increased hyperinflation, which then further worsens lung mechanics and can lead to impaired function and fatigue of the respiratory muscles.[14] Due to the difficulty in obtaining specimens from people with exacerbations of COPD, further complicated by heterogeneous triggers, knowledge of the inflammatory response during an episode is incomplete.

Acute exacerbations have significant impact on activity level, functional status, and quality of life experienced by people with COPD.[1] [12] [53] Moreover, recovery from exacerbations may be prolonged, and some patients never regain their prior level of lung function and/or functional status.[11] There is evidence to suggest that exacerbations not only tend to be more frequent and more severe as COPD progresses,[54] [55] but may themselves accelerate the decline in lung function in COPD.[22] Indeed, some patients may also be at increased risk for COPD exacerbations (i.e., have a phenotype of increased susceptibility) independent of disease severity.[55] Currently recommended assessment of COPD patients includes determination of the severity of the airflow obstruction, assessment of symptoms, as well as assessment of the risk of exacerbations. People with severe or very severe airflow obstruction, those with a history of two or more exacerbations in the preceding year, or those with history of hospitalisation due to exacerbation in the previous year are considered at high risk of subsequent exacerbations.[1] Several additional factors are also associated with exacerbations and/or hospitalisations for COPD.[56] [57] COPD exacerbations, particularly those requiring hospitalisation, are associated with increased mortality, as well as significant healthcare costs.[1]
Case history

Case history #1

A 67-year-old woman with a history of COPD presents with 3 days of worsening dyspnoea and increased frequency of coughing. Her cough is now productive of green, purulent sputum. The patient has a 100-pack-year history of smoking. She has had intermittent, low-grade fever of 37.7°C (100°F) for the past 3 days and her appetite is poor. She has required increased use of rescue bronchodilator therapy in addition to her maintenance medications to control symptoms.

Other presentations

COPD often goes unrecognised. By the time that COPD is diagnosed, patients typically experience dyspnoea with only mild to moderate exertion and may have a chronic productive cough, and FEV₁ is often already <50% of predicted level. Many patients are diagnosed with COPD for the first time when they require hospitalisation for an acute exacerbation of disease.[2] Exacerbations may be triggered by an infection or exposure to an airborne pollutant or other change in environmental conditions. Patients commonly present with a complaint of increased dyspnoea, a change in the intensity and frequency of chronic cough and/or wheezing, and a change in the colour and/or volume of sputum produced. Patients experiencing an exacerbation may have a low-grade fever, but the presence of a fever, especially >38.5°C (>101.3°F), should increase suspicion for an alternate diagnosis such as pneumonia.
**Urgent**

Consider whether COVID-19 infection could be causing acute symptoms. In practice, it may be difficult to differentiate between COVID-19 infection and an acute exacerbation of COPD clinically. Arrange a **severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) polymerase chain reaction test** if a patient with COPD presents with new or worsening respiratory symptoms, fever, and/or any other symptoms that could be COVID-19 related, even if these are mild. See our topic [Coronavirus disease 2019 (COVID-19)].

Be alert to the presence or imminent onset of **acute respiratory failure**. Involve your senior team if you suspect this.

Check for signs of life-threatening complications of COPD or common comorbidities, such as **cor pulmonale, haemodynamic instability, heart failure, and sepsis.**

- Investigate and manage with the multidisciplinary team appropriately. Admission to a higher-level care facility (high-dependency unit or intensive care unit) may be necessary.

Be aware that the patient’s status can change quickly.

Perform an arterial blood gas (ABG) to detect chronic hypercapnia and assess for acute respiratory acidosis.

- Patients with acute decompensated respiratory failure with acidaemia (pH <7.35 and PaCO₂ >6.5 kPa) have a poor prognosis.

**In the community**, consider referring the patient to hospital urgently if they have:

- Sudden worsening of resting dyspnoea
- High respiratory rate/acute respiratory failure (>30 breaths/minute)
- Decreased oxygen saturation (SaO₂): SaO₂ <90% on air[88] or deteriorating SaO₂ in patients with known hypoxaemia (i.e., those on long-term oxygen therapy)
- Confusion or drowsiness
- Change in or onset of new physical signs, such as cyanosis or worsening peripheral oedema
- Failure to respond to initial management
- Serious comorbidities that would affect recovery or impact treatment, such as heart failure, atrial fibrillation, or other cardiorespiratory conditions
- Insufficient support at home or in the community treatment setting.

**Key Recommendations**

**Presentation**

**Patients typically present with dyspnoea, cough, and increased sputum purulence and volume** (the cardinal symptoms of an exacerbation of COPD). [1] [88] #

- Document the current degree of shortness of breath using a score validated for exacerbations.
  Define how this has changed from the patient’s baseline and/or the rate of deterioration using previous results or by asking the patient or family/carers.
- **Wheeze** may also be present.[1] [88]
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**Diagnosis**

- Identify any **comorbidities** and any other **focal complaints** (e.g., chest pain, palpitations, light-headedness, or leg swelling).
- **Monitor the patient** using an early warning score, such as the **NEWS2 score**.[92]
- **Check for signs of hyperinflation**.
- **Auscultate**:
  - This may reveal **wheeze and/or crackles** in the presence of concurrent infection or **pneumonia**
  - Note that patients or relatives may describe ‘wheeze’, especially on exertion, that is actually upper airway transmitted noise and not wheeze
  - **Beware a ‘silent chest’** (decreased breath sounds), which may indicate **impending respiratory failure**.

**Diagnostic confirmation**

Make a clinical diagnosis, dependent on the presence and severity of symptoms and a medical history of COPD confirmed by previous spirometry results.[93]

- **Exclude differential diagnoses** that require immediate management, such as acute myocardial infarction or pneumothorax.

**Imaging**

Request a chest x-ray (CXR) to check for pneumonic consolidation[88] and to exclude other diagnoses, such as pneumothorax, lung cancer, or heart failure.

- A CXR is also useful to check for the presence of respiratory, cardiac, or skeletal comorbidities.[1]

**Risk stratification**

Exacerbations are defined by the Global Initiative for Chronic Obstructive Lung Disease (GOLD) as mild, moderate, or severe.[1] Severe exacerbations may have associated acute respiratory failure and should be dealt with in hospital. Mild and moderate exacerbations may be dealt with in primary care or as an outpatient.

- Initial observations and physical examination may be what you base decisions on until further results are available. Once available, these results together with the history and examination findings determine your management and escalation strategy for the patient.
- Assess the severity of the exacerbation using a prognostic score, such as **DECAF** (Dyspnoea, Eosinopenia, Consolidation, Acidaemia, and atrial Fibrillation) or **BAP-65**. The score will indicate which patients are likely to benefit from early intervention, such as non-invasive ventilation.

**Care planning**

Determine escalation policies and ‘ceilings of care’.

- You should:
  - **Assess the patient’s symptoms compared with their baseline functional status**
  - Obtain a **collateral history** urgently
  - Plan with senior colleagues what to do if the patient deteriorates, including ‘ceilings of care’, and consider DNACPR (‘Do Not Attempt Cardiopulmonary Resuscitation’) for patients not suitable for escalation to an intensive care unit.[88]
Full Recommendations

Clinical presentation

Patients typically present with an acute worsening of one or more existing cardinal symptoms over several hours or days (requiring a subsequent change in medication): [1] [88]#

- Dyspnoea
- Cough
- Sputum purulence and volume
- Wheeze
- Chest tightness.

Dyspnoea

A common presenting feature of acute exacerbation of COPD. [1] [88]#

Document the current degree of shortness of breath and exercise tolerance. Use a score validated for exacerbations or refer back to previous score results taken in the stable condition, such as the extended Medical Research Council dyspnoea (eMRCD) scale, which is used in stable COPD to grade the degree of breathlessness according to level of exertion. [94]#

- Define how this has changed from the patient’s baseline and/or the rate of deterioration, if possible, using previous results or by asking the patient or family/carers.
  - This helps determine the escalation strategy and what level of functionality to aim for upon discharge.

Practical tip

Patients may describe breathlessness in terms of reduced exercise capacity. For example, they might report only being able to walk 10 metres for the last couple of days, when they would usually be able to walk 50 metres before feeling short of breath.

Cough

The patient might report an increase in frequency or severity of cough; [1] [88] #often productive.#

- Ask about an increase or change in character compared with the patient’s day-to-day cough.
- Sputum quality may change with exacerbations or superimposed infection.[1] [88]

Sputum purulence and volume

Ask if there is a change to the volume, thickness, or colour of the sputum.

- Investigate for bronchiectasis in patients who repeatedly present with exacerbations with purulent sputum.[1]

An increase in sputum purulence may indicate the presence of bacteria. [1]

- The presence of green sputum has been found to be 94.4% sensitive and 77% specific for the yield of a high bacterial load, identifying a distinct subset of patients in whom bacteria are strongly associated with the exacerbation.[95]
- The most frequently identified bacterial pathogens include Haemophilus influenzae, Streptococcus pneumoniae, and Moraxella catarrhalis. [31] [51]
• Viral infection may also cause increased sputum production alone or lead to an altered environment that may promote secondary bacterial infection.[95]

• Co-infection with viruses and bacterial pathogens is not uncommon.

**Practical tip**
It may be difficult to evaluate sputum production as some patients swallow rather than expectorate it.[1] This will vary from patient to patient, but be aware of this possibility when asking patients about changes to volume or thickness. Ideally **ask for a sample** to assess the colour and thickness yourself.

**Wheeze**

* Auscultate to check for presence of a wheeze. [1] #Beware a ‘silent chest’ (decreased breath sounds), which may indicate impending respiratory failure.#

• May present as prolongation of the expiratory phase of breathing on examination.
• Consider cardiac causes for wheeze or the presence of asthma.[96]

**Practical tip**
Transmitted upper airway noise ‘wheeze’ is common both as a symptom and as a sign. Be aware that patients or relatives may describe ‘wheeze’, especially on exertion, that is actually **upper airway transmitted noise and not wheeze**. Consider this on auscultation. Likewise wheeze heard at the end of the bed is often from the upper airway rather than small airways and may not improve with usual COPD treatment.

**Chest tightness**

* Ask if the patient feels ‘tightness’ in the chest.

• May result from worsened airflow limitation and chest hyperinflation.[14]
• Chest pain is common secondary to coughing and/or increased work of breathing (respiratory muscle discomfort).
• Consider the possibility of an **asthma exacerbation**, **myocardial infarction**, or **pneumothorax** if marked chest tightness or other chest discomfort/pain is present. Involve senior colleagues for appropriate investigation and management.

**Practical tip**
Many patients with COPD are elderly and frail, and may have comorbidities with abnormal baseline parameters. When assessing severity, consider any changes in symptom status relative to the patient’s baseline level rather than using absolute cut-offs.

**Respiratory failure**

* Beware respiratory failure.

**Patients may be peri-arrest due to type 1 (hypoxic) or type 2 (hypercapnic) respiratory failure.**

In consultation with your senior team, arrange admission to a higher-level care facility (high-dependency unit or intensive care unit) if the exacerbation is severe and you detect signs of acute respiratory failure. Observe for: #

• Tachypnoea[1]
• Accessory muscle use[1]
• Chest retractions
• Paradoxical movements of the abdomen
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**Diagnosis**

- Cyanosis
- Confusion
- Drowsiness
- Silent chest.

**History**

Take a detailed history including:

1. **Relevant medical history**
   - **Spirometry-confirmed diagnosis** of COPD.[93]
   - **Ask about previous exacerbations and previous use of non-invasive ventilation**, as patients with a history of two or more exacerbations in the preceding year, or those with a history of hospitalisation due to exacerbation in the previous year, are considered to be at high risk of subsequent exacerbations.[24] [55]
   - **Change in symptoms**: did existing symptoms *worsen*, or are there *new symptoms*? How long have the symptoms been present?
     - Consider taking a collateral history.
   - **Recent infection**: ask the patient if they have had increased cough, breathlessness, or mucopurulent sputum in the last 5 days. Ask if they have had a fever or noticed changes in sputum.
     - Viral infections are the main cause of an exacerbation, with human rhinovirus the most common causative agent.[1]
     - Viral infection may also cause increased sputum production alone or lead to an altered environment that may promote secondary bacterial infection.[95]
     - The most frequently identified bacterial pathogens in exacerbations of COPD include *H influenzae*, *S pneumoniae*, and *M catarrhalis*.[31] [51]
     - Co-infection with viral and bacterial pathogens is not uncommon.
   - **Consider differential diagnoses**, such as acute exacerbation of asthma and heart failure.
   - Ask about gastro-oesophageal reflux and/or swallowing dysfunction, a possible trigger for exacerbations of COPD.[65] [66]

2. **Risk factors for an exacerbation**

   **Practical tip**

   When asking a patient about previous exacerbations, bear in mind that they may not think in terms of ‘exacerbations’ but might instead explain that they received antibiotics and corticosteroids for a previous ‘chest infection’. It might help to ask about the constellation of symptoms experienced (increased cough, breathlessness, and mucopurulent sputum) or to ask specific questions about previous:
   - Hospital visits
   - GP visits
   - Courses of oral corticosteroids or antibiotics.

   * Some patients keep corticosteroids as stand-by medication at home and therefore will be able to take a course without seeing a healthcare provider.

   Symptoms of an exacerbation usually last 7 to 10 days, though may be longer.[1]
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**Diagnosis**

- **Smoking**: check if the patient currently smokes and/or they have had significant exposure to tobacco smoke.[88] [93]
- **Exposure to pollution**[88] ask about wood smoke, dust, and other pollutants. This may include biofuel exposure from cooking over an open fire indoors. Check the patient’s occupation. It may expose them to pollutants or irritants that would cause an exacerbation.
- Short-term exposure to fine particulate matter is associated with increased hospitalisations for acute exacerbations and increased mortality.[1]

3. **Medication**

- Check the patient’s **adherence to routine COPD medication**.
- Ask about **previous use of antibiotics** (for COPD exacerbations or for other conditions). This may have led to resistant bacteria.[97]
- Ask about **recent use of oral corticosteroids**. This may impact the available duration for further courses of corticosteroids. Consider the need to wean the dose down gradually at the time of stepping down medication.
- Check if the patient currently uses **supplemental oxygen**.
- Check if there has been any change in the patient’s use of a **rescue inhaler**.

**Physical examination**

Physical findings vary according to the severity of the exacerbation. Remember that the patient’s status can change quickly.

- Use an **ABCD (Airway, Breathing, Circulation, Disability, Exposure) approach** to assess the patient. In hospital, involve your senior team when needed.

**Be alert for the presence or imminent onset of respiratory failure.** Observe for:

- **Tachypnoea**[1]
- Accessory muscle use (which may be accompanied by pursed lip breathing)[1]
- Chest retractions
- Paradoxical movements of the abdomen
- Cyanosis
- Confusion[1]
- Drowsiness [1]
- Silent chest.

Arrange for **admission to a higher-level care facility** (high-dependency unit or intensive care unit) if the exacerbation is severe and if there are **signs of acute respiratory failure** (in consultation with your senior team).

**Perform a physical examination of the patient.**

- **Determine**: [88]
  
  - **Vital signs** (including **SaO₂** via pulse oximetry or **ABG**)[98]
    
    - All measurements of a patient’s oxygen level – via pulse oximetry or ABG – should have the fraction of inspired oxygen (FiO₂) or O₂ flow rate documented
  
  - **Mental status**
    
    - Ability to continue to provide self-care at home.
  
  - In the absence of a spirometry-confirmed diagnosis of COPD (check the patient’s notes), arrange **spirometry** if the patient is admitted to hospital for an exacerbation. [93]
• During periods of high prevalence of COVID-19 in the community, spirometry should be restricted to patients requiring urgent or essential tests for the diagnosis of COPD and/or to assess lung function status for interventional procedures or surgery. Performing spirometry and pulmonary function testing may lead to SARS-CoV-2 transmission as a result of droplet and aerosol formation during the tests, especially with coughing.

• Auscultate, checking for presence of wheeze and/or crackles if concurrent infection or pneumonia.

• Note pulse rate and rhythm.

• Atrial fibrillation is a common comorbidity and forms part of the DECAF score, a prognostic score that is used to predict in-hospital mortality.

Use initial observations and physical examination to guide early management decisions until investigations are under way. As test results become available, use these in conjunction with history and examination findings to determine management and escalation strategies for the patient.

Comorbidities

Check and monitor for signs of life-threatening complications of an acute exacerbation of COPD or comorbidities, such as cor pulmonale, haemodynamic instability, and sepsis.

• Investigate any sinister symptoms, and manage in line with recommended approaches.

• Involve your senior team; admission to a higher-level care facility (high-dependency unit or intensive care unit) may be necessary.

Check for signs of haemodynamic instability, such as:

• Pale, clammy skin

• Peripheral cyanosis

• Diminished urine output.

Check for a decline in mental status, which may indicate respiratory failure or sepsis:

• Confusion

• Drowsiness

• Reduced consciousness.

Also check for any findings that may indicate an alternative diagnosis, such as pneumonia, bronchiectasis, lung cancer, pneumothorax, or heart failure.

Evidence: Causes of early death in patients hospitalised with COPD exacerbation

Consider comorbidities and complications of COPD contributing to the mortality risk.

A retrospective study looked at the autopsy results of 43 patients with a hospital admission diagnosis of COPD exacerbation. All had died within 24 hours of admission to hospital.
Diagnosis

- Respiratory failure due to a progression of COPD was the primary cause of death in only six patients (14%), highlighting the importance of considering comorbidities and complications of COPD.
- The main (primary) causes of death were reported as:
  - Cardiac failure (n = 16; 37.2%)
  - Pneumonia (n = 12; 27.9%)
  - Pulmonary thromboembolism (PTE) (n = 9; 20.9%).
- The study concludes that there should be a focus on recognising and treating these conditions at the time of hospital admission. [25]

Cor pulmonale

Cor pulmonale may develop as a result of increased pulmonary artery hypoxaemic vasoconstriction due to exacerbation-induced hypoxaemia. The resulting increase in pulmonary vascular resistance and/or pulmonary artery pressure can lead to acute right heart failure.

If you suspect cor pulmonale, exclude other causes of peripheral oedema and make a clinical diagnosis based on the presence of: [88]

- Peripheral oedema
- Elevated jugular venous pressure
- Hepatojugular reflux
- Systolic parasternal heave
- Relative hypotension
- Loud pulmonary second heart sound.

These signs may be difficult to define in practice due to the presence of a hyperinflated chest.

Treat cor pulmonale caused by COPD by managing the COPD exacerbation. [88] 

- Use diuretics to control oedema.
- Review the patient’s current medications.
- Do not use the following medications to treat cor pulmonale caused by COPD: [88]
  - Alpha-blockers
  - ACE inhibitors
  - Calcium-channel blockers
  - Digoxin (unless there is atrial fibrillation).
  - Consider assessment for long-term oxygen therapy as an outpatient.

Care planning

Early in your assessment, determine escalation policies and ‘ceilings of care’ with colleagues, the patient, and relatives. These are difficult conversations and can be distressing for patients. However, planning in this way avoids making hasty or ill-thought-out decisions later on.

- Assess the exacerbation symptoms compared with the patient’s baseline functional status to help determine the escalation strategy.
Acute exacerbation of chronic obstructive pulmonary disease

**Diagnosis**

- Plan with senior colleagues what to do if the patient deteriorates, including 'ceilings of care';[88] consider DNACPR for patients not suitable for escalation to an intensive care unit.

- Referral to intensive care (with a view to intubate and ventilate) is appropriate for many patients but, even if successful, may be associated with ICU-related complications.
- Establish the existence of any advance directives. Some patients may express wishes not to be referred to higher-level care.
- Consider palliative care for appropriate patients with advanced disease.

**Use a planning tool, such as the AMBER care bundle.** [The AMBER care bundle] #

**Practical tip**

The AMBER care bundle is a communication and planning tool used in hospitals in the UK. It supports a systematic approach for clinical teams to proactively manage the care of hospital patients who are facing an uncertain recovery and who are at risk of dying despite treatment. AMBER reflects the need for close attention to:

- **A**ssessment
- **M**anagement
- **B**est practice
- **E**ngagement
- **R**ecovery uncertain.

In practice, this means:

1. Talk to the patient and their family to let them know that the healthcare team has concerns about their condition; establish their preferences and wishes
2. Decide together how the patient will be cared for should their condition get worse
3. Document a medical plan
4. Agree these plans with all members of the clinical team.

Monitor the patient's condition closely and ensure daily follow-up. Record any changes and address any concerns that they or their family may have. [The AMBER care bundle]

**Severity and treatment setting**

There are no absolute criteria to determine the most appropriate treatment setting. Consider the full clinical picture in the context of the patient’s usual state.

- **Assess severity** to determine where and how to treat the patient.[1][88]
- Use clinical assessment and the change in symptoms from the patient's baseline to gauge the severity of an exacerbation.
- Take into account frailty and comorbidities.
- Consult senior colleagues if you are uncertain of the best treatment setting.
- Not all people with an exacerbation of COPD will require admission to hospital. It is safe to treat some patients in the community.

- Some patients can manage an exacerbation themselves at home or at a community setting, with an appropriate management plan.
- Along with the clinical presentation, a good understanding of the patient’s social and functional history as well as knowledge of the local services and support available will help to guide your decision on the best treatment setting for the patient.

Both GOLD and National Institute for Health and Care Excellence guidelines stratify exacerbations into mild, moderate, and severe, based on the management required: [1][88] #
Acute exacerbation of chronic obstructive pulmonary disease

Diagnosis

Assess severity to determine where and how to treat the patient

- Use pulse oximetry and ABG (when available) to help determine severity of an exacerbation, acknowledging that values will need to be compared against the patient’s baseline.
- When assessing severity, you should also take into account frailty, as well as cardiorespiratory complications and other co-morbidities.

**Mild**

- NICE: Increased need for medication, which they can manage in their own normal environment
- GOLD: Treated with short-acting bronchodilators only

**Moderate**

- NICE: A sustained worsening of respiratory status that requires treatment with systemic corticosteroids and/or antibiotics
- GOLD: Treated with short-acting bronchodilators plus antibiotics and/or oral corticosteroids

**Severe**

- NICE: A rapid deterioration in respiratory status that requires hospitalisation
- GOLD: Requires hospitalisation or presents to emergency department. May be associated with acute respiratory failure

Mild and moderate exacerbations may be dealt with in the community (depending on the cause of the exacerbation and the patient’s social factors)

As severe exacerbations may have associated acute respiratory failure, they should be dealt with in hospital

Referring to hospital

In the community, consider referring the patient to hospital urgently if they have:

- Sudden worsening of resting dyspnoea
- High respiratory rate/acute respiratory failure (>30 breaths/minute)
- Decreased oxygen saturations: SaO₂ <90% on air[88] or deteriorating SaO₂ in patients with known hypoxaemia (i.e., those on long-term oxygen therapy)
- Confusion or drowsiness
- Change in or onset of new physical signs, such as cyanosis or worsening peripheral oedema
- Failure to respond to initial management
- Serious comorbidities that would affect recovery or impact treatment, such as heart failure, atrial fibrillation, or other cardiorespiratory conditions
- Insufficient support at home or in the community treatment setting.
Severity assessment in hospital

In hospitalised patients, assess the severity of the exacerbation using a prognostic score, such as DECAF [101] or BAP-65.

- The score will indicate which patients are likely to benefit from early intervention, such as non-invasive ventilation.

Further stratify hospitalised patients based on their clinical signs. [1] #

- **No respiratory failure**
  - Respiratory rate 20 to 30 breaths/minute
  - No use of accessory respiratory muscles
  - No change in mental status
  - Supplemental oxygen given via Venturi mask up to 28% to 35% inspired oxygen (FiO₂) restores oxygen saturations
    - Ensure that there is no evidence of hypercapnia before moving to higher concentrations of oxygen
    - Perform ongoing assessment of ABGs
    - Document the FiO₂ or O₂ flow rate
  - No increase in PaCO₂.

- **Acute respiratory failure – non-life threatening**
  - Respiratory rate >30 breaths/minute
  - Using accessory respiratory muscles
  - No change in mental status
  - Hypoxaemia improves when supplemental oxygen at higher concentrations is given via Venturi mask
    - Ensure that there is no evidence of hypercapnia before moving to higher concentrations of oxygen
    - Perform ongoing assessment of ABGs
    - Document the FiO₂ or O₂ flow rate
  - PaCO₂ increased compared with baseline or elevated approximately 6.7 kPa (50-60 mmHg).

- **Acute respiratory failure – life threatening**
  - Respiratory rate >30 breaths/minute
  - Using accessory respiratory muscles
  - Acute changes in mental status
  - Hypoxaemia not improved with supplemental oxygen via Venturi mask or increased FiO₂
    - You must ensure that there is no evidence of hypercapnia before moving to higher concentrations of oxygen
    - Perform ongoing assessment of ABGs
    - Document the FiO₂ or O₂ flow rate
  - PaCO₂ increased compared with baseline or elevated approximately 8 kPa (>60 mmHg) or acidosis present.
Acute exacerbation of chronic obstructive pulmonary disease

Diagnosis

Investigations

ABG (in hospital)#
Perform in patients with a moderate to severe acute exacerbation of COPD, when there is any evidence of hypercapnia, in all hypoxic patients, in all patients requiring oxygen, and in all patients who seem unwell.

- Use to detect chronic hypercapnia and assess for acute respiratory acidosis.
- Ensure you compare results with prior baseline ABG (when available).
- Document the FiO$_2$ or O$_2$ flow rate of any supplemental oxygen given (controlled oxygen given via a Venturi mask).
  - Performing the ABG while the patient is on controlled oxygen allows the A-a gradient to be established.
  - PaO$_2$ <8.0 kPa (approximately 60 mmHg) indicates respiratory failure.
  - pH <7.35 and PaCO$_2$ >6.5 kPa define acute respiratory acidosis.[102]
  - Acidaemia implies a severe exacerbation and predicts in-hospital and 30-day mortality.[103]
  - Repeat after 30 to 60 minutes of treatment with controlled oxygen and bronchodilators to check for a rise in PaCO$_2$ or a fall in pH.[98]
  - If possible, perform a blood gas analysis within 30-60 minutes of starting acute NIV.
  - Although the British Thoracic Society (BTS) recommends performing blood gas analysis within 2 hours of starting acute NIV,[104] in practice, specialists recommend ideally waiting only 30-60 minutes to check for changes in PaCO$_2$ and pH.
  - Arrange review by a specialist healthcare professional with expertise in managing patients on NIV within 30 minutes if blood gas measurements fail to improve. [104]
- Venous blood gas sampling is not considered a reliable alternative measure. [105]

Practical tip

Some patients with known hypoxaemia (e.g., those on long-term oxygen therapy) may have low oxygen saturations usually. However, deteriorating SaO$_2$ is concerning and should warrant an urgent assessment.

Pulse oximetry (in hospital and in the community)

In hospital, use pulse oximetry at presentation to measure oxygen saturations as part of vital signs. [1] [98] In the community, use pulse oximetry if there are clinical features of a severe exacerbation. [88]

- Ensure a good pulse wave is picked up by the device.
- During an exacerbation, oxygen saturation is frequently depressed below the patient's baseline level.
- Document the FiO$_2$ or O$_2$ flow rate if supplemental oxygen is given.

ECG (in hospital and in the community if available)#

Perform an ECG, as cardiovascular disease is common in people with COPD. [106] #

- Consider a myocardial infarction or pneumothorax if chest tightness or other chest discomfort is present. However, note that chest tightness is also a symptom of COPD due to airflow limitation and chest hyperinflation.
Acute exacerbation of chronic obstructive pulmonary disease

**Diagnosis**

- Patients with COPD are at higher risk of developing cardiac ischaemia and/or arrhythmias, such as new-onset atrial fibrillation, that can also lead to dyspnoea.

**FBC with platelets (in hospital)**

*Perform in patients with moderate to severe exacerbations.*

- Screens for abnormalities that may suggest additional medical disorders, such as infection or anaemia.

**Urea, electrolytes, and creatinine (in hospital)**

*Perform in patients with moderate to severe exacerbations.*

- An abnormal result may suggest additional medical disorders.
- Patients with COPD exacerbations may have decreased oral intake and may become volume depleted.

**CRP (in hospital)**

*Perform in patients with moderate to severe exacerbations.*

- An abnormal result may suggest presence of infection.

**CXR (in hospital)**

*Request for patients with moderate to severe disease and/or suspected pneumonia.*

*Can be used to exclude differential or comorbid diagnoses, including pneumothorax, congestive heart failure, and pleural effusion.*

*Radiological changes seen in COPD include (but be aware these are not diagnostic of an exacerbation):*

- Flattened diaphragm and increased retrosternal air space volume, indicating lung hyperinflation
- Hyperlucency of the lungs
- Rapid tapering of vascular markings.[1]

**Sputum microscopy, culture, and Gram stain (in hospital)**

*Obtain for potential bacterial pathogens that may have triggered the episode. Use in severe disease and if hospitalisation is being considered.*

- **Not a routine investigation in primary care.**
- The most frequently identified bacterial pathogens include *H influenzae*, *S pneumoniae*, and *M catarrhalis*. [31] [51]

**Vitamin D (in hospital or in the community)**

*Once they are stable, investigate all patients who have required hospitalisation for an exacerbation of COPD for vitamin D deficiency. Vitamin D levels are lower in patients with COPD. Supplementation of patients with severe deficiency results in a reduction in exacerbations and hospitalisation. Assess for severe vitamin D deficiency (<10 ng/mL or <25 nM) and supplement if required.[1]*
Further investigations sometimes required in hospital

Blood cultures
Request if the patient has pyrexia.

Respiratory virus diagnostics
Consider in severe disease.

- Use to identify any treatable agent.
- Use to identify the need for expanded infection control precautions in hospital.

Cardiac troponin
Assess for an elevation, which would indicate myocardial injury.

- COPD exacerbations can lead to myocardial injury.
- Elevations in troponin may be associated with increased mortality.[107]

Serum theophylline level
Measure on admission for patients who are taking theophylline or aminophylline therapy.

Pro-brain natriuretic peptide
Use to exclude heart failure, a key differential of COPD exacerbation.

CT scan of chest
Use to exclude alternative diagnoses if the diagnosis and basis of respiratory decompensation remains uncertain after routine CXR.

- May identify a pulmonary embolus, pneumonia, pleural effusion, or a malignancy.

Spirometry
If there is no recorded spirometry result, and the patient is admitted to hospital for an exacerbation, arrange spirometry to confirm diagnosis of COPD.[93] The presence of a post-bronchodilator FEV₁/FVC <0.70 confirms the presence of persistent airflow limitation.

During periods of high prevalence of COVID-19 in the community, spirometry should be restricted to patients requiring urgent or essential tests for the diagnosis of COPD, and/or to assess lung function status for interventional procedures or surgery.[1] [99] Performing spirometry and pulmonary function testing may lead to SARS-CoV-2 transmission as a result of droplet and aerosol formation during the tests, especially with coughing.

Practical tip

Do not routinely order a chest CT. Only request a chest CT if you suspect malignancy, a pulmonary embolus, or bronchiectasis, or when considering surgery.[1] [88]

Do not assess the patient using peak flow as an acute investigation. This is not recommended for assessment of an exacerbation due to the results being of lower quality[108] or
unreliable. In practice, patients are often unable to perform a good-quality forced expiratory manoeuvre during an acute exacerbation.

**Emerging investigations**

**Procalcitonin**

Procalcitonin is being investigated as a biomarker for the diagnosis of bacterial infections. [109] [110]

- Higher levels of procalcitonin have been detected in severe bacterial infections. [109]
- It may have a function in guiding when to use antibiotics for the treatment of lower respiratory tract infection; however, this is unclear.
- A Cochrane review of the use of procalcitonin to guide initiation and duration of antibiotic treatment in people with acute respiratory tract infections found it lowered the risk of mortality, and led to lower antibiotic consumption and lower risk for antibiotic-related side effects in all patients, including those with acute exacerbation of COPD. [109] Further research is required to establish its use in clinical practice.
- In a separate analysis of 1656 patients, 826 were randomly assigned to a group where the decision on whether to provide antibiotics was based on the results of a procalcitonin assay (830 patients were given usual care). [110]
- The assay results did not result in less use of antibiotics.

  - There was no significant difference between the procalcitonin group and the usual-care group in antibiotic-days (mean 4.2 and 4.3 days, respectively; difference −0.05 days; 95% CI −0.6 to +0.5; P = 0.87) or the proportion of patients with adverse outcomes (11.7% [96 patients] and 13.1% [109 patients]; difference −1.5 percentage points; 95% CI, −4.6 to +1.7; P <0.001 for non-inferiority) within 30 days. [110]

**Point-of-care C-reactive protein (CRP)**

Point-of-care CRP testing safely reduces antibiotic use in patients with acute exacerbations of COPD. [111]

- Raised levels of CRP suggest the presence of bacterial infection.
- In the community, it is difficult to rapidly determine whether an acute exacerbation is due to an infection, and antibiotics are often prescribed in case there is an underlying bacterial infection.
- A randomised controlled trial of the use of point-of-care CRP testing to guide antibiotic prescribing for COPD exacerbations found it reduced unnecessary antibiotic use, without compromising safety or patient outcomes. [111]

**History and exam**

**Key diagnostic factors**

**dyspnoea (common)**

A sustained increase from the baseline level of dyspnoea beyond day-to-day variation is the key symptom of an exacerbation. [1] [88]

- Document the current degree of shortness of breath and exercise tolerance.

  - Use a score validated for exacerbations or refer back to previous score results taken in the stable condition, such as the extended Medical Research Council dyspnoea (eMRCD)
scale, which is used in stable COPD to grade the degree of breathlessness according to level of exertion.[94]

- Define how this has changed from the patient’s baseline and/or the rate of deterioration, if possible, using previous results or by asking the patient or family/carers.

  - This helps determine the escalation strategy and what level of functionality to aim for upon discharge.

Practical tip

Patients may describe breathlessness in terms of reduced exercise capacity. For example, they might report only being able to walk 10 metres for the last couple of days when they would usually be able to walk 50 metres before feeling short of breath.

cough (common)

The patient might report an increase in frequency or severity of cough; [1] [88] #often productive.#

  - An increase or change in character compared with the patient’s day-to-day cough.
  - Sputum quality may change with exacerbations or superimposed infection.[1] [88]

increased sputum purulence and volume (common)

Ask if there is a change to the volume, thickness, or colour of the sputum.

  - Investigate for bronchiectasis in patients who repeatedly present with exacerbations with purulent sputum.[1]

An increase in sputum purulence may indicate the presence of bacteria. [1]

  - The presence of green sputum has been found to be 94.4% sensitive and 77% specific for the yield of a high bacterial load , identifying a distinct subset of patients in whom bacteria are strongly associated with the exacerbation.[95]
  - The most frequently identified bacterial pathogens include Haemophilus influenzae , Streptococcus pneumoniae , and Moraxella catarrhalis . [31] [51]
  - Viral infection may also cause increased sputum production alone or lead to an altered environment that may promote secondary bacterial infection.[95]

  - Co-infection with viruses and bacterial pathogens is not uncommon.

Practical tip

It may be difficult to evaluate sputum production as some patients swallow rather than expectorate it.[1] This will vary from patient to patient, but be aware of this possibility when asking patients about changes to volume or thickness. Ideally ask for a sample to assess the colour and thickness yourself.

wheeze (common)

Auscultate to check for presence of a wheeze. [1] #Beware a 'silent chest' (decreased breath sounds), which may indicate impending respiratory failure.#
Acute exacerbation of chronic obstructive pulmonary disease

**Diagnosis**

- May present as prolongation of the expiratory phase of breathing on examination.
- Consider cardiac causes for wheeze or the presence of asthma.[96]

**Practical tip**

Transmitted upper airway noise 'wheeze' is common both as a symptom and as a sign. Be aware that patients or relatives may describe 'wheeze', especially on exertion, that is actually upper airway transmitted noise and not wheeze. Consider this on auscultation. Likewise wheeze heard at the end of the bed is often from the upper airway rather than small airways and may not improve with usual COPD treatment.

**chest tightness/chest pain (common)**

Ask if the patient feels 'tightness' in the chest.#

- May result from worsened airflow limitation and chest hyperinflation.[14]
- Chest pain is common secondary to coughing and/or increased work of breathing (respiratory muscle discomfort).
- Consider the possibility of an asthma exacerbation, myocardial infarction, or pneumothorax if marked chest tightness or other chest discomfort/pain is present. Involve senior colleagues for appropriate investigation and management.

**Practical tip**

Many patients with COPD are elderly and frail, and may have comorbidities with abnormal baseline parameters. When assessing severity, consider any changes in symptom status relative to the patient’s baseline level rather than using absolute cut-offs.

**tachypnoea (common)**

Use an Airway, Breathing, Circulation, Disability, Exposure (ABCDE) approach to assess the patient. In hospital, involve your senior team when needed.

- Observe for tachypnoea.
- Be alert for the presence or imminent onset of respiratory failure.

**tachycardia (common)**

Note pulse rate and rhythm.

- Atrial fibrillation is a common comorbidity and forms part of the DECAF (Dyspnoea, Eosinopenia, Consolidation, Acidaemia, and atrial Fibrillation) score, a prognostic score that is used to predict in-hospital mortality.[101]

**risk factors (common)**

Take a history covering the likely risk factors for an exacerbation of COPD, including:

**Spirometry-confirmed diagnosis of COPD#**

Ask about previous exacerbations and previous use of non-invasive ventilation, as patients with a history of two or more exacerbations in the preceding year, or those with a
Acute exacerbation of chronic obstructive pulmonary disease

**Diagnosis**

- Review the patient's notes to check for recent spirometry results confirming a diagnosis of COPD.[93] #If there is no recorded spirometry result, and the patient is admitted to hospital for an exacerbation, arrange spirometry to confirm diagnosis of COPD.[93] During periods of high prevalence of COVID-19 in the community, spirometry should be restricted to patients requiring urgent or essential tests for the diagnosis of COPD and/or to assess lung function status for interventional procedures or surgery.[1] [99]
- **Ask about a change in symptoms**: did existing symptoms worsen, or are there new symptoms? How long have the symptoms been present?

**Recent infection** [1] [88]

Ask the patient if they have had increased cough, breathlessness, or mucopurulent sputum in the last 5 days. Ask if they have had a fever or noticed changes in sputum.

- Viral infections are the main cause of an exacerbation, with human rhinovirus the most common causative agent.[1]
- Viral infection may also cause increased sputum production alone or lead to an altered environment that may promote secondary bacterial infection.[95]
- The most frequently identified bacterial pathogens in exacerbations of COPD include *Haemophilus influenzae*, *Streptococcus pneumoniae*, and *Moraxella catarrhalis*. [31] [51]
- Co-infection with viral and bacterial pathogens is not uncommon.

**Practical tip**

When asking a patient about previous exacerbations, bear in mind that they may not think in terms of 'exacerbations', but might instead explain that they received antibiotics and corticosteroids for a previous 'chest infection'.

It might help to ask about the constellation of symptoms experienced (increased cough, breathlessness, and mucopurulent sputum) or to ask specific questions about previous:

- Hospital visits
- GP visits
- Courses of oral corticosteroids or antibiotics.

- Some patients keep corticosteroids as stand-by medication at home and therefore will be able to take a course without seeing a healthcare provider.

Symptoms of an exacerbation usually last 7 to 10 days, though may be longer.[1]

**Smoking**

Check if the patient currently smokes and/or they have had significant exposure to tobacco smoke. [88] #

**Exposure to pollution** [88]

Ask about wood smoke, dust, and other pollutants.

- This may include biofuel exposure from cooking over an open fire indoors.
Acute exacerbation of chronic obstructive pulmonary disease

Diagnosis

- Check the patient’s occupation. It may expose them to pollutants or irritants that would cause an exacerbation.
- Short-term exposure to fine particulate matter is associated with increased hospitalisations for acute exacerbations and increased mortality.[1]

Cor pulmonale (common)

Cor pulmonale may develop as a result of increased pulmonary artery hypoxaemic vasoconstriction due to exacerbation-induced hypoxaemia. The resulting increase in pulmonary vascular resistance and/or pulmonary artery pressure can lead to acute right heart failure.

If you suspect cor pulmonale, exclude other causes of peripheral oedema and make a clinical diagnosis based on the presence of: [88]

- Peripheral oedema
- Elevated jugular venous pressure
- Hepatojugular reflex
- Systolic parasternal heave
- Relative hypotension
- Loud pulmonary second heart sound.

These signs may be difficult to define in practice due to the presence of a hyperinflated chest.

Other diagnostic factors

Signs of respiratory failure (uncommon)

Assess for signs suggestive of respiratory failure. In consultation with your senior team, arrange admission to a higher-level care facility (high-dependency unit or intensive care unit) if the exacerbation is severe and you detect signs of acute respiratory failure.#

Change in mental status [1]#

Look for drowsiness, confusion, personality change, irritability.

Morning headaches

Sign of worsening hypercapnic ventilatory failure.

- This may be accompanied by increased daytime somnolence.

Malaise and fatigue

These symptoms and other non-specific symptoms such as insomnia, decreased activity level, and loss of appetite are commonly identified in people with an acute exacerbation of COPD. [112] [113] #

- These symptoms have a great impact on quality of life, but are not on their own diagnostic of an exacerbation.
**Acute exacerbation of chronic obstructive pulmonary disease**

**Diagnosis**

**Accessory muscle use**
Sign of impending respiratory failure.

- This may be accompanied by pursed lip breathing.

**Paradoxical movements of abdomen**
Sign of impending respiratory failure.

- More common when there is respiratory muscle weakness.

**fever (uncommon)**
May be a sign of bacterial infection meaning antibiotic therapy is required.

- Consider a bacterial pneumonia or influenza virus infection if there is a high and/or persistent fever.

**gastro-oesophageal reflux and/or swallowing dysfunction (uncommon)**
A possible trigger for exacerbations of COPD. [65] [66] #

- No available studies guide whether the treatment of reflux improves exacerbations of COPD.
Investigations

1st test to order

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>arterial blood gas (in hospital)</td>
<td>• PaO₂ &lt; 8.0 kPa (approximately 60 mmHg) indicates respiratory failure</td>
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Perform in patients with a moderate to severe acute exacerbation of COPD, when there is any evidence of hypercapnia, in all hypoxic patients, in all patients requiring oxygen, and in all patients who seem unwell.

- Use to detect chronic hypercapnia and assess for acute respiratory acidosis.
- Ensure you compare results with prior baseline ABG (when available).
- Document the fraction of inspired oxygen (FiO₂) or O₂ flow rate of any supplemental oxygen given (controlled oxygen given via a Venturi mask).

  - Performing the ABG while the patient is on controlled oxygen allows the A-a gradient to be established.
  - PaO₂ < 8.0 kPa (approximately 60 mmHg) indicates respiratory failure.
  - pH < 7.35 and PaCO₂ > 6.5 kPa define acute respiratory acidosis.[102]

  • Acidaemia implies a severe exacerbation and predicts in-hospital and 30-day mortality.[103]
  - Repeat the ABG after 30 to 60 minutes of treatment with controlled oxygen and bronchodilators to check for a rise in PaCO₂ or a fall in pH.[98]
  - If possible, perform a blood gas analysis within 30-60 minutes of starting acute NIV.

  • Although the British Thoracic Society (BTS) recommends performing a blood gas analysis within 2 hours of starting acute NIV,[104] in practice, specialists recommend ideally waiting only 30-60 minutes to check for changes in PaCO₂ and pH.
  - Arrange review by a specialist healthcare professional with expertise in managing patients on NIV within 30 minutes if blood gas measurements fail to improve.[104]
  - Venous blood gas sampling is not considered a reliable alternative measure.[105]

Practical tip

Some patients with known hypoxaemia (e.g., those on long-term oxygen therapy) may have low oxygen saturations usually. However, deteriorating oxygen saturation is concerning and should warrant an urgent assessment.
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| • Ensure a good pulse wave is picked up by the device.  
  • During an exacerbation, oxygen saturation is frequently depressed below the patient’s baseline level.  
  • Document the fraction of inspired oxygen (FiO₂) or O₂ flow rate if supplemental oxygen is given. |
| **ECG (in hospital and in the community if available)** | **may be right heart enlargement, arrhythmia, ischaemia** |
| Perform an ECG as cardiovascular disease is common in people with COPD. [106] # |
| • Consider a myocardial infarction or pneumothorax if chest tightness or other chest discomfort is present. However, note that chest tightness is also a symptom of COPD due to airflow limitation and chest hyperinflation.  
  • Patients with COPD are at higher risk of developing cardiac ischaemia and/or arrhythmias, such as new-onset atrial fibrillation, that can also lead to dyspnoea. |
| **FBC with platelets (in hospital)** | **may show elevated haematocrit, elevated WBC count, or anaemia** |
| Perform in patients with moderate to severe exacerbations. |
| • Screens for abnormalities that may suggest additional medical disorders, such as infection or anaemia. |
| **urea, electrolytes, and creatinine (in hospital)** | **usually normal** |
| Perform in patients with moderate to severe exacerbations. |
| • An abnormal result may suggest additional medical disorders.  
  • Patients with COPD exacerbations may have decreased oral intake and may become volume depleted. |
| **CRP (in hospital)** | **elevated CRP suggests presence of infection** |
| Perform in patients with moderate to severe exacerbations. |
| • An abnormal result may suggest presence of infection. |
| **CXR (in hospital)** | **hyperinflation, flattened diaphragm, increased retrosternal air space (seen on lateral x-ray, if performed), bullae, and a small vertical heart suggest COPD, but are** |
| Request for patients with moderate to severe disease and/or suspected pneumonia. |
| Can be used to exclude differential or comorbid diagnoses, including pneumothorax, congestive heart failure, and pleural effusion. |
### Test

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# Other tests to consider

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</tr>
<tr>
<td>Request if the patient has pyrexia.</td>
<td></td>
</tr>
<tr>
<td><strong>respiratory virus diagnostics</strong></td>
<td>• may confirm viral infection</td>
</tr>
<tr>
<td>Consider in severe disease.</td>
<td></td>
</tr>
<tr>
<td>• Use to identify any treatable agent.</td>
<td></td>
</tr>
<tr>
<td>• Use to identify the need for expanded</td>
<td></td>
</tr>
<tr>
<td>infection control precautions in hospital.</td>
<td></td>
</tr>
<tr>
<td><strong>cardiac troponin</strong></td>
<td>• normal if no myocardial injury</td>
</tr>
<tr>
<td>Assess for an elevation, which would</td>
<td></td>
</tr>
<tr>
<td>indicate myocardial injury.</td>
<td></td>
</tr>
<tr>
<td>• COPD exacerbations can lead to</td>
<td></td>
</tr>
<tr>
<td>myocardial injury.</td>
<td></td>
</tr>
<tr>
<td>• Elevations in troponin may be</td>
<td></td>
</tr>
<tr>
<td>associated with increased mortality.[107]</td>
<td></td>
</tr>
<tr>
<td><strong>serum theophylline level</strong></td>
<td>• therapeutic range: 10-20 mg/L (55–110 micromols/litre)</td>
</tr>
<tr>
<td>Measure on admission for patients who are</td>
<td></td>
</tr>
<tr>
<td>taking theophylline (or aminophylline).</td>
<td></td>
</tr>
<tr>
<td>[88]</td>
<td></td>
</tr>
<tr>
<td><strong>pro-brain natriuretic peptide (BNP)</strong></td>
<td>• normal BNP &lt;100 picograms/mL but some variability</td>
</tr>
<tr>
<td>Use to exclude heart failure, a possible</td>
<td>according to gender and age</td>
</tr>
<tr>
<td>differential of COPD exacerbation.</td>
<td></td>
</tr>
<tr>
<td><strong>CT scan of chest</strong></td>
<td>• may still show presence of emphysema, even if no</td>
</tr>
<tr>
<td>Use to exclude alternative diagnoses if</td>
<td>pneumonia, pleural effusion, malignancy, or pulmonary</td>
</tr>
<tr>
<td>the diagnosis and basis of respiratory</td>
<td>embolus present</td>
</tr>
<tr>
<td>decompensation remains uncertain after</td>
<td></td>
</tr>
<tr>
<td>routine CXR.</td>
<td></td>
</tr>
<tr>
<td>• May identify a pulmonary embolus,</td>
<td></td>
</tr>
<tr>
<td>pneumonia, pleural effusion, or a</td>
<td></td>
</tr>
<tr>
<td>malignancy.</td>
<td></td>
</tr>
<tr>
<td><strong>Practical tip</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Do not routinely order a chest CT.</strong></td>
<td></td>
</tr>
<tr>
<td>Only request a chest CT if you suspect</td>
<td></td>
</tr>
<tr>
<td>malignancy, a pulmonary embolus, or</td>
<td></td>
</tr>
<tr>
<td>bronchiectasis, or when considering</td>
<td></td>
</tr>
<tr>
<td>surgery.[1] [88]</td>
<td></td>
</tr>
<tr>
<td><strong>spirometry</strong></td>
<td>• confirms diagnosis of COPD</td>
</tr>
<tr>
<td>Arrange for all patients admitted to</td>
<td></td>
</tr>
<tr>
<td>hospital with an acute exacerbation if</td>
<td></td>
</tr>
<tr>
<td>previous spirometry results are not</td>
<td></td>
</tr>
<tr>
<td>available to confirm the diagnosis of</td>
<td></td>
</tr>
<tr>
<td>COPD. [93]</td>
<td></td>
</tr>
<tr>
<td>During periods of high prevalence of</td>
<td></td>
</tr>
<tr>
<td>COVID-19 in the community, spirometry</td>
<td></td>
</tr>
<tr>
<td>should be restricted to patients requiring</td>
<td></td>
</tr>
<tr>
<td>urgent or</td>
<td></td>
</tr>
</tbody>
</table>
### Acute exacerbation of chronic obstructive pulmonary disease

#### Diagnosis

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>essential tests for the diagnosis of COPD and/or to assess lung function status for interventional procedures or surgery.</td>
<td>[1] [99]</td>
</tr>
</tbody>
</table>

**Practical tip**

**Do not assess the patient using peak flow as an acute investigation.** This is not recommended for assessment of an exacerbation due to the results being of lower quality or unreliable. In practice, patients are often unable to perform a good-quality forced expiratory manoeuvre during an acute exacerbation.

#### Emerging tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>procalcitonin</strong></td>
<td>• higher levels of procalcitonin have been detected in severe bacterial infections [109]</td>
</tr>
</tbody>
</table>

Procalcitonin is being investigated as a biomarker for the diagnosis of bacterial infections. [109] [110]

- Higher levels of procalcitonin have been detected in severe bacterial infections. [109]
- It may have a function in guiding when to use antibiotics for the treatment of lower respiratory tract infection; however, this is unclear.
- A Cochrane review of the use of procalcitonin to guide initiation and duration of antibiotic treatment in people with acute respiratory tract infections found it lowered the risk of mortality, and led to lower antibiotic consumption and lower risk for antibiotic-related side effects in all patients, including those with acute exacerbation of COPD. [109] Further research is required to establish its use in clinical practice. In a separate analysis of 1656 patients, 826 were randomly assigned to a group where the decision on whether to provide antibiotics was based on the results of a procalcitonin assay (830 patients were given usual care). [110]
- The assay results did not result in less use of antibiotics.
  - There was no significant difference between the procalcitonin group and the usual-care group in antibiotic-days (mean 4.2 and 4.3 days, respectively; difference −0.05 day; 95% CI −0.6 to +0.5; P = 0.87) or the proportion of patients with adverse outcomes (11.7% [96 patients] and 13.1% [109 patients]; difference −1.5 percentage points; 95% CI, −4.6 to +1.7; P <0.001 for non-inferiority) within 30 days. [110]

| point-of-care CRP | • elevated CRP suggests presence of infection |

Point-of-care CRP testing safely reduces antibiotic use in patients with acute exacerbations of COPD. [111]

- Raised levels of CRP suggest the presence of bacterial infection.
<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>• In the community, it is difficult to rapidly determine whether an acute exacerbation is due to an infection, and antibiotics are often prescribed in case there is an underlying bacterial infection.</td>
<td></td>
</tr>
<tr>
<td>• A randomised controlled trial of the use of point-of-care CRP testing to guide antibiotic prescribing for COPD exacerbations found it reduced unnecessary antibiotic use, without compromising safety or patient outcomes.[111]</td>
<td></td>
</tr>
</tbody>
</table>
## Differentials

<table>
<thead>
<tr>
<th>Condition</th>
<th>Differentiating signs / symptoms</th>
<th>Differentiating tests</th>
</tr>
</thead>
</table>
| **Coronavirus disease 2019 (COVID-19)**       | • Residence in/travel to a country/area or territory with local transmission, or close contact with a confirmed or probable case of COVID-19, in the 14 days prior to symptom onset.  
  • Signs and symptoms are similar so it may be difficult to differentiate between the conditions clinically. Maintain a high index of suspicion for COVID-19 in patients with COPD who present with symptoms of an exacerbation, especially if accompanied by fever, impaired taste or smell, or gastrointestinal complaints.[1]  
  • The situation is evolving rapidly; see our COVID-19 topic for further information. | • Real-time reverse transcription polymerase chain reaction: positive for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) RNA. |
| **Acute exacerbation of asthma**              | • An increase in cough may be the first symptom of an asthma exacerbation. Ask about the presence of chest tightness.  
  • Progressive worsening of wheeze and shortness of breath may occur. Assess for accessory muscle use, tachypnoea, and tachycardia.  
  • Key risk factors include: viral infection, exposure to cigarette smoke, exposure to allergens, atopic eczema, environmental irritants, poor indoor air quality, gastrooesophageal reflux disease, history of asthma, use of oral corticosteroids, non-compliance to asthma medication. | • Extent of asthma exacerbation can be determined by measuring peak flow as a percentage of normal value: mild >80%; moderate 60% to 80%; severe <60%.  
  • Oxygen saturation values measured by pulse oximetry vary with degree of exacerbation: mild >95%; moderate 91% to 95%; severe <90%.  
  • Treatment with a short-acting bronchodilator can also be used as a diagnostic trial. Lack of response is extremely unusual and suggests that the condition is not caused by asthma. |
<p>| <strong>Congestive heart failure</strong>                  | • Patients with systolic left-sided or biventricular congestive heart failure will often have a history of heart failure. Underlying diastolic | • Chest imaging may show an enlarged heart, pulmonary vascular congestion, and/or pleural effusions. An elevated B-type natriuretic |</p>
<table>
<thead>
<tr>
<th>Condition</th>
<th>Differentiating signs / symptoms</th>
<th>Differentiating tests</th>
</tr>
</thead>
</table>
| Acute exacerbation of COPD | heart failure is often under-recognised.  
• Physical examination may note signs consistent with heart failure, such as an elevated jugular venous pressure, extra heart sounds, coarse breath sounds with crackles above the lung bases, wheezing, and dependent pitting oedema.[114] It may be difficult to distinguish heart failure, particularly left-sided heart failure, from an acute exacerbation of COPD. | peptide is often present.[115]  
[116] An echocardiogram may be used to determine cardiac function. |
| Pneumonia       | Many aspects of acute exacerbations including dyspnoea, cough, and sputum production may be found in patients with pneumonia and it is often not possible to differentiate without chest imaging.  
• About 10% to 15% of patients presenting with an apparent acute exacerbation are found to have pneumonia, or other abnormalities, defined by chest imaging.[117]  
[118] [119] Patients with pneumonia have in general been found to experience higher fevers, more acute onset of illness, and somewhat greater severity of acute illness when compared with COPD patients without pneumonia.[117] [120] The presence of pneumonia as a cause of respiratory decompensation in a patient with COPD does not necessarily imply the presence of a COPD exacerbation per se (i.e., the presence of worsened airflow limitation related to airways inflammation and/or bronchoconstriction), and as such careful consideration should be given as to whether systemic | Chest imaging in patients with pneumonia should identify changes consistent with an infiltrative process in the lung parenchyma. |
<table>
<thead>
<tr>
<th>Condition</th>
<th>Differentiating signs / symptoms</th>
<th>Differentiating tests</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pleural effusion</strong></td>
<td>• Pleural effusions may exacerbate dyspnoea in patients with COPD. Physical examination may demonstrate decreased or absent breath sounds with dullness to percussion related to a pleural effusion.</td>
<td>• Chest imaging is recommended.</td>
</tr>
<tr>
<td><strong>Pneumothorax</strong></td>
<td>• Patients with COPD found to have pneumothoraces may or may not have additional signs or symptoms suggestive of a respiratory tract infection, but their presentation may closely mirror that of an acute exacerbation. Decreased breath sounds may be identified on the affected side and tracheal deviation away from the affected side and/or hypotension may be present in patients with a tension pneumothorax.</td>
<td>• Chest imaging is recommended to exclude a possible pneumothorax in patients with more than mild episodes. [121]</td>
</tr>
<tr>
<td><strong>Pulmonary embolism</strong></td>
<td>• Clinically, pulmonary embolism may present with signs and symptoms similar to an acute exacerbation of COPD, and the two are difficult to distinguish. [122] Pulmonary embolism should be considered as a cause of the acute symptoms if no other identifiable trigger for the exacerbation is evident. People with prior thrombo-embolic disease or underlying malignancy may be at particular risk. [122] • A low systolic blood pressure and/or the inability to increase the $\text{PaO}_2 &gt; 60$ mmHg with oxygen may indicate the presence of a pulmonary embolism.</td>
<td>• Pulmonary embolus may be diagnosed using D-dimer assay, spiral computed tomography angiogram, or pulmonary angiography in patients with COPD. Test selection should be based on local expertise. Dopplers of the lower extremities may be considered to evaluate for deep vein thrombosis.</td>
</tr>
<tr>
<td><strong>Cardiac ischaemia</strong></td>
<td>• Clinically, may be difficult to distinguish. Chest pain may be more apparent, with radiation down left side.</td>
<td>• An electrocardiogram should be performed, especially for patients who may require hospitalisation for care of an acute exacerbation of</td>
</tr>
</tbody>
</table>
### Condition | Differentiating signs / symptoms | Differentiating tests
--- | --- | ---
Acute exacerbation of COPD | Nausea, jaw pain, and/or diaphoresis may be present. | COPD, to identify possible cardiac ischaemia and arrhythmias.[1]
Cardiac arrhythmia | • Differentiating features may include palpitations, light-headedness, loss of consciousness, and/or collapse. | • An electrocardiogram should be performed, especially for patients who may require hospitalisation for care of an acute exacerbation of COPD or who are experiencing palpitations or dizziness, to identify possible cardiac ischaemia and arrhythmias.[1]
Upper airway obstruction | • Large airway obstruction typically presents with dyspnoea and wheeze (particularly during exertion and with forced exhalation manoeuvre), and it is commonly mistaken for refractory exacerbations of COPD; variable intrathoracic upper airway obstruction is often caused by tracheobronchomalacia, an aspirated object, or central airway tumour; variable extrathoracic upper airway obstruction is commonly caused by vocal cord paralysis, as well as by inflammation and swelling of the perilaryngeal soft tissues and intermittent vocal cord spasm associated with GORD, undiagnosed or untreated obstructive sleep apnoea, and chronic post nasal drip; fixed upper airway obstruction may be caused by tracheal stenosis (e.g., due to prior intubation for mechanical ventilation), extrinsic compression of central airways (e.g., lymphadenopathy or mass), or large airway tumour; auscultation over the larynx, trachea, and main bronchi during both quiet breathing and forced exhalation or hyperpnoea manoeuvre should be done to evaluate for the presence of upper airway obstruction. | • Spirometry with flow volume loop can identify the presence of upper airway obstruction; when tracheobronchomalacia is suspected, CT scanning with inspiration and expiration views or direct bronchoscopic airway inspection can be diagnostic.
## Diagnosis

### Inappropriate oxygen therapy

- While oxygen therapy is clearly indicated for many patients with COPD and acute exacerbations, excessive oxygen leads to further degradation of the patient's respiratory physiology. Exposure to oxygen leads to decrease of hypoxic vasoconstriction of arteries supplying poorly ventilated spaces, increasing the degree of V/Q mismatch and/or intrapulmonary shunt.[123] [124] An excess of oxygen may also decrease the capacity of erythrocytes to carry CO₂ (Haldane effect).[125] These changes may then result in worsening of the patient's hypercarbia and respiratory acidosis. Selected patients with impaired respiratory drive may also develop worsening hypercarbia.

- An ABG should be performed for patients who are hypoxaemic or are receiving oxygen therapy who present with an apparent acute exacerbation of COPD.

### Criteria

Both GOLD and NICE guidelines stratify exacerbations into mild, moderate, and severe, based on the management required: [1] [88] #
Assess severity to determine where and how to treat the patient

- Use pulse oximetry and ABG (when available) to help determine severity of an exacerbation, acknowledging that values will need to be compared against the patient’s baseline.
- When assessing severity, you should also take into account frailty, as well as cardiorespiratory complications and other co-morbidities.

<table>
<thead>
<tr>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>NICE Increased need for medication, which they can manage in their own normal environment</td>
<td>NICE A sustained worsening of respiratory status that requires treatment with systemic corticosteroids and/or antibiotics</td>
<td>NICE A rapid deterioration in respiratory status that requires hospitalisation</td>
</tr>
<tr>
<td>GOLD Treated with short-acting bronchodilators only</td>
<td>GOLD Treated with short-acting bronchodilators plus antibiotics and/or oral corticosteroids</td>
<td>GOLD Requires hospitalisation or presents to emergency department. May be associated with acute respiratory failure</td>
</tr>
</tbody>
</table>

Mild and moderate exacerbations may be dealt with in the community (depending on the cause of the exacerbation and the patient’s social factors)

As severe exacerbations may have associated acute respiratory failure, they should be dealt with in hospital

In hospitalised patients, assess the severity of the exacerbation using a prognostic score, such as DECAF (Dyspnoea, Eosinopenia, Consolidation, Acidemia, and atrial Fibrillation) [101] or BAP-65.

- The score will indicate which patients are likely to benefit from early intervention, such as non-invasive ventilation.

Further stratify hospitalised patients based on their clinical signs. [1]

- No respiratory failure#
  - Respiratory rate 20 to 30 breaths/minute.
  - No use of accessory respiratory muscles.
  - No change in mental status.
  - Supplemental oxygen given via Venturi mask up to 28% to 35% inspired oxygen (FiO₂) restores oxygen saturations.
• Ensure that there is no evidence of hypercapnia before moving to higher concentrations of oxygen.
• Perform ongoing assessment of arterial blood gas (ABG).
• Document the FiO₂ or O₂ flow rate.

• No increase in PaCO₂.

• **Acute respiratory failure – non-life threatening**

  • Respiratory rate >30 breaths/minute.
  • Using accessory respiratory muscles.
  • No change in mental status.
  • Hypoxaemia improves when supplemental oxygen at higher concentrations is given via Venturi mask.

  • You must ensure that there is no evidence of hypercapnia before moving to higher concentrations of oxygen.
  • Perform ongoing assessment of ABGs.
  • Document the FiO₂ or O₂ flow rate.

• PaCO₂ increased compared with baseline or elevated approximately 6.7 kPa (50-60 mmHg).

• **Acute respiratory failure – life threatening**

  • Respiratory rate >30 breaths/minute.
  • Using accessory respiratory muscles.
  • Acute changes in mental status.
  • Hypoxaemia not improved with supplemental oxygen via Venturi mask or increased FiO₂.

  • You must ensure that there is no evidence of hypercapnia before moving to higher concentrations of oxygen.
  • Perform ongoing assessment of ABGs.
  • Document the FiO₂ or O₂ flow rate.

• PaCO₂ increased compared with baseline or elevated approximately 8 kPa (>60 mmHg) or acidosis present.
Urgent

If COVID-19 infection is confirmed, manage the patient in line with your local COVID-19 guidelines. See our topic [Coronavirus disease 2019 (COVID-19)].

- Use systemic corticosteroids in COPD exacerbations according to the usual indications (see Initial pharmacological management below) whether or not there is evidence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection. There is no evidence that this approach modifies the patient’s susceptibility to SARS-CoV-2 infection or worsens outcomes.[1]
- Treat the patient with antibiotics according to the usual indications (see Treat the underlying cause below) whether or not there is evidence of SARS-COV-2 infection, particularly as patients with COPD who also have COVID-19 frequently develop bacterial or fungal co-infections.[1]

Immediately give a short-acting beta-2 agonist (at an increased dose or frequency from the patient’s usual baseline treatment), with or without a short-acting muscarinic antagonist. [1]

- Stop any long-acting muscarinic antagonist the patient may already be on for maintenance therapy if a short-acting muscarinic antagonist is given.

Consider a systemic corticosteroid. [1] [88]

Prescribe controlled oxygen for severe exacerbations in patients who are hypoxic.

- Titrate controlled oxygen to a target saturation of 88% to 92% as COPD patients are considered at risk of hypercapnic (type 2) respiratory failure.[1] [98]

Obtain arterial blood gas (ABG) and pulse oximetry measurements on presentation and repeat after 30 to 60 minutes. [1] [98]

Monitor for signs of hypercapnic (type 2) respiratory failure with respiratory acidosis.

Acute respiratory failure is life-threatening when:[1]

- Respiratory rate >30 breaths/minute
- Patient using accessory respiratory muscles
- Acute changes in mental status
- Hypoxaemia does not improve with supplemental oxygen via Venturi mask or requiring fraction of inspired oxygen (FiO₂) >40%

- Ensure that there is no evidence of hypercapnia before moving to higher concentrations of oxygen.
- Carry out ongoing assessment with ABGs.
- Document the FiO₂ or O₂ flow rate.
- PaCO₂ increased compared with baseline or elevated approximately 8 kPa (>60 mmHg), or acidosis present.

In the community, refer the patient to hospital if they have:[1]
Management

- Sudden worsening of resting dyspnoea
- High respiratory rate/acute respiratory failure (>30 breaths/minute)
- Decreased oxygen saturation (\(\text{SaO}_2\): \(\text{SaO}_2 <90\% \) on air\[88\]) or deteriorating \(\text{SaO}_2\) in patients with known hypoxaemia (i.e., those on long-term oxygen therapy)
- Confusion or drowsiness
- Acute respiratory failure
- Change in or onset of new physical signs, such as cyanosis or worsening peripheral oedema\[88\]
- Failure to respond to initial management
- Serious comorbidities that would affect recovery or impact treatment, such as heart failure, atrial fibrillation, or other cardiorespiratory conditions
- Insufficient support at home or in the community treatment setting.

Key Recommendations

Initial treatment for all patients

Give a short-acting beta-2 agonist (with or without a short-acting muscarinic antagonist) and consider a systemic corticosteroid.\[1\]

- For the beta-2 agonist, use:
  - A nebuliser driven on air (not oxygen, due to the risk of hypercapnia) for a moderate to severe exacerbation\[88\]
  - During the COVID-19 pandemic, seek advice from a respiratory specialist and consult local guidelines before using a nebuliser. There are currently differences of opinion between organisations in different countries on whether use of a nebuliser is an aerosol-generating procedure
  - A metered-dose inhaler (MDI) plus spacer for a mild exacerbation.
  - Add a short-acting muscarinic antagonist (e.g., ipratropium) administered via a nebuliser if the initial dose of the short-acting beta-2 agonist does not provide sufficient and prompt benefit. [1][126]
  - Stop any long-acting muscarinic antagonist the patient may already be on for maintenance therapy if a short-acting muscarinic antagonist is given.

Monitor the patient using an early warning score, such as the NEWS2 score.\[92\]

- Respiration rate
- Oxygen saturation (document \(\text{FiO}_2\) or \(\text{O}_2\) flow rate)
- Systolic blood pressure
- Pulse rate
- Level of consciousness or new-onset confusion
- Temperature.

Oxygen

Titrate controlled oxygen to a target saturation of 88% to 92%, as COPD patients are considered at risk for hypercapnic (type 2) respiratory failure.\[1][98][102\]
Acute exacerbation of chronic obstructive pulmonary disease

**Management**

- Use a **Venturi mask** to deliver 24% to 28% oxygen.[98]
- Document the **FiO₂ or O₂ flow rate**.
- **Check blood gases** to ensure satisfactory oxygenation and monitor for carbon dioxide retention and acidosis.
  - Obtain **arterial blood gas and pulse oximetry** measurements on admission and then after 30 to 60 minutes.[1] [98]
  - Repeat ABG if the patient's clinical condition deteriorates or they fail to respond to initial therapy.

Avoid excessive oxygen use in patients with COPD as this can lead to worsening hypercapnia, acidosis, and respiratory failure and death.

- This can develop rapidly (within the time of a hospital admission) even if the initial blood gas results were satisfactory.[98]
- Beware that hypercapnic respiratory failure and death may occur as a consequence of high oxygen delivery in an ambulance when attempting hypoxaemia correction.[127]

**Ventilation**

Start **non-invasive ventilation (NIV)** for patients who have any of the following, despite optimal medical therapy, [102] and have no contraindications to treatment:[1]

- **Respiratory acidosis** (pH <7.35 and PaCO₂ >6.5 kPa).[102]
  - Acidaemia implies a severe exacerbation and predicts in-hospital and 30-day mortality.[103]
- **Severe dyspnoea** (as shown by use of respiratory accessory muscles, pursed lip breathing, paradoxical motion of the abdomen, or retraction of intercostal spaces).
- **Persistent hypoxaemia** despite supplemental oxygen.

Consider the patient's escalation policy and 'ceilings of care' before starting ventilation.

Follow your hospital’s protocol for initiation of NIV and subsequent management.

- This will include recommendations on pressures, oxygen titrations, and frequency of ABGs.
- In the UK, in line with recommendations from the **British Thoracic Society**, for patients who meet the criteria for acute NIV start treatment within:[93] [104]
  - **60 minutes of the blood gas result** associated with the clinical decision to go ahead with treatment
  - **120 minutes of hospital arrival** for patients who present acutely.

Only consider **invasive mechanical ventilation after careful consideration and discussion with the senior medical team**. Bear in mind existing escalation strategies and any advance directives.[1]

**Antibiotics**

Give antibiotics to any patient who needs ventilation (invasive or non-invasive) or patients experiencing exacerbations with: [1]
Acute exacerbation of chronic obstructive pulmonary disease

Management

- Increase in sputum volume, plus
- Increase in sputum purulence, and/or
- Increase in dyspnoea.
- Still give antibiotics if the patient has only two of the cardinal symptoms if increased sputum purulence is one of them.[1]
- Choice of antibiotic should be based on local resistance patterns, any previous culture results for the individual patient,[1] and local antibiotic guidelines.
- Duration of therapy should be 5 to 7 days, but consult your local guidelines. [1]
- Give oral antibiotics first-line if possible and if the severity of the exacerbation does not require intravenous antibiotics.[1] If intravenous antibiotics are given, review them within 48 hours and consider stepping down to oral antibiotics where possible.[97]

Supplemental treatment for all patients

- Monitor fluid balance.
- Offer nicotine replacement therapy to all current smokers while in hospital and discuss smoking cessation options for after discharge.[88]
- Treat any comorbidities.
- Consider prophylaxis against thromboembolism.
- Consider nutritional supplements.

Full Recommendations

Treatment goals

The main treatment goals are to:

- Alleviate the patient's symptoms of dyspnoea
- Stabilise and improve respiratory status
- Minimise the impact of the current exacerbation on the patient's overall health[1]
- Prevent subsequent exacerbations[1]
- Manage any underlying conditions.

Treatment setting

There are no absolute criteria to determine the most appropriate treatment setting.

- Consider the full clinical picture in the context of the patient’s usual state.
- Consult senior colleagues if you are uncertain of the best treatment setting.
- See Diagnostic recommendations for specific advice on when to admit to hospital.

Initial pharmacological management

Inhaled bronchodilators

Give a short-acting beta-2 agonist (e.g., salbutamol) at an increased dose or frequency from the patient's usual baseline treatment as first-line therapy. [1] [88]

- For a moderate to severe exacerbation, use a nebuliser driven on air (not oxygen). [88]
Acute exacerbation of chronic obstructive pulmonary disease

Management

- This is to avoid worsening hypercapnia.[88]
- The driving gas for nebulised therapy should always be specified in the prescription.[88]
- For a mild exacerbation, use an MDI plus spacer.
- People with severe dyspnoea with low inspiratory flow rates may have difficulty achieving proper technique and medication delivery from the MDI; a nebuliser may be easier for these patients to use.
- You may see benefit from this initial treatment within 30 minutes.

During the COVID-19 pandemic, seek advice from a respiratory specialist and consult local guidelines before using a nebuliser.

- There are currently differences of opinion between organisations in different countries on whether use of a nebuliser is an aerosol-generating procedure.
- International guidelines from the Global Initiative for Chronic Obstructive Lung Disease (GOLD) recommend minimal use of nebulisers, advising that inhalers should ideally be used for drug delivery instead. GOLD acknowledges that nebulisers may be needed in critically ill patients with COVID-19 receiving ventilatory support. GOLD recommends using a mesh nebuliser (to keep the circuit intact and prevent virus transmission) if absolutely necessary to do so (e.g., in ventilated patients).[1] However, nebulisers are not considered to represent a significant infectious risk for COVID-19 according to Public Health England and the UK National Institute for Health and Care Excellence.[128][129]
- For more detailed information on COVID-19 see our topic [Coronavirus disease 2019 (COVID-19)].

Practical tip

Observe patients while they use an MDI. It is common for patients to need advice and training on technique. If a patient is struggling to obtain the required dose, switch to a nebuliser.

Add a short-acting muscarinic antagonist (e.g., ipratropium) administered via a nebuliser if the initial dose of the short-acting beta-2 agonist does not provide sufficient and prompt benefit. [1][126]

- Short-acting beta-2 agonists are typically favoured as a first-line option as they tend to have a more rapid effect than antimuscarinics.

Give ipratropium alone if the patient experiences adverse effects due to salbutamol (e.g., tremor, palpitations, headache, nausea, dizziness).

To avoid overdose, stop any long-acting muscarinic antagonist the patient may already be on for maintenance therapy (e.g., aclidinium, glycopyrronium, tiotropium, umeclidinium) while the short-acting muscarinic antagonist is given.

- Continue the long-acting beta-2 agonist (the patient’s maintenance therapy) alongside the additional short-acting beta-2 agonist needed for recovery from the exacerbation.
- Many patients are on a long-acting beta-2 agonist/long-acting muscarinic antagonist (with or without a corticosteroid) combination inhaler for maintenance therapy. If this is the case, stop the combination inhaler during the acute exacerbation.
Seek specialist advice on the optimal method of delivering bronchodilators (MDI or nebuliser) to adults with COPD exacerbation who are receiving mechanical ventilation via endotracheal tube.

- There is insufficient evidence to recommend one route of delivery over the other.[130]

**Systemic corticosteroids**

Consider a systemic (oral or intravenous) corticosteroid. [1] [88] Oral administration is preferred; however, some patients may require intravenous administration if they cannot tolerate oral therapy (e.g., if they are vomiting).

- National Institute for Health and Care Excellence (NICE) and Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines recommend a 5-day treatment course.[1] [88]
- Latest evidence shows no benefit from prolonged therapy.[131]
- Corticosteroids are associated with risk of pneumonia, sepsis, and death and should only be used in patients with significant exacerbations.[1]
- Avoid use of a corticosteroid with a fluoroquinolone antibiotic, because co-administration could exacerbate fluoroquinolone-induced tendinitis and tendon rupture.[132]

**Evidence: Corticosteroids**

*Evidence shows no benefit from prolonged therapy of corticosteroids.*

A Cochrane review compared the efficacy of short-duration (7 or fewer days) and conventional longer-duration (longer than 7 days) systemic corticosteroid treatment of adults with acute exacerbations of COPD. [131]

- Eight studies with 582 participants were included.
- Corticosteroid treatment was given at equivalent daily doses for 3 to 7 days for short-duration treatment and for 10 to 15 days for longer-duration treatment.
- Patients treated for 7 or fewer days did not have a higher rate of treatment failure.
- Time in hospital and lung function at the end of treatment were not different.
- No differences in side effects or death were noted between treatments.

The balance of risks and benefits of corticosteroids for people with milder exacerbations is uncertain.

- Note that there may be guidance in future over which patients to prescribe corticosteroids to, in an effort to reduce their prescription.
- At the moment there is no consensus owing to a lack of peer-reviewed data. Eosinophil count may become a useful determinant of this.[133]

**Evidence: The role of methylxanthines**

*The use of methylxanthines is not routinely recommended.*

GOLD states that methylxanthines (theophylline or aminophylline) are not recommended due to their side-effect profile. [1] #
NICE states that intravenous theophylline should only be used as an adjunct to exacerbation management if there is an inadequate response to nebulised bronchodilators, noting that there is potential for toxicity in patients already taking oral theophylline and that levels should be monitored. [88]

A meta-analysis of four randomised controlled trials found no consistent benefit from taking a methylxanthine to treat an exacerbation of COPD, but that they were associated with an increase in nausea and vomiting. [134] #

• The risks of nausea or vomiting were significantly higher for patients receiving a methylxanthine (OR 4.6, 95% CI 1.7 to 12.6) than for patients receiving placebo.[134]

In a trial to assess whether theophylline helps to prevent exacerbations, 1567 participants were randomised to receive low-dose theophylline or placebo. [135] #

• The main outcome measured was the number of participant-reported moderate or severe exacerbations treated with antibiotics, oral corticosteroids, or both over a 1-year treatment period.
• It found that among adults with COPD at high risk of exacerbation treated with inhaled corticosteroids, the addition of low-dose theophylline, compared with placebo, did not reduce the number of COPD exacerbations over a 1-year period.
  • In total, there were 3430 exacerbations:
    • 1727 in the theophylline group (mean exacerbations per year 2.24, 95% CI 2.10 to 2.38)
    • 1703 in the placebo group (mean exacerbations per year 2.23, 95% CI 2.09 to 2.37).
  • The findings do not support the use of low-dose theophylline as adjunctive therapy to inhaled corticosteroids for the prevention of COPD exacerbations.

Assess severity

Assess severity to determine where and how to treat the patient.[1] [88]

• Use pulse oximetry and ABG , acknowledging that values will need to be compared against the patient's baseline .
• Consider the patient's prior status and any changes to previous baseline investigation (based on symptoms, examination, and investigations).
• Take into account frailty and comorbidities .

See Diagnostic recommendations for specific advice on how to stratify exacerbations (into mild, moderate, and severe) and the impact of this on management.

Respiratory support
Oxygen

Check arterial blood gas and pulse oximetry on presentation and then after 30 to 60 minutes to ensure satisfactory oxygenation and monitor for carbon dioxide retention and acidosis. [1] [98] #

- Administer the oxygen in a controlled fashion via a Venturi mask to deliver 24% to 28% oxygen. [98]
- Titrate controlled oxygen to a target saturation of 88% to 92% as COPD patients are considered at risk for hypercapnic (type 2) respiratory failure. [1] [98] [102]
- Document the FiO₂ or O₂ flow rate.

Repeat ABG if the patient’s clinical condition deteriorates or they fail to respond to initial therapy.

Avoid excessive oxygen use in patients with COPD due to the risk of hypercapnic (type 2) respiratory failure.

- It is likely there are at least six mechanisms responsible for oxygen-induced hypercapnia: [98]
  - V/Q mismatch
  - Ventilatory drive
  - Haldane effect (the ability of deoxyhaemoglobin to carry more carbon dioxide than oxyhaemoglobin [136])
  - Absorption atelectasis
  - Higher density of oxygen compared with air
  - Rebreathing can occur if low oxygen flow rates are used through a face mask.

- Risk factors for hypercapnic respiratory failure include:
  - Previous respiratory failure
  - Morbid obesity [98]
  - Chest wall deformities, such as severe kyphoscoliosis [98]
  - Neuromuscular disorders [98]
  - Fixed airflow obstruction associated with bronchiectasis [98]
  - Concurrent obstructive sleep apnoea.

- The risk of respiratory acidosis in patients with hypercapnic respiratory failure is increased if the PaO₂ is above 10.0 kPa (75 mmHg) due to previous excessive oxygen use. [98]

Use a Venturi mask in preference to nasal prongs as they offer a more accurate delivery of oxygen. [1] #

- More evidence is needed on the use of high-flow oxygen therapy by nasal cannula in patients with acute exacerbations of COPD. [1]
Beware that hypercapnic respiratory failure may occur as a consequence of high oxygen delivery in an ambulance when attempting hypoxaemia correction.[127] Note that nasal prongs and standard Hudson masks do not deliver controlled oxygen.

Gradually reduce oxygen therapy as the patient recovers. [98]

Discontinue oxygen therapy once the patient can maintain their target oxygen saturation on room air. [98]

- Bear in mind that some patients will be on long-term oxygen therapy as part of their usual treatment and this will need to be maintained.

**Ventilation**

**Non-invasive ventilation (NIV)**

Start NIV for patients with acute hypercapnic respiratory failure (pH <7.35, PaCO₂ >6.5 kPa), despite optimal medical therapy [102] without contraindications. [1] #

- NIV:[1] [137]
  - Improves survival
  - Improves gas exchange
  - Reduces the work of breathing
  - Reduces the need for intubation
  - Decreases length of hospital stay.

Provide non-invasive mechanical ventilation to patients with any of the following: [1] #

- Respiratory acidosis (pH <7.35 and PaCO₂ >6.5 kPa).[102]
  - Acidaemia implies a severe exacerbation and predicts in-hospital and 30-day mortality.[103]
  - The evidence is less clear for patients with arterial pH ≤7.25. In these patients NIV may be used as a 'ceiling of care' treatment for severe hypercapnic acidoaemic ventilatory failure.
  - Severe dyspnoea (as shown by use of respiratory accessory muscles, paradoxical motion of the abdomen, or retraction of intercostal spaces).
  - Persistent hypoxaemia despite supplemental oxygen.

Follow your hospital’s protocol for initiation of NIV and subsequent management.#

- This should include recommendations on pressures, oxygen titrations, and frequency of ABGs.

In general:

- Monitor oxygen saturations continuously. [102] #
- Take intermittent measurements of PaCO₂ and pH. [102] #
- Use ECG monitoring if the patient has a pulse rate >120 bpm or if there is dysrhythmia or possible cardiomyopathy. [102]
- Frequently assess the patient to monitor for any complications occurring.
**Acute exacerbation of chronic obstructive pulmonary disease**

**Management**

The British Thoracic Society sets out specific timeframes as measurable markers of good practice for the use of acute NIV in the UK. [93] [104] #

- For patients who meet the criteria for acute NIV, start it within:
  - 60 minutes of the blood gas result associated with the clinical decision to go ahead with NIV.
  - 120 minutes of hospital arrival for patients who present acutely.
  - Review the patient’s clinical progress within 4 hours of starting NIV.
    - This should be done by a healthcare professional with appropriate training and competence.
    - A consultant with training and competence in acute NIV should review the patient’s clinical progress within 14 hours of starting acute NIV.

If possible, perform a blood gas analysis within 30-60 minutes of starting acute NIV.

- Although the British Thoracic Society (BTS) recommends performing blood gas analysis within 2 hours of starting acute NIV, [104] in practice, specialists recommend ideally waiting only 30-60 minutes to check for changes in PaCO₂ and pH. [104]
- Arrange review by a specialist healthcare professional with expertise in managing patients on NIV within 30 minutes if blood gas measurements fail to improve.

**Plan with senior colleagues** what to do if the patient deteriorates,[102] including ‘ceilings of care’, [88] and consider DNACPR (‘Do Not Attempt Cardiopulmonary Resuscitation’) for patients not suitable for escalation to an intensive care unit.

- See Diagnostic recommendations for specific advice on care planning.

Admit the patient to an intensive care unit if they have:[1]

- Severe dyspnoea with a poor response to initial emergency therapy
- Changes in mental status
- Persistent or worsening hypoxaemia (PaO₂ <40 mmHg or 5.3 kPa) and/or severe or worsening respiratory acidosis (pH <7.25) despite supplemental oxygen and non-invasive ventilation
- Need for invasive mechanical ventilation
- Haemodynamic instability (need for vasopressors).

**Invasive mechanical ventilation**

Only consider invasive ventilation after careful consideration and discussion with the senior medical team. [1] #

- This is not purely a clinical decision and there are no absolute numerical thresholds to adhere to. You will need to take many factors into account, including the patient’s own wishes regarding resuscitation.
- Compare the patient’s functional status to their baseline and consider their overall fitness for ventilation.
- Indications for invasive mechanical ventilation include:[1]
  - Unable to tolerate NIV.
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- When NIV has failed
- Post respiratory arrest or cardiac arrest
- Diminished consciousness or inadequately controlled psychomotor agitation
- Massive aspiration or persistent vomiting
- Persistent respiratory secretions that cannot be removed
- Severe haemodynamic instability, not successfully treated with fluid and drugs
- Severe arrhythmias
- Hypoxaemia and unable to tolerate NIV.

- Complications associated with mechanical ventilation include:[1]
  - Ventilator-associated pneumonia
  - Barotrauma
  - Volutrauma
  - Respiratory weakness after prolonged ventilation (weaning and tracheostomy may be required to manage this).

Patient suitability

When assessing suitability for intubation and ventilation, take into account:[88]

- Functional status
- BMI
- Need for oxygen when stable
- Comorbidities
- Previous admissions to intensive care units
- Age
- FEV₁.

- Do not use age or FEV₁ in isolation when assessing suitability for intubation and ventilation.

Treat the underlying cause

Give antibiotics to any patient who needs ventilation (invasive or non-invasive) or patients experiencing exacerbations with: [1] #

- Increase in sputum purulence, plus
- Increase in sputum volume, and/or
- Increased dyspnoea.

As well as the severity of symptoms, particularly sputum colour changes and increases in volume or thickness beyond the patient’s normal day-to-day variation, NICE urges you to also consider: [97] #

- Whether the patient needs to go into hospital for treatment
- Previous exacerbation and hospital admission history
- Risk of developing complications
- Previous sputum culture and susceptibility results
- Risk of antimicrobial resistance with repeated courses of antibiotics.
Choose an antibiotic regimen based on local resistance patterns, any previous culture results for the individual patient, [1] # and local antibiotic guidelines.

- Duration of therapy will tend to be 5 to 7 days, but consult your local guidelines. [1] #
  - More recent guidance from the American College of Physicians recommends limiting antibiotic treatment to 5 days in patients with COPD exacerbations and acute uncomplicated bronchitis.[141]
  - When used appropriately, antibiotics can:
    - Shorten recovery time
    - Reduce the risk of early relapse and treatment failure
    - Shorten the length of hospital stay.

Give oral antibiotics first-line if the patient is able to tolerate oral medications, and if the severity of the exacerbation does not require intravenous antibiotics. [1] [97]

- If a patient is started on intravenous antibiotics, review them by 48 hours and consider stepping down to oral therapy where possible.[97]
- NICE recommends amoxicillin, doxycycline, or clarithromycin as suitable first-line oral options. Alternative oral options include amoxicillin/clavulanate, levofloxacin, and trimethoprim/sulfamethoxazole. Suitable first-line intravenous options include amoxicillin, amoxicillin/clavulanate, clarithromycin, trimethoprim/sulfamethoxazole, or piperacillin/tazobactam.[97]
- It is worth noting that you must not prescribe fluoroquinolones (e.g., levofloxacin) for mild to moderate acute exacerbation of COPD unless other antibiotics are considered inappropriate. This is due to reports of disabling, long-lasting, or potentially irreversible adverse reactions affecting the musculoskeletal and nervous systems.[132] [142] Avoid fluoroquinolones in patients who have previously had serious adverse effects with a fluoroquinolone antibiotic. Avoid use of a corticosteroid with a fluoroquinolone, because co-administration could exacerbate fluoroquinolone-induced tendinitis and tendon rupture.[132]

Look for improvements in dyspnoea and sputum purulence to measure success of antibiotic treatment. [1]

**Additional considerations in the community**

Give the patient/their family specific advice about when to seek further medical help, in particular: [97]

- If symptoms worsen rapidly or significantly
- If symptoms do not start to improve within an agreed time (e.g., 2 to 3 days if taking antibiotics)
- If the patient becomes systemically very unwell.

Give advice on possible adverse effects of antibiotics (particularly diarrhoea). [97]

Explain that their respiratory symptoms may not be fully resolved when the course has been completed.[97]

Reassess the patient if their symptoms worsen rapidly or significantly. In particular:

- Beware symptoms and signs of:
Management

- Pneumonia
- Cardiorespiratory failure
- Sepsis.

- **Refer the patient to hospital** if you suspect a more serious illness (e.g., sepsis or cardiorespiratory failure).

Consider antibiotic-resistant bacteria and send a sputum sample for microscopy, culture, and Gram stain if symptoms have not improved following antibiotic treatment and these tests have not been done already. [97]#

- Only request sputum microscopy, culture, and Gram stain in **severe disease** and if hospitalisation is being considered. This is **not a routine investigation in primary care**. [88]

Seek specialist advice for patients: [97]#

- Whose symptoms do not improve after repeated courses of antibiotics
- With a bacterial infection resistant to oral antibiotics
- Who cannot take oral medications.

- Other options may be to give intravenous antibiotics at home or in the community, rather than in hospital, where appropriate.

Some patients will keep antibiotics at home for use in an exacerbation as part of their existing action plan.

**Evidence: Efficacy of antibiotics[143]#**

Antibiotics offer a large and consistent beneficial effect across outcomes of patients admitted to an intensive care unit (ICU), but for inpatients and outpatients the effects are inconsistent.

A Cochrane review of 19 trials with 2663 participants looked at the effects of antibiotics in the management of acute COPD exacerbations on:

- Treatment failure (observed 7 days to 1 month after treatment initiation)
- Mortality
- Length of hospital stay.

In the study:

- Three groups of patients were considered:
  - Outpatients (mild to moderate exacerbation)
  - Inpatients (severe exacerbation)
  - ICU patients (very severe exacerbation)

- In outpatients, there was low-quality evidence that antibiotics do significantly reduce the risk for treatment failure between 7 days and 1 month after treatment initiation (RR 0.72, 95% CI 0.56 to 0.94).
• In inpatients (excluding ICU), moderate-quality evidence does not show that antibiotics significantly reduce the risk of treatment failure in inpatients with severe exacerbations (RR 0.65, 95% CI 0.38 to 1.12).
• In ICU patients:
  • A trial of 93 patients showed a large and statistically significant effect of antibiotics on treatment failure (RR 0.19, 95% CI 0.08 to 0.45)
  • Antibiotics significantly reduced length of hospital stay (mean difference -9.60 days, 95% CI -12.84 to -6.36 days).
  • Length of hospital stay (in days) was similar in the antibiotic and placebo groups for inpatients.
• The authors conclude that there is beneficial effect across outcomes of patients admitted to an ICU, but that for inpatients and outpatients the effects of antibiotics are inconsistent.[143]

Evidence: Choice of antibiotic

Many antibiotics have been found to be effective for the treatment of an acute exacerbation of COPD.

A review of 19 randomised controlled trials (RCTs) found that macrolides, fluoroquinolones, and amoxicillin/clavulanate may be considered equivalent for the treatment of patients with an acute bacterial exacerbation of chronic bronchitis in short-term effectiveness. [144]

• Treatment success was lower for macrolides compared with fluoroquinolones (OR 0.47, 95% CI 0.31 to 0.69).
• Fewer fluoroquinolone recipients experienced a recurrence of acute exacerbation after resolution of the initial episode, compared with macrolide recipients, during the 26-week period following therapy.
• Amoxicillin/clavulanate was associated with more adverse effects (mainly diarrhoea) than fluoroquinolones (OR 1.36, 95% CI 1.01 to 1.85).

An analysis of five RCTs involving 287 patients found that there were no differences between patients with acute exacerbation of chronic bronchitis receiving semisynthetic penicillins (e.g., amoxicillin, ampicillin) and those receiving trimethoprim-based regimens (e.g., trimethoprim, trimethoprim/sulfamethoxazole, trimethoprim/sulfadiazine) in:

- Treatment success (intention-to-treat patients: n = 262; OR 1.68, 95% CI 0.91 to 3.09; clinically evaluable patients: n = 246; OR 1.59, 95% CI 0.79 to 3.20)
- Number of drug-related adverse events in general (n = 186 patients; OR 0.37, 95% CI 0.11 to 1.24).

Choose an antibiotic regimen based on local resistance patterns, any previous culture results for the individual patient, [1] and local antibiotic guidelines.#

Supplemental treatment in hospital

Monitor fluid balance.

• This may be particularly important in patients with comorbidities, such as heart failure.

Depending on the patient’s clinical condition, you may need to:[1] #
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• Treat any comorbidities
  • Comorbidities, such as lung cancer, cardiovascular disease, osteoporosis, and depression, are common in patients with COPD
  • Consider any other drugs the patient is taking
• Administer prophylaxis against thromboembolism, if needed
• Give nutritional supplements
  • Patients with COPD who are undernourished are at an increased risk of exacerbations.[146]

Ongoing management and discharge

Monitor recovery

Regularly assess symptoms and observe the patient’s functional status.[88] 

• Use intermittent ABG measurements to monitor the recovery of people with respiratory failure who are hypercapnic or acidotic, until they are stable with a normalised pH.[88]
• Use pulse oximetry to monitor the recovery of people with non-hypercapnic, non-acidotic respiratory failure.[88]
• Do not use daily monitoring of peak expiratory flow or FEV₁ to monitor recovery from an exacerbation, because the magnitude of change is small compared with the variability of the measurement.[88]

Practical tip

Change drug delivery from a nebuliser to an MDI once the patient has stabilised. This may allow an earlier discharge from hospital.

Discharge planning

You (along with the patient and family) should be confident that the patient can manage their symptoms at home before they are discharged.

• If the patient smokes, reinforce the advice to the patient that they must stop smoking and provide information on how to access the services that help with this.[147]
  • Offer a 'harm reduction' approach, such as reducing the number of cigarettes smoked or temporary abstinence. This may be a practical step for patients struggling to quit.[148]
• Review the patient’s long-term medication.
  • Re-establish people on their optimal maintenance bronchodilator therapy before discharge.[88]
• Provide vitamin D supplementation, if required. Supplementation of patients with severe deficiency results in a reduction in exacerbations and hospitalisation.[1]
• Consider a hospital-at-home or assisted discharge scheme, where available, once the patient is stable.[88][149][150]
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- The decision over which patients are suitable for such schemes will need a team approach, as will the implementation of such schemes. Take patient factors and preferences into account.[88] Consider using a validated prognostic score, such as the DECAF (Dyspnoea, Eosinopenia, Consolidation, Acidemia, and atrial Fibrillation) score, to determine which patients are suitable for this approach.[149]

- Be aware that patients who have suffered from a significant exacerbation of COPD may not always recover back to their pre-illness functional status. Discuss this as needed with the patient and their family, so that their expectations of the duration and extent of recovery are realistic.

- Refer for a pulmonary rehabilitation programme, as required, to improve exercise tolerance, physical ability, and quality of life.[151]

- Pulmonary rehabilitation is a multidisciplinary programme of care that involves physical rehabilitation as well as guidance on disease management, nutrition, and other lifestyle issues (e.g., smoking cessation, medicine compliance and inhaler technique, supplemental oxygen, and maintenance of physical activity).[152]

Prior to discharge: [1] [88]

- Review all clinical data and test results: identify and manage any abnormalities.
- Measure (or review previous) spirometry in all patients.[93] During periods of high prevalence of COVID-19 in the community, spirometry should be restricted to patients requiring urgent or essential tests for the diagnosis of COPD, and/or to assess lung function status for interventional procedures or surgery.[1] [99] Performing spirometry and pulmonary function testing may lead to SARS-CoV-2 transmission as a result of droplet and aerosol formation during the tests, especially with coughing.
- Ensure satisfactory oximetry or ABG results in patients who have had an episode of respiratory failure.
- Assess the need for continuing oxygen therapy.
- Check the patient’s understanding of the withdrawal of their acute medications and their re-established maintenance therapy.
- Give appropriate information on the correct use of medications and oxygen.
- Reassess Inhaler technique.
- Provide a management plan for comorbidities.
- Make arrangements for follow-up and home care.

Practical tip

Although there are insufficient data that specific ‘care bundles’ at hospital discharge reduce readmission rates, improve mortality, or are cost-effective,[1] the general principles are all worth considering as part of discharge and follow-up:

- Education
- Optimisation of medication
- Supervision and correction of inhaler technique
- Assessment and management of comorbidities
- Early rehabilitation
- Telemonitoring
Evidence: Pulmonary rehabilitation

Pulmonary rehabilitation was found to be a safe intervention to improve quality of life and exercise capacity for patients with COPD after an exacerbation.

A Cochrane review looked at 20 studies involving 1477 participants with COPD to assess the impact of pulmonary rehabilitation after an exacerbation of COPD versus usual care.

• Quality of life was measured using questionnaires and exercise capacity was measured using walking tests, such as the 6-minute walk test.
• Eight studies that used the St George’s Respiratory Questionnaire reported a statistically significant effect on total score.
• Thirteen studies involving 819 participants used the 6-minute walk test. The 6-minute walk distance improved, on average, by 62 metres (95% CI 38 to 86).
• Six studies including 670 participants contributed data on mortality. The quality of evidence was low. Meta-analysis showed no statistically significant effects of rehabilitation on mortality (pooled OR 0.68, 95% CI 0.28 to 1.67).
• Eight studies involving 810 participants contributed data on hospital readmissions. Moderate-quality evidence showed that pulmonary rehabilitation reduced hospital readmission (pooled OR 0.44, 95% CI 0.21 to 0.91). However, of the eight studies, four showed large and statistically significant reductions in the risk of hospital admission associated with pulmonary rehabilitation, and four showed no effect.

Treatment algorithm overview

Please note that formulations/routes and doses may differ between drug names and brands, drug formularies, or locations. Treatment recommendations are specific to patient groups: see disclaimer

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Treatment algorithm

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# Acute exacerbation of chronic obstructive pulmonary disease

## Management

### Acute on presentation

**1st short-acting bronchodilator**

**Primary options**

- **salbutamol inhaled**: (100 micrograms/dose inhaler) 2-10 puffs inhaled every 10-20 minutes or when required (each puff should be inhaled separately via a large volume spacer); 5 mg inhaled via nebuliser every 20-30 minutes or when required

- **ipratropium inhaled**: 500 micrograms inhaled via nebuliser when required, may repeat dose until patient is stable (time interval between doses may be determined by physician), maximum 2 mg/day

- **Give a short-acting beta-2 agonist** (e.g., salbutamol) at an increased dose or frequency from the patient’s usual baseline treatment as first-line therapy. [1] [88]

  - For a **moderate to severe** exacerbation, use a **nebuliser driven on air (not oxygen)**. [88]
    - This is to avoid worsening hypercapnia. [88]
    - The driving gas for nebulised therapy should always be specified in the prescription. [88]
  
  - For a **mild** exacerbation, use a **metered-dose inhaler (MDI) plus spacer**.
  
  - People with **severe dyspnoea with low inspiratory flow rates** may have difficulty achieving proper technique and medication delivery from the MDI; a **nebuliser** may be easier for these patients to use.
  
  - You may see benefit from this initial treatment **within 30 minutes**.

- During the COVID-19 pandemic, seek advice from a respiratory specialist and consult local guidelines before using a nebuliser.

  - There are currently differences of opinion between organisations in different countries on whether use of a nebuliser is an aerosol-generating procedure.
  
  - International guidelines from the Global Initiative for Chronic Obstructive Lung Disease (GOLD) recommend minimal use
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Acute

of nebulisers, advising that inhalers should ideally be used for drug delivery instead. GOLD acknowledges that nebulisers may be needed in critically ill patients with COVID-19 receiving ventilatory support. GOLD recommends using a mesh nebuliser (to keep the circuit intact and prevent virus transmission) if absolutely necessary to do so (e.g., in ventilated patients).[1] However, nebulisers are not considered to represent a significant infectious risk for COVID-19 according to Public Health England and the UK National Institute for Health and Care Excellence.[128] [129]

• For more detailed information on COVID-19 see our topic [Coronavirus disease 2019 (COVID-19)].

Practical tip

Observe patients while they use an MDI. It is common for patients to need advice and training on technique. If a patient is struggling to obtain the required dose, switch to a nebuliser.

» Add a short-acting muscarinic antagonist (e.g., ipratropium) administered via a nebuliser if the initial dose of the short-acting beta-2 agonist does not provide sufficient and prompt benefit. [1] [126]

• Short-acting beta-2 agonists are typically favoured as a first-line option as they tend to have a more rapid effect than antimuscarinics.

» Give ipratropium alone if the patient experiences adverse effects due to salbutamol (e.g., tremor, palpitations, headache, nausea, dizziness).

» To avoid overdose, stop any long-acting muscarinic antagonist the patient may already be on for maintenance therapy (e.g., aclidinium, glycopyrronium, tiotropium, umeclidinium) while the short-acting muscarinic antagonist is given.

• Continue the long-acting beta-2 agonist (the patient’s maintenance therapy) alongside the additional short-acting beta-2 agonist needed for recovery from the exacerbation.
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Management

Acute

• Many patients are on a long-acting beta-2 agonist/long-acting muscarinic antagonist (with or without a corticosteroid) combination inhaler for maintenance therapy. If this is the case, stop the combination inhaler during the acute exacerbation.

» Seek specialist advice on the optimal method of delivering bronchodilators (MDI or nebuliser) to adults with COPD exacerbation who are receiving mechanical ventilation via endotracheal tube.

• There is insufficient evidence to recommend one route of delivery over the other.[130]

Consider systemic corticosteroid

Treatment recommended for SOME patients in selected patient group

Primary options

» prednisolone: 30 mg orally once daily

OR

» hydrocortisone sodium succinate: 100 mg intravenously every 6 hours; convert to oral prednisolone as soon as possible to complete course

Consider a systemic (oral or intravenous) corticosteroid. [1] [88] Oral administration is preferred; however, some patients may require intravenous administration if they cannot tolerate oral therapy (e.g., if they are vomiting).

• National Institute for Health and Care Excellence and Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines recommend a 5-day treatment course .[1] [88]

• Latest evidence shows no benefit from prolonged therapy.[131]

• Corticosteroids are associated with risk of pneumonia, sepsis, and death and should only be used in patients with significant exacerbations.[1]

• Avoid use of a corticosteroid with a fluoroquinolone antibiotic, because co-administration could exacerbate...
Acute exacerbation of chronic obstructive pulmonary disease Management

Acute fluorquinolone-induced tendinitis and tendon rupture.[132]

Evidence: Corticosteroids

Evidence shows no benefit from prolonged therapy of corticosteroids.

A Cochrane review compared the efficacy of short-duration (7 or fewer days) and conventional longer duration (longer than 7 days) systemic corticosteroid treatment of adults with acute exacerbations of COPD. [131] #

- Eight studies with 582 participants were included.
- Corticosteroid treatment was given at equivalent daily doses for 3 to 7 days for short-duration treatment and for 10 to 15 days for longer-duration treatment.
- Patients treated for 7 or fewer days did not have a higher rate of treatment failure.
- Time in hospital and lung function at the end of treatment were not different.
- No differences in side effects or death were noted between treatments.

The balance of risks and benefits of corticosteroids for people with milder exacerbations is uncertain.

- Note that there may be guidance in future over which patients to prescribe corticosteroids to, in an effort to reduce their prescription.
- At the moment there is no consensus owing to a lack of peer-reviewed data. Eosinophil count may become a useful determinant of this.[133]

consider oxygen

Treatment recommended for SOME patients in selected patient group

» Check arterial blood gas and pulse oximetry on presentation and then after 30 to 60 minutes to ensure satisfactory oxygenation and monitor for carbon dioxide retention and acidosis. [1] [98] #
Acute exacerbation of chronic obstructive pulmonary disease

Management

**Acute**

- **Administer the oxygen in a controlled fashion via a Venturi mask** to deliver 24% to 28% oxygen.[98]
- **Titrate controlled oxygen** to a target saturation of 88% to 92% as COPD patients are considered at risk for hypercapnic (type 2) respiratory failure.[1][98][102]
- Document the fraction of inspired oxygen (FiO₂) or O₂ flow rate.

» **Repeat arterial blood gas (ABG)** if the patient’s clinical condition deteriorates or they fail to respond to initial therapy.

» **Avoid excessive oxygen use** in patients with COPD due to the risk of hypercapnic (type 2) respiratory failure.

- It is likely that there are at least six mechanisms responsible for oxygen-induced hypercapnia:[98]
  - V/Q mismatch
  - Ventilatory drive
  - Haldane effect (the ability of deoxyhaemoglobin to carry more carbon dioxide than oxyhaemoglobin[136])
  - Absorption atelectasis
  - Higher density of oxygen compared with air
  - Rebreathing can occur if low oxygen flow rates are used through a face mask.

- **Risk factors** for hypercapnic respiratory failure include:
  - Previous respiratory failure
  - Morbid obesity[98]
  - Chest wall deformities, such as severe kyphoscoliosis[98]
  - Neuromuscular disorders[98]
  - Fixed airflow obstruction associated with bronchiectasis[98]
  - Concurrent obstructive sleep apnoea.

- The **risk of respiratory acidosis** in patients with hypercapnic respiratory failure is **increased** if the PaO₂ is **above 10.0 kPa** (75 mmHg) due to previous excessive oxygen use.[98]
Acute exacerbation of chronic obstructive pulmonary disease

### Management

**Acute**

- **Use a Venturi mask in preference to nasal prongs as they offer a more accurate delivery of oxygen.** [1] #
  - More evidence is needed on the use of high-flow oxygen therapy by nasal cannula in patients with acute exacerbations of COPD.[1]

**Practical tip**

Beware that hypercapnic respiratory failure may occur as a consequence of high oxygen delivery in an ambulance when attempting hypoxaemia correction.[127] Note that nasal prongs and standard Hudson masks do not deliver controlled oxygen.

- **Gradually reduce oxygen therapy as the patient recovers.** [98]
- **Discontinue oxygen therapy once the patient can maintain their target oxygen saturation on room air.** [98]
  - Bear in mind that some patients will be on long-term oxygen therapy as part of their usual treatment and this will need to be maintained.

**Consider ventilation**

Treatment recommended for SOME patients in selected patient group

- **Start non-invasive ventilation (NIV) for patients who have acute hypercapnic respiratory failure (pH <7.35, PaCO\(_2\) >6.5 kPa), despite optimal medical therapy,** [102] # and have no contraindications. [127]
  - NIV:[1][150]
    - Improves survival
    - Improves gas exchange
    - Reduces the work of breathing
    - Reduces the need for intubation
    - Decreases length of hospital stay.

- **Provide non-invasive mechanical ventilation to patients with any of the following:** [1] #
  - Respiratory acidosis (pH <7.35 and PaCO\(_2\) >6.5 kPa). [102]
• Acidaemia implies a severe exacerbation and predicts in-hospital and 30-day mortality.\[103\]
• The evidence is less clear for patients with arterial pH ≤7.25. In these patients NIV may be used as a ceiling of care treatment for severe hypercapnic acidaemic ventilatory failure.

• **Severe dyspnoea** (as shown by use of respiratory accessory muscles, paradoxical motion of the abdomen, or retraction of intercostal spaces).
• **Persistent hypoxaemia** despite supplemental oxygen.

» Follow your hospital’s protocol for initiation of NIV and subsequent management.#

• This should include recommendations on pressures, oxygen titrations, and frequency of ABGs.

» In general:

• Monitor oxygen saturations continuously. \[102\] #
• Take intermittent measurements of PaCO$_2$ and pH. \[102\] #
• Use ECG monitoring if the patient has a pulse rate >120 bpm or if there is dysrhythmia or possible cardiomyopathy. \[102\] #
• Frequently assess the patient to monitor for any complications occurring.

» The British Thoracic Society sets out specific timeframes as measurable markers of good practice for the use of acute NIV in the UK. \[93\] \[104\] #

• For patients who meet the criteria for acute NIV, start it within:

  • 60 minutes of the blood gas result associated with the clinical decision to go ahead with NIV
  • 120 minutes of hospital arrival for patients who present acutely.

• Review the patient’s clinical progress within 4 hours of starting NIV.
Acute exacerbation of chronic obstructive pulmonary disease

Management

Acute

• This should be done by a healthcare professional with appropriate training and competence.

• A consultant with training and competence in acute NIV should review the patient’s clinical progress within 14 hours of starting acute NIV.

» If possible, perform a blood gas analysis within 30-60 minutes of starting acute NIV.

• Although the BTS recommends performing a blood gas analysis within 2 hours of starting NIV,[104] in practice, specialists recommend ideally waiting only 30-60 minutes to check for changes in PaCO$_2$ and pH.

• Arrange review by a specialist healthcare professional with expertise in managing patients on NIV within 30 minutes if the blood gas measurements have failed to improve.

» Plan with senior colleagues what to do if the patient deteriorates,[102] including ‘ceilings of care’, [88] and consider DNACPR (‘Do Not Attempt Cardiopulmonary Resuscitation’) for patients not suitable for escalation to an intensive care unit.

• See Diagnostic recommendations for specific advice on care planning.

» Admit the patient to an intensive care unit if they have:[1]

• Severe dyspnoea with a poor response to initial emergency therapy

• Changes in mental status

• Persistent or worsening hypoxaemia (PaO$_2$ <40 mmHg or 5.3 kPa) and/or severe or worsening respiratory acidosis (pH <7.25) despite supplemental oxygen and non-invasive ventilation

• Need for invasive mechanical ventilation

• Haemodynamic instability (need for vasopressors).

» Only consider invasive ventilation after careful consideration and discussion with the senior medical team. [1]
• This is not purely a clinical decision and there are no absolute numerical thresholds to adhere to. You will need to take many factors into account, including the patient's own wishes regarding resuscitation.
• Compare the patient’s functional status to their baseline and consider their overall fitness for ventilation.
• Indications for invasive mechanical ventilation include:[1]
  • Unable to tolerate NIV
  • When NIV has failed
  • Post respiratory arrest or cardiac arrest
  • Diminished consciousness or inadequately controlled psychomotor agitation
  • Massive aspiration or persistent vomiting
  • Persistent respiratory secretions that cannot be removed
  • Severe haemodynamic instability, not successfully treated with fluid and drugs
  • Severe arrhythmias
  • Hypoxaemia and unable to tolerate NIV.
• Complications associated with mechanical ventilation include:[1]
  • Ventilator-associated pneumonia
  • Barotrauma
  • Volutrauma
  • Respiratory weakness after prolonged ventilation (weaning and tracheostomy may be required to manage this).

» **When assessing suitability for intubation and ventilation, take into account:** [88]
  • Functional status
  • BMI
  • Need for oxygen when stable
  • Comorbidities
Acute exacerbation of chronic obstructive pulmonary disease

Management

**Acute**

- Previous admissions to intensive care units
- Age
- FEV₁

- Do not use age or FEV₁ in isolation when assessing suitability for intubation and ventilation.

**consider antibiotic therapy**

Treatment recommended for SOME patients in selected patient group

**Primary options**

- **amoxicillin**: 500 mg orally three times daily, may increase to 1000 mg three times daily in severe infections; 500 mg intravenously every 8 hours, may increase to 1000 mg every 6 hours in severe infections

**OR**

- **doxycycline**: 200 mg orally on the first day, followed by 100 mg once daily thereafter, may increase to 200 mg once daily in severe infections

**OR**

- **clarithromycin**: 500 mg orally (immediate-release)/intravenously twice daily

**Secondary options**

- **amoxicillin/clavulanate**: 500/125 mg orally three times daily; 1.2 g intravenously every 8 hours
  Intravenous dose consists of 1 g of amoxicillin plus 0.2 g of clavulanate.

**OR**

- **trimethoprim/sulfamethoxazole**: 160/800 mg orally twice daily; 160/800 mg intravenously every 12 hours, may increase to 240/1200 mg every 12 hours in severe infections
  Also known as cotrimoxazole. Should only be considered in acute exacerbations of COPD when there is bacteriological evidence of sensitivity and good reason to prefer this combination to a single antibiotic. National Institute for Health and Care Excellence.
Acute exacerbation of chronic obstructive pulmonary disease

**Management**

Acute exacerbation: antimicrobial prescribing. December 2018 [internet publication]. https://www.nice.org.uk/guidance/ng114

OR

- **piperacillin/tazobactam**: 4.5 g intravenously every 8 hours, may increase to 4.5 g every 6 hours in severe infections
  - Dose consists of 4 g of piperacillin plus 0.5 g of tazobactam.

OR

- **levofloxacin**: 500 mg orally once daily for 5 days

Give antibiotics to any patient who needs ventilation (invasive or non-invasive) or patients experiencing exacerbations with: [1] #

- Increase in sputum purulence, plus
- Increase in sputum volume, and/or
- Increased dyspnoea.

As well as the severity of symptoms, particularly sputum colour changes and increases in volume or thickness beyond the patient’s normal day-to-day variation, the National Institute for Health and Care Excellence (NICE) urges you to also consider: [97]

- Whether the patient needs to go into hospital for treatment
- Previous exacerbation and hospital admission history
- Risk of developing complications
- Previous sputum culture and susceptibility results
- Risk of antimicrobial resistance with repeated courses of antibiotics.

Choose an antibiotic based on local resistance patterns, any previous culture results for the individual patient, [1] # and local antibiotic guidelines.

- Duration of therapy will tend to be 5 to 7 days, but consult your local guidelines. [1]
  - More recent guidance from the American College of Physicians recommends limiting antibiotic treatment to 5 days in patients with...
Acute exacerbation of chronic obstructive pulmonary disease

**Management**

**Acute**

COPD exacerbations and acute uncomplicated bronchitis.[141]

- When used appropriately, antibiotics can:[1]
  - Shorten recovery time
  - Reduce the risk of early relapse and treatment failure
  - Shorten the length of hospital stay.

» Give oral antibiotics first-line if the patient is able to tolerate oral medications, and if the severity of the exacerbation does not require intravenous antibiotics. [1] [97]

- If a patient is started on intravenous antibiotics, review them by 48 hours and consider stepping down to oral therapy where possible.[97]
- NICE recommends amoxicillin, doxycycline, or clarithromycin as suitable first-line oral options. Alternative oral options include amoxicillin/clavulanate, levofloxacin, and trimethoprim/sulfamethoxazole. Suitable first-line intravenous options include amoxicillin, amoxicillin/clavulanate, clarithromycin, trimethoprim/sulfamethoxazole, or piperacillin/tazobactam.[97]
- It is worth noting that you must not prescribe fluoroquinolones (e.g., levofloxacin) for mild to moderate acute exacerbation of COPD unless other antibiotics are considered inappropriate. This is due to reports of disabling, long-lasting, or potentially irreversible adverse reactions affecting the musculoskeletal and nervous systems.[132] [142] Avoid fluoroquinolones in patients who have previously had serious adverse effects with a fluoroquinolone antibiotic. Avoid use of a corticosteroid with a fluoroquinolone, because co-administration could exacerbate fluoroquinolone-induced tendinitis and tendon rupture.[132]

» Look for improvements in dyspnoea and sputum purulence to measure success of antibiotic treatment. [1]

» Additional considerations in the community:
Acute exacerbation of chronic obstructive pulmonary disease

**Management**

**Acute**

- Give the patient/their family specific advice about when to seek further medical help, in particular: [97]
  - If symptoms worsen rapidly or significantly
  - If symptoms do not start to improve within an agreed time (e.g., 2-3 days if taking antibiotics)
  - If the patient becomes systemically very unwell.
- Give advice on possible adverse effects of antibiotics (particularly diarrhoea). [97]
- Explain that their respiratory symptoms may not be fully resolved when the course has been completed. [97]
- Reassess the patient if their symptoms worsen rapidly or significantly. In particular:
  - Beware symptoms and signs of:
    - Pneumonia
    - Cardiorespiratory failure
    - Sepsis.
  - Refer the patient to hospital if you suspect a more serious illness (e.g., sepsis or cardiorespiratory failure).
- Consider antibiotic-resistant bacteria and send a sputum sample for microscopy, culture, and Gram stain if symptoms have not improved following antibiotic treatment and these tests have not been done already. [97]
  - Only request sputum microscopy, culture, and Gram stain in severe disease and if hospitalisation is being considered. This is not a routine investigation in primary care. [88]
- Seek specialist advice for patients: [97]
  - Whose symptoms do not improve after repeated courses of antibiotics
  - Who have bacteria that are resistant to oral antibiotics
  - Who cannot take oral medications.
Acute exacerbation of chronic obstructive pulmonary disease

Management

• Other options may be to give intravenous antibiotics at home or in the community, rather than in hospital, where appropriate.

• Some patients will keep antibiotics at home for use in an exacerbation as part of their existing action plan.

Evidence: Efficacy of antibiotics[143]

Antibiotics offer a large and consistent beneficial effect across outcomes of patients admitted to an intensive care unit (ICU), but for inpatients and outpatients the effects are inconsistent.

A Cochrane review of 19 trials with 2663 participants looked at the effects of antibiotics in the management of acute COPD exacerbations on:

• Treatment failure (observed 7 days to 1 month after treatment initiation)
• Mortality
• Adverse events
• Length of hospital stay.

In the study:

• Three groups of patients were considered:
  • Outpatients (mild to moderate exacerbation)
  • Inpatients (severe exacerbation)
  • ICU patients (very severe exacerbation)

• In outpatients, there was low-quality evidence that antibiotics do significantly reduce the risk for treatment failure between 7 days and 1 month after treatment initiation (RR 0.72, 95% CI 0.56 to 0.94).

• In inpatients (excluding ICU), moderate-quality evidence does not show that antibiotics significantly reduce the risk of treatment failure in
Acute exacerbation of chronic obstructive pulmonary disease

### Management

**Acute**

- Inpatients with severe exacerbations (RR 0.65, 95% CI 0.38 to 1.12).
  - In ICU patients:
    - A trial of 93 patients showed a large and statistically significant effect of antibiotics on treatment failure (RR 0.19, 95% CI 0.08 to 0.45).
    - Antibiotics significantly reduced length of hospital stay (mean difference -9.60 days, 95% CI -12.84 to -6.36 days).
  - Length of hospital stay (in days) was similar in the antibiotics and placebo groups for inpatients.
  - The authors conclude that there is a beneficial effect across outcomes of patients admitted to an ICU, but that for inpatients and outpatients the effects of antibiotics are inconsistent.[143]

**Evidence: Choice of antibiotic**

Choose an antibiotic regimen based on local resistance patterns, any previous culture results for the individual patient [1] and local antibiotic guidelines.

A review of 19 randomised controlled trials (RCTs) found that macrolides, fluoroquinolones, and amoxicillin/clavulanate may be considered equivalent for the treatment of patients with an acute bacterial exacerbation of chronic bronchitis in short-term effectiveness. [144]

- Treatment success was lower for macrolides compared with fluoroquinolones (OR 0.47, 95% CI 0.31 to 0.69).
- Fewer fluoroquinolone recipients experienced a recurrence of acute exacerbation after resolution of the initial episode, compared with macrolide recipients, during the 26-week period following therapy.
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Management

Acute

• Amoxicillin/clavulanate was associated with more adverse effects (mainly diarrhoea) than fluoroquinolones (OR 1.36, 95% CI 1.01 to 1.85).

An analysis of five RCTs involving 287 patients found that there were no differences between patients with acute exacerbation of chronic bronchitis receiving semisynthetic penicillins (e.g., amoxicillin, ampicillin) and those receiving trimethoprim-based regimens (e.g., trimethoprim, trimethoprim/sulfamethoxazole, trimethoprim/sulfadiazine) in: [145]#

• Treatment success (intention-to-treat patients: n = 26; OR 1.68, 95% CI 0.91 to 3.09; clinically evaluable patients: n = 246; OR 1.59, 95% CI 0.79 to 3.20).
• Number of drug-related adverse events in general (n = 186 patients; OR 0.37, 95% CI 0.11 to 1.24).

Consider supplemental treatment

Treatment recommended for SOME patients in selected patient group

» Monitor fluid balance.

• This may be particularly important in patients with comorbidities, such as heart failure.

» Depending on the patient’s clinical condition, you may need to:[1]#

• Treat any comorbidities
  • Comorbidities, such as lung cancer, cardiovascular disease, osteoporosis, and depression, are common in patients with COPD
  • Consider any other drugs the patient is taking
  • Administer prophylaxis against thromboembolism, if needed
• Give nutritional supplements
• Patients with COPD who are undernourished are at an increased risk of exacerbations.
Ongoing

after stabilisation

1st monitor recovery and plan discharge

» Regularly assess symptoms and observe the patient’s functional status. [88]

- Use intermittent arterial blood gas (ABG) measurements to monitor the recovery of people with respiratory failure who are hypercapnic or acidotic, until they are stable with a normalised pH. [88]
- Use pulse oximetry to monitor the recovery of people with non-hypercapnic, non-acidotic respiratory failure. [88]
- Do not use daily monitoring of peak expiratory flow or FEV₁ to monitor recovery from an exacerbation, because the magnitude of change is small compared with the variability of the measurement. [88]

Practical tip

Change drug delivery from a nebuliser to an MDI once the patient has stabilised. This may allow an earlier discharge from hospital.

» You (along with the patient and family) should be confident that the patient can manage their symptoms at home before they are discharged.

- If the patient smokes, reinforce the advice to the patient that they must stop smoking and provide information on how to access the services that help with this. [147] #
  - Offer a 'harm reduction' approach, such as reducing the number of cigarettes smoked or temporary abstinence. This may be a practical step for patients struggling to quit. [148]
- Review the patient’s long-term medication.
  - Re-establish people on their optimal maintenance bronchodilator therapy before discharge. [88]
Acute exacerbation of chronic obstructive pulmonary disease

Management

**Ongoing**

- Provide vitamin D supplementation, if required. Supplementation of patients with severe deficiency results in a reduction in exacerbations and hospitalisation.[1]
- **Consider a hospital-at-home or assisted discharge scheme, where available, once the patient is stable.** [88] [149] [150]
  - The decision over which patients are suitable for such schemes will need a team approach, as will the implementation of such schemes. Take patient factors and preferences into account.[88] Consider using a validated prognostic score, such as the DECAF (Dyspnoea, Eosinopenia, Consolidation, Acidaemia, and atrial Fibrillation) score, to determine which patients are suitable for this approach.[149]
- Refer for a pulmonary rehabilitation programme, as required, to improve exercise tolerance, physical ability, and quality of life. [151] #
  - Pulmonary rehabilitation is a **multidisciplinary programme of care** that involves physical rehabilitation as well as guidance on disease management, nutrition, and other lifestyle issues (e.g., smoking cessation, medicine compliance and inhaler technique, supplemental oxygen, and maintenance of physical activity).[152]

» **Prior to discharge:** [1] [88]

- Review all clinical data and test results: identify and manage any abnormalities.
- Measure (or review previous) **spirometry** in all patients.[93]
- Ensure **satisfactory oximetry or ABG results** in patients who have had an episode of respiratory failure.
- Assess the need for **continuing oxygen therapy**.
- Check the **patient's understanding of the withdrawal of their acute medications and their re-established maintenance therapy**.
Management

**Ongoing**

- Give appropriate information on the **correct use** of medications and oxygen.
- Reassess **inhaler technique**.
- Provide a management plan for **comorbidities**.
- Make arrangements for **follow-up and home care**.

**Practical tip**

Although there are insufficient data that specific 'care bundles' at hospital discharge reduce readmission rates, improve mortality, or are cost-effective,[1] the general principles are all worth considering as part of discharge and follow-up:

- Education
- Optimisation of medication
- Supervision and correction of inhaler technique
- Assessment and management of comorbidities
- Early rehabilitation
- Telemonitoring
- Continuing patient contact.

**Evidence: Pulmonary rehabilitation[151]**

Pulmonary rehabilitation was found to be a safe intervention to improve quality of life and exercise capacity for patients with COPD after an exacerbation.

A Cochrane review looked at 20 studies involving 1477 participants with COPD to assess the impact of pulmonary rehabilitation after an exacerbation of COPD versus usual care.

- Quality of life was measured using questionnaires and exercise capacity was measured using walking tests, such as the 6-minute walk test.
- Eight studies that used the St George’s Respiratory Questionnaire reported a statistically significant effect on total score.
- Thirteen studies involving 819 participants used the 6-minute walk.
### Primary prevention

Multiple factors impact the risk of subsequent exacerbations and these vary among individual patients. Following COPD exacerbation, every effort should be made to both identify and mitigate potentially modifiable factors to reduce the risk of subsequent exacerbation events.

Previous exacerbation history is a key risk factor for future exacerbations.[1] [55] People with a high burden of symptoms and history of frequent exacerbations are at particular risk of future exacerbations and mortality.[1] [80]

Offer smoking cessation advice and treatment to all people with COPD who smoke.[81] Smoking cessation can reduce the risk of exacerbations in people with COPD.[82] See our topic Smoking cessation.

Advise all patients to avoid other potential triggers such as wood smoke, dust, and other airborne pollutants.

A primary goal of treating stable COPD is to reduce symptoms and future risk of exacerbations.[1] Vaccinations can reduce the chance of COPD exacerbations; specifically consider the following.

- Pneumonia: in the UK, all patients with COPD should receive pneumococcal immunisation with a single dose of PPV23.[83] Outside of the UK, many countries follow recommendations from the Global Initiative for Chronic Obstructive Lung Disease (GOLD) that all patients >65 years of age should receive PCV13 and PPSV23. The PPSV23 is also recommended by GOLD for younger COPD patients with significant comorbid conditions including chronic heart or lung disease.[1]
Acute exacerbation of chronic obstructive pulmonary disease

Management

- Evidence from a Cochrane review showed that pneumococcal vaccination in people with COPD reduced the chance of an acute exacerbation (and additionally provided some protection against community-acquired pneumonia).[84]

- Influenza: all patients with COPD should be vaccinated against influenza virus to reduce COPD exacerbations.[1] [85]

- Evidence from randomised controlled trials showed that inactivated influenza vaccination had a clinically important and significant effect on influenza-related exacerbations, and probably an effect on the total number of exacerbations, in people with COPD.[86]

- Tetanus/diphtheria/pertussis: GOLD endorses the recommendation from the US Centers for Disease Control and Prevention that all patients with COPD who have not been vaccinated against tetanus/diphtheria/pertussis in adolescence should receive the Tdap vaccine.[1] However, bear in mind that this is not a current recommendation in some countries, including the UK.

Consider also prophylactic pharmacotherapy.

- Consider using mucolytic agents to decrease exacerbations in people with COPD. Mucolytic agents may be beneficial in reducing days of disability per month and possibly hospitalisations.[87] The 2021 GOLD guideline states that treatment with mucolytic agents such as carbocisteine and acetylcysteine may be most beneficial for patients not on inhaled corticosteroids. GOLD also states that erdosteine may have a significant effect on (mild) exacerbations, irrespective of concurrent treatment with inhaled corticosteroids.[1] However, bear in mind that the National Institute for Health and Care Excellence in the UK does not recommend routinely using mucolytics to prevent exacerbations in people with stable COPD.[88]

- A specialist team might consider prophylactic use of a macrolide antibiotic for preventing exacerbations on an individual patient basis. Although there appears to be some benefit of using macrolides in decreasing exacerbations, this is based on a limited number of studies, and concerns remain about antibiotic resistance with long-term use.[89] In clinical practice, prophylactic antibiotics are contraindicated in patients with previously isolated non-tuberculous mycobacteria, due to the risk of developing resistant non-tuberculous mycobacteria.

Secondary prevention

After an exacerbation, ensure the patient understands their usual treatment regimen and assess their inhaler technique. Discuss the importance of adhering to their routine COPD medication and explain that they may develop worsening signs and symptoms if they don’t continue with their usual regimen as prescribed.[245] A goal of managing stable COPD is to reduce further exacerbations.[1]

In addition, advise the patient to continue with other measures that will contribute to the prevention of further exacerbations, such as seasonal vaccines, smoking cessation, and trigger avoidance; consider prophylactic pharmacotherapy as appropriate. For more on this, see Primary prevention.

Provide vitamin D supplementation, if required. Supplementation of patients with severe deficiency results in a reduction in exacerbations and hospitalisation.[1]

People with COPD tend to be less physically active than those without the condition, and low physical activity levels are associated with a faster rate of decline in lung function and increased hospitalisations for COPD exacerbations over time.[239] [246] [247] Encourage patients to participate in pulmonary rehabilitation programmes, where available. Pulmonary rehabilitation is a multidisciplinary programme of care that involves physical rehabilitation as well as guidance on disease management, nutrition, and other lifestyle issues (e.g., smoking cessation, medicine compliance and inhaler technique, supplemental oxygen, and maintenance of physical activity).[152] These initiatives can improve exercise tolerance, physical ability, and quality of life, therefore playing an important role in the prevention of subsequent exacerbations.[151]

Consider a hospital-at-home or assisted discharge scheme, where available, once the patient is stable.[88] [149] [150] The decision over which patients are suitable for such schemes will need a team approach, as will the implementation of such schemes. Take patient factors and preferences into account...
Acute exacerbation of chronic obstructive pulmonary disease

Management

Consider using a validated prognostic score, such as the DECAF score, to determine which patients are suitable for this approach.[149] Outpatient follow-up of patients within 30 days of hospital discharge following acute exacerbations also helps prevent readmissions and relapse of disease.[248] Action plans can help patients recognise worsening symptoms, initiate earlier treatment, and reduce overall impact of exacerbations.[81] [249]

Although tele-health is used in some regions for home-based disease monitoring and management intervention,[250] it is not currently recommended for exacerbation prevention.[1] [81] Randomised controlled trials have suggested that the use of nurse-centred tele-assistance may decrease the occurrence of exacerbations of COPD, urgent care visits, and hospitalisation.[250] The use of such programmes may be cost-saving.[251] Other analyses have suggested that home tele-monitoring may prolong the time free of hospitalisations or accident and emergency department visits,[252] but the total number of hospitalisations may not be affected and another randomised controlled trial showed no clear beneficial effects.[253]

Patient discussions

Patients with COPD often under-report symptoms of acute exacerbation.[243] Regularly ask patients at clinic visits about escalation of symptoms; ensure they understand the difference between the expected day-to-day variation in symptoms and symptoms heralding a COPD exacerbation. Advise patients to seek clinical advice if they experience fever, worsening of their respiratory status beyond usual day-to-day variation, and/or a significant increase in their production of purulent sputum.

Advise any patient with diabetes taking systemic corticosteroids for an acute exacerbation of COPD to closely monitor their blood glucose and seek medical advice if it is outside the target range.[244]

In any patient prescribed antibiotics for an exacerbation:[97]

- Give advice about possible adverse effects of the antibiotic, particularly diarrhoea.
- Explain that symptoms may not be fully resolved when the antibiotic course has been completed. Give the patient/their family specific advice about when to seek further medical help, in particular if:
  - Symptoms worsen rapidly or significantly
  - Symptoms do not start to improve within an agreed time (e.g., 2-3 days if taking antibiotics)
  - The patient becomes systemically very unwell.
Monitoring

- **Follow up patients at 1 month and 3 months (according to local service provision).** [1]
  
  - **At 1 month**: [1]
    
    - Review discharge therapy and the patient’s understanding of the treatment regimen
    - Review the need for any long-term oxygen therapy by assessing oxygen saturation and arterial blood gas
    - Consider any new need for antibiotics or corticosteroids
    - Reassess inhaler technique
    - Evaluate the patient’s ability to cope in their usual environment
    - Document their physical capabilities
    - Document current symptoms
    - Assess and manage comorbidities.
  
  - **At 3 months ensure the patient has returned to a stable clinical state**: [1]
    
    - Review symptoms
    - Review the patient’s understanding of the treatment regimen
    - Reassess inhaler technique
    - Document their physical capabilities
    - Check lung function by spirometry
    - Check oxygen saturations and blood gas to assess the need for ongoing long-term oxygen therapy
    - Assess prognosis using a scoring system, such as the Body mass index, airflow obstruction, Dyspnoea, and Exercise (BODE) index
    - Assess and manage comorbidities
    - Request a CT to check for the presence of bronchiectasis or emphysema in patients with recurrent exacerbations.

- **Advise the patient to continue with other measures that will contribute to the prevention of further exacerbations, such as seasonal vaccines, smoking cessation, and a pulmonary rehabilitation programme.** For more detailed information on prevention, see Primary prevention.

- Some presentations of an exacerbation actually represent ongoing deterioration and disease progression.
Complications

<table>
<thead>
<tr>
<th>Complications</th>
<th>Timeframe</th>
<th>Likelihood</th>
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<tbody>
<tr>
<td>mechanical ventilation and ventilator-associated pneumonia</td>
<td>short term</td>
<td>high</td>
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</tbody>
</table>

Patients who are ventilated are at high risk of infection. May be due to aspiration following intubation and/or related to bypassing normal anatomical structures involved in host defense.

<table>
<thead>
<tr>
<th>antibiotic-related diarrhoea</th>
<th>short term</th>
<th>high</th>
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Antibiotic-associated colitis, which may be due to *Clostridium difficile*, is a recognised complication of exposure to antibiotics.

<table>
<thead>
<tr>
<th>mechanical ventilation and ventilator-associated barotrauma</th>
<th>short term</th>
<th>medium</th>
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Occurs due to mechanical ventilation, and is the development of extra-alveolar air. Careful use of ventilator settings, including use of lower tidal volumes, faster inspiratory flow rates, and monitoring airway pressures may help prevent the occurrence of this complication.

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<th>hypotension due to mechanical ventilation</th>
<th>variable</th>
<th>low</th>
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Occurs due to increased intrathoracic pressure and increased dynamic hyperinflation, leading to decreased venous return to the heart, often in conjunction with relative volume depletion and/or use of anxiolytic and/or narcotic medications.

Prognosis

Morbidity and mortality among people with COPD occurs most often in the context of exacerbations. A study identified an approximately 50% 5-year mortality following hospitalisation for COPD exacerbation.[234] Re-hospitalisation and/or mortality have been associated with lower FEV₁, higher PaCO₂, lower PaO₂, lower body mass index, older age, comorbidities, and low physical activity levels.[235] [236] [237] [238] [239] [240] [241] The multidimensional CODEX (comorbidity, obstruction, dyspnoea, previous severe exacerbations) index can predict readmission and survival at 3 months and 1 year after hospitalisation for COPD exacerbation.[242]

Acute exacerbations range from very mild to severe and life-threatening.

Patients who have had a significant exacerbation of COPD may not always recover back to their pre-illness functional status. Pulmonary rehabilitation may be required to improve exercise tolerance, physical ability, and quality of life after discharge.
## Diagnostic guidelines

### United Kingdom

**Chronic obstructive pulmonary disease in over 16s: diagnosis and management**

*Published by:* National Institute for Health and Care Excellence  
*Last published:* 2019

### International

**Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: 2021 report**

*Published by:* Global Initiative for Chronic Obstructive Lung Disease  
*Last published:* 2021

### North America

**VA/DoD clinical practice guideline for the management of chronic obstructive pulmonary disease**

*Published by:* US Department of Veterans Affairs; US Department of Defense  
*Last published:* 2014

## Treatment guidelines

### United Kingdom

**Chronic obstructive pulmonary disease in over 16s: diagnosis and management**

*Published by:* National Institute for Health and Care Excellence  
*Last published:* 2019

**Chronic obstructive pulmonary disease (acute exacerbation): antimicrobial prescribing**

*Published by:* National Institute for Health and Care Excellence  
*Last published:* 2018

**BTS guideline for oxygen use in adults in healthcare and emergency settings**

*Published by:* British Thoracic Society  
*Last published:* 2017

**BTS/ICS guideline for the ventilatory management of acute hypercapnic respiratory failure in adults**

*Published by:* British Thoracic Society; Intensive Care Society  
*Last published:* 2016
<table>
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<th>Region</th>
<th>Title</th>
<th>Published by</th>
<th>Last Published</th>
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<tr>
<td>Europe</td>
<td>Guidelines for the management of adult lower respiratory tract infections</td>
<td>European Respiratory Society; European Society for Clinical Microbiology and Infectious Diseases</td>
<td>2011</td>
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<tr>
<td>International</td>
<td>Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: 2021 report</td>
<td>Global Initiative for Chronic Obstructive Lung Disease</td>
<td>2021</td>
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<tr>
<td>North America</td>
<td>ACR appropriateness criteria: acute respiratory illness in immunocompetent patients</td>
<td>American College of Radiology</td>
<td>2018</td>
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<td></td>
<td>Screening for chronic obstructive pulmonary disease</td>
<td>US Preventive Services Task Force</td>
<td>2016</td>
</tr>
<tr>
<td></td>
<td>VA/DoD clinical practice guideline for the management of chronic obstructive pulmonary disease</td>
<td>US Department of Veterans Affairs; US Department of Defense</td>
<td>2014</td>
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Online resources


2. The AMBER care bundle (external link)
Key articles


- British Thoracic Society. BTS guideline for oxygen use in healthcare and emergency settings. June 2017 [internet publication]. Full text


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Figure 1: Assess severity to determine where and how to treat the patient

Created by the BMJ Knowledge Centre based on GOLD and NICE guidelines
Acute exacerbation of chronic obstructive pulmonary disease

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4-digit numerals: 1000
numerals < 1: 0.25

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