British Thoracic Society Guideline for oxygen use in adults in healthcare and emergency settings

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The concise version of the BTS Guideline should be read in conjunction with the full version – also available for public consultation at:

https://www.brit-thoracic.org.uk/guidelines-and-quality-standards/emergency-oxygen-use-in-adult-patients-guideline/

This guideline replaces the 2008 British Thoracic Society guideline for emergency oxygen use. O'Driscoll BR, Howard LS, Davison AG; British Thoracic Society. BTS guideline for emergency oxygen use in adult patients. Thorax. 2008 Oct;63 Suppl 6:vi1-68.[1]

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Healthcare providers need to use clinical judgement, knowledge and expertise when deciding whether it is appropriate to apply recommendations for the management of patients. The recommendations cited here are a guide and may not be appropriate for use in all situations. The guidance provided does not override the responsibility of healthcare professionals to make decisions appropriate to the circumstances of each patient, in consultation with the patient and/or their guardian or carer.

Executive summary of the Guideline

Philosophy of the Guideline

- Oxygen is a treatment for hypoxaemia, not breathlessness. Oxygen has not been proven to have any consistent effect on the sensation of breathlessness in non-hypoxaemic patients.

- The essence of this guideline can be summarised simply as a requirement for oxygen to be prescribed according to a target saturation range and for those who administer oxygen therapy to monitor the patient and keep within the target saturation range.

- The Guideline recommends aiming to achieve normal or near-normal oxygen saturation for all acutely ill patients apart from those at risk of hypercapnic respiratory failure or those receiving terminal palliative care.

1. Assessing patients

- For critically ill patients, high concentration oxygen should be administered immediately (Table 1 and Chart 1) and this should be recorded afterwards in the patient's health record.

- The oxygen saturation should be checked by pulse oximetry in all breathless and acutely ill patients, "the fifth vital sign", (supplemented by blood gases when necessary) and the inspired oxygen concentration should be recorded on the observation chart with the oximetry result. (The other vital signs are Pulse rate, Blood Pressure, Temperature and Respiratory Rate).

- Pulse oximetry must be available in all locations where emergency oxygen is used. Clinical assessment is recommended if the saturation falls by ≥3% or below the target range for the patient.

- All critically ill patients should be assessed and monitored using a recognised physiological track and trigger system such as the national early warning score (NEWS).

2. Oxygen prescription

- Oxygen should be prescribed to achieve a target saturation of 94-98% for most acutely ill patients or 88-92% or patient-specific target range for those at risk of hypercapnic respiratory failure. (Tables 1-4).

- Best practice is to prescribe a target range for all hospital patients at the time of admission so that appropriate oxygen therapy can be commenced in the event of unexpected clinical deterioration with hypoxaemia and also to ensure that the oximetry section of the early warning score can be scored appropriately.

- The target saturation should be written (or ringed) on the drug chart or entered in an electronic prescribing system (Guidance on Chart 1).

3. Oxygen administration

- Oxygen should be administered by staff who are trained in oxygen administration.

- These staff should use appropriate devices and flow rates in order to achieve the target saturation range (Chart 2).

4. Monitoring and maintenance of target saturation

- Oxygen saturation and delivery system (including flow rate) should be recorded on the patient's monitoring chart.

- Oxygen delivery devices and flow rates should be adjusted to keep the oxygen saturation in the target range. Clinical assessment is required if oxygen therapy needs to be initiated or increased due to a falling saturation level.

- Oxygen should be prescribed and a signature should be entered on the drug chart on each drug round.

5. Weaning and discontinuation of oxygen therapy

- Oxygen should be reduced in stable patients with satisfactory oxygen saturation.

- Oxygen should be discontinued once the patient can maintain saturation within the target range breathing air but the prescription for a target range should be left in place in case of future deterioration and to guide early warning scores.

Key changes since the first edition of this Guideline published in 2008

Methodology:

The evidence review methodology has changed from NICE methodology to the BTS NICE accredited guideline production process which is based on SIGN methodology and adheres to AGREE methodology (see section 1).

Evidence levels and grade of recommendation:

These are now in SIGN format (see section 1 and tables 5 and 6).

Evidence base:

The evidence base for the Guideline has been updated to August 2013 (and extended to mid-2014 for key references). None of the 2008 recommendations have been challenged by new evidence but many of the existing recommendations are supported by new information. There have been many observational studies but few randomised trials directly relevant to the Guideline since 2008.

The remit of the Guideline has been extended.

The new Guideline covers not just emergency oxygen use but most oxygen use in health care settings. It also covers short-term oxygen use by health care workers outside of health care settings but domiciliary oxygen use by patients is covered by the BTS Guideline for home oxygen use in adults [2].

The scope of the guideline has been widened:

The present Guideline includes the following new topics and settings which have been requested by Guideline users:

- Postoperative and perioperative care including patient-controlled analgesia
- Endoscopy and other procedures requiring sedation
- Palliative care settings including hospices
- Use of helium-oxygen mixtures (Heliox) and nitrous oxide/oxygen mixtures (Entonox)
- Use of CPAP (continuous positive airway pressure)
- Use of oxygen by health care professionals in patients' homes
- Use of oxygen by voluntary rescue organisations and other non-NHS first responders
- High flow nasal cannulae

The structure and format of the Guideline has been changed since 2008:

The 2008 Guideline was published as a self-contained document in Thorax [1]. Additional educational materials and other resources including audit tools were made available on the British Thoracic Society website. The new Guideline exists in two complementary formats.

- A concise guideline which contains recommendations and good practice points is published in Thorax.
- The full guideline including evidence review, physiology overview, illustrations and references is available on the British Thoracic Society website **www.brit-thoracic.org.uk**

1. INTRODUCTION

1.1 Aim of the Guideline

The key aim of this Guideline is to make emergency oxygen use safer, simpler and more effective. Oxygen is probably the commonest drug used in the care of patients who present with medical emergencies. Prior to the publication of the first British Thoracic Society Guideline for Emergency Oxygen Use in Adult Patients in 2008 [1], ambulance teams and emergency department teams were likely to give oxygen to virtually all breathless or seriously ill patients and also to a large number of non-hypoxaemic patients with conditions such as ischaemic heart disease or stroke based on custom and practice. About 34% of UK ambulance journeys in 2007 involved oxygen use [3]. This translated to about two million instances of emergency oxygen use per annum by all UK ambulance services, with further use in patients' homes, GP surgeries and in hospitals. Audits of oxygen use and oxygen prescription have shown consistently poor performance in many countries and most clinicians who deal with medical emergencies have encountered adverse incidents and occasional deaths due to underuse and overuse of oxygen [4-10].

Historically, oxygen has been administered for three main indications of which only one is evidence-based. First, oxygen is given to correct hypoxaemia because severe hypoxaemia is clearly harmful to the human body. Second, oxygen has been administered to ill patients in case they might become hypoxaemic. Recent evidence suggests that, if impaired gas exchange does actually develop, this practice may actually place patients at increased risk (see online section 3). Third, a very high proportion of medical oxygen was administered because most clinicians believed, prior to 2008, that oxygen can alleviate breathlessness in most circumstances. However, there is no good evidence that oxygen relieves breathlessness in non-hypoxaemic patients. There is evidence of lack of effectiveness or minimal effectiveness in mildly hypoxaemic breathless patients with chronic obstructive pulmonary disease (COPD) and advanced cancer (see online section 6 and section 8.11.4).

Against this background, the Standards of Care Committee of the British Thoracic Society (BTS) established a working party in association with 21 other societies to produce an evidence-based guideline for emergency oxygen use in the UK. This led to the production of the 2008 British Thoracic Society Guideline for emergency oxygen use in adult patients which was the world's first guideline for emergency oxygen therapy [1]. This guideline has been implemented throughout the UK and in many other countries leading to over 200 citations in the medical literature up to the end of 2013.

The purpose of the 2015 update to the guideline is to strengthen the evidence-base of the previous guideline based on revised methodology (which meets criteria contained in the AGREE Instrument) and to extend the evidence base to the end of 2013 and extended to mid 2014 for key references [11]. Additionally, the remit of the 2008 Guideline has been broadened to cover several new aspects of oxygen use and a broader range of locations where oxygen might be used.

1.2 Intended users of the guideline and target patient populations

This guideline is mainly intended for use by all healthcare professionals who may be involved in emergency oxygen use. This will include ambulance staff, first responders, paramedics, doctors, nurses, midwives, physiotherapists, pharmacists and all other healthcare professionals who may deal with ill or breathless patients. Advice is also provided for first responders belonging to voluntary organizations or other non-NHS bodies. Information based on this guideline is available on the BTS website for use in the following situations:

- Hospital use
- Primary care use

- Ambulance use (supplemented by Ambulance service Guidance based on this guideline [12].
- Use by nursing staff and allied health professions

These abbreviated versions of the guideline contain the key recommendations and tables and charts that are relevant to the particular situation. The ‘‘mini-guidelines’’ can be downloaded by health care trusts for use on trust intranets and to produce paper versions of the guideline for key staff.

1.3 Areas covered by this guideline

The guideline addresses the use of oxygen in three main categories of adult patients in the pre-hospital and hospital setting and in other settings such as palliative care:

- Critically ill or hypoxaemic patients.
- Patients at risk of hypoxaemia.
- Non-hypoxaemic patients who may benefit from oxygen (e.g., carbon monoxide poisoning).

1.4 Areas not covered by this guideline

- Oxygen use in paediatrics: the present guideline applies only to subjects aged >16 years.
- Oxygen use for high altitude activities.
- Oxygen use during air travel.
- Underwater diving and diving accidents.
- Oxygen use in animal experiments.
- Oxygen use in high-dependency units.
- Oxygen use in intensive care units.
- Inter-hospital level 3 transfers.
- Hyperbaric oxygen.
- Respiratory support techniques including tracheal intubation, invasive ventilation and non-invasive ventilation (NIV) [Continuous Positive Airway Pressure (CPAP) is included]
- Self-initiated use of oxygen by patients who have home oxygen for any reason.
- Ongoing care of hypoxaemic patients at home.

1.5 Limitations of the guideline

This guideline is based on the best available evidence concerning oxygen therapy. However, a guideline can never be a substitute for clinical judgement in individual cases. There may be cases where it is appropriate for clinicians to act outwith the advice contained in this guideline because of the needs of individual patients, especially those with complex or interacting disease states. Furthermore, the responsibility for the care of individual patients rests with the clinician in charge of the patient’s care and the advice offered in this guideline must, of necessity, be of a general nature and should not be relied upon as the only source of advice in the treatment of individual patients. In particular, this guideline gives very little advice about the management of the many medical conditions that may cause hypoxaemia (apart from the specific issue of managing the patients’ hypoxaemia). Readers are referred to other guidelines for advice on the management of specific conditions such as COPD, pneumonia, heart failure, etc. Some of these disease-specific guidelines may suggest slightly different approaches to emergency oxygen therapy whereas the present guideline aims to provide simple all-embracing advice about oxygen therapy.

2. METHODOLOGY OF GUIDELINE PRODUCTION

2.1 Methodology

The methodology for the 2015 Guideline is described in detail in the full Guideline which is available on the BTS website at: www.brit-thoracic.org.uk The 2008 Guideline used NICE methodology but the 2015 Guideline follows the BTS Guideline Production Manual 2014 which adheres to the AGREE instrument [11 13]. Significant new areas in the 2015 Guideline include the use of oxygen during procedures requiring sedation, the non-emergency use of oxygen in health care settings and the use of CPAP, Heliox and oxygen-nitrous oxide mixtures.

2.2 Planned review and updating of the guideline

2015 guideline will be reviewed by the BTS and by the endorsing organisations within 5 years from publication.

2.3 Declarations of interest

All members of the Guideline Group made declarations of interest in line with the BTS Policy and further details can be obtained on request from BTS.

3. SUMMARY OF GUIDELINE RECOMMENDATIONS AND GOOD PRACTICE POINTS

A Achieving desirable oxygen saturation ranges in acute illness (see online sections 6 and 8 and Charts 1-2)

A1. This guideline recommends aiming to achieve a normal or near-normal oxygen saturation for all acutely ill patients apart from those at risk of hypercapnic respiratory failure. [Grade D]

A2. The recommended target saturation range for acutely ill patients not at risk of hypercapnic respiratory failure is 94–98%. [Grade D]

A3. For most patients with known COPD or other known risk factors for hypercapnic respiratory failure (e.g. morbid obesity, cystic fibrosis, chest wall deformities or neuromuscular disorders), a target saturation range of 88–92% is suggested pending the availability of blood gas results. [Grade A for COPD, Grade D for other conditions]

A4. Most non-hypoxaemic breathless patients do not benefit from oxygen therapy, but a sudden reduction of ≥3% in a patient's oxygen saturation within the target saturation range should prompt fuller assessment of the patient (and the oximeter signal) because this may be the first evidence of an acute illness. [Grade D]

A5. Because oxygenation is reduced in the supine position, fully conscious hypoxaemic patients should ideally be allowed to maintain the most upright posture possible (or the most comfortable posture for the patient) unless there are good reasons to immobilise the patient (e.g., skeletal or spinal trauma). [Grade D]

B Clinical and laboratory assessment of hypoxaemia and hypercapnia (see online section 7)

B1. Fully trained clinicians should assess all acutely ill patients by measuring pulse rate, blood pressure, temperature, respiratory rate and assessing circulating blood volume and anaemia. Expert assistance from specialists in intensive care or from other disciplines should be sought at an early stage if patients are thought to have major life-threatening illnesses and clinicians should be prepared to call for assistance when necessary including a call for a 999 ambulance in pre-hospital care or a call for the resuscitation team or ICU outreach team in hospital care. [Grade D]

B2. Initial clinical assessment and subsequent monitoring of acutely unwell patients should include the use of a recognised physiological ''track and trigger'' system, such as the national early warning score (NEWS) which may trigger clinical review due to hypoxaemia, need for supplementary oxygen or for other reasons. [Grade D]

B3. Oxygen saturation, ''the fifth vital sign'', should be checked by trained staff using pulse oximetry in all breathless and acutely ill patients (supplemented by blood gases when necessary) and the inspired oxygen device and flow rate should be recorded on the observation chart with the oximetry result. [Grade D]

B4. The presence of a normal SpO2 does not always negate the need for blood gas measurements because pulse oximetry will be normal in a patient with normal oxygen tension but abnormal blood pH or PCO2 or with a low blood oxygen content due to anaemia. Blood gases and full blood count

tests are therefore required as early as possible in all situations where these measurements may affect patient outcomes. [Grade D]

Good Practice Points for clinical assessment of patients with suspected hypoxaemia

- The medical history should be taken when possible in an acutely breathless patient and may point to the diagnosis of a particular acute illness such as pneumonia or pulmonary embolism or an exacerbation of a chronic condition such as COPD, asthma or heart failure.
- Do not discontinue oxygen therapy to obtain an oximetry measurement on room air in patients who clearly require oxygen therapy.
- Physical examination may provide evidence of a specific diagnosis such as heart failure or a large pleural effusion, but it is common for the cause of breathlessness to remain undiagnosed until the results of tests such as chest radiographs are available.
- Patients with severe hypoxaemia may present with a non-respiratory manifestation such as confusion or agitation rather than breathlessness and cyanosis is a difficult physical sign to record confidently (especially in poor light or with an anaemic or plethoric patient).
- Tachycardia and tachypnoea are more common than a physical finding of cyanosis in hypoxaemic patients.
- Appropriate changes should be made to any "track and trigger" system used to allow for a lower target range in patients at risk of type 2 respiratory failure. These patients should score no EWS points for saturation if within their target range and they should score points if the oxygen saturation falls below the target range or if the saturation rises above the target range whilst breathing oxygen.

C Arterial and arterialised capillary blood gases (see online sections 7.1.3 and 8.4 and 8.5)

C1. For critically ill patients or those with shock or hypotension (systolic blood pressure <90 mm Hg), the initial blood gas measurement should be obtained from an arterial sample. For most patients who require blood gas sampling, either arterial blood gases or arterialised earlobe blood gases may be used to obtain an accurate measure of pH and PCO2. However, the PaO2 is less accurate in earlobe blood gas samples (it underestimates the oxygen tension by 0.5– 1 kPa) so oximetry should be monitored carefully if earlobe blood gas specimens are used and a repeat arterial specimen should be taken if there is any concern about the accuracy of a capillary sample. [Grade D]

C2. Local anaesthesia should be used for all arterial blood gas specimens except in emergencies or if the patient is unconscious or anaesthetised. [Grade A]

C3. Blood gases should be checked in the following situations:
– All critically ill patients.
– Unexpected or inappropriate fall in SpO2 below 94% in patients breathing air or oxygen) or any patient requiring oxygen to achieve the above target range. (Allowance should be made for transient dips in saturation to 90% or less in normal subjects during sleep). [Grade D]
– Deteriorating oxygen saturation (fall of ≥3%.)or increasing breathlessness in a patient with previously stable chronic hypoxaemia (e.g. severe COPD). [Grade D]
– Most previously stable patients who deteriorate clinically and require increased FiO_2 to maintain a constant oxygen saturation. [Grade D]
– Any patient with risk factors for hypercapnic respiratory failure who develops acute breathlessness, deteriorating oxygen saturation, drowsiness or other symptoms of carbon dioxide retention. [Grade D]
– Patients with breathlessness who are thought to be at risk of metabolic conditions such as diabetic ketoacidosis or metabolic acidosis due to renal failure. [Grade D]
– Any other evidence from the patient's medical condition that would indicate that blood gas results would be useful in the patient's management (e.g. an unexpected change in ''track and trigger''

systems such as a sudden rise of several units in the NEWS score or an unexpected fall in oxygen saturation of 3% or more, even if within the target range). [Grade D]

Good Practice Point: Patients requiring increased concentration of oxygen

- The requirement for an increased concentration of oxygen is an indication for urgent clinical reassessment of the patient (and repeat blood gas measurements in most instances, see recommendations V13 and V18 for exceptions).

D Initial oxygen therapy; initial choice of equipment for patients who do not have critical illness (see charts 1-2 and table 2 and online section 8.9 and section 10). *Initial oxygen therapy in critical illness is covered in the next section*

D1. For acutely breathless patients not at risk of hypercapnic respiratory failure who have saturations below 85%, treatment should be commenced with a reservoir mask at 15 l/min in the first instance. The oxygen concentration can be adjusted downwards (using nasal cannulae or a simple face mask) to maintain a target saturation of 94–98% once the patient has stabilised. [Grade D]

D2. In other cases of acute hypoxaemia without critical illness or risk factors for hypercapnic respiratory failure, treatment should be commenced with nasal cannulae (or a simple face mask if cannulae are not tolerated or not effective) with the flow rate adjusted to achieve a saturation of 94–98%. [Grade D]

D3. If medium-concentration therapy with nasal cannulae or a simple face mask does not achieve the desired saturation, change to a reservoir mask and seek senior or specialist advice. [Grade D]

Good Practice Point

- High flow nasal oxygen should be considered as an alternative to reservoir mask treatment in patients with acute hypoxaemic (type 1) respiratory failure.

*For initial management of patients at risk of hypercapnic respiratory failure, see recommendations G1 and G2

E Oxygen therapy in critical illness (see table 1 and online section 8.10)

E1. Use the highest feasible inspired oxygen for ventilation during **cardiopulmonary resuscitation.** Once spontaneous circulation has returned, aim for a target saturation range of 94-98% and take an arterial blood gas sample to guide on-going oxygen therapy. [Grade D]

E2. In **critical illness, including major trauma, sepsis**, shock and anaphylaxis, initiate treatment with a reservoir mask at 15 l/min and aim at a saturation range of 94–98%. This advice also applies to patients with critical illness who have risk factors for hypercapnia pending the results of blood gas measurements and expert assessment. In patients with spontaneous circulation and a reliable oximetry reading it may be possible to maintain a saturation of 94-98% using lower concentrations of oxygen. Grade D

E3. In cases of **drowning**, aim at an oxygen saturation of 94–98% once spontaneous circulation is restored. [Grade D]

E4. In patients with **acute seizures due to epilepsy or other causes**, high concentration oxygen should be administered until a satisfactory oximetry measurement can be obtained and clinicians should then aim an oxygen saturation of 94–98% or 88–92% if the patient is at risk of hypercapnic respiratory failure. [Grade D]

E5. In cases of **major head injury**, aim at an oxygen saturation of 94–98%. Initial treatment should involve high concentration oxygen from a reservoir mask at 15 l/min pending availability of satisfactory blood gas measurements or until the airway is secured by intubation. [Grade D]

E6. In cases of **carbon monoxide poisoning**, an apparently ‘‘normal’’ oximetry reading may be produced by carboxyhaemoglobin, so aim at an oxygen saturation of 100% and use a reservoir mask at 15 l/min irrespective of the oximeter reading and PaO2. [Grade D]

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Table 1 Critical illnesses requiring high levels of supplemental oxygen *Section 8.10*

The initial oxygen therapy is a reservoir mask at 15 l/min pending the availability of reliable oximetry readings.

For patients with spontaneous circulation and a reliable oximetry reading, it may quickly become possible to reduce the oxygen dose whilst maintaining a target saturation range of 94-98%.

If oximetry is unavailable, continue to use a reservoir mask until definitive treatment is available.

Patients with COPD and other risk factors for hypercapnia who develop critical illness should have the same initial target saturations as other critically ill patients pending the results of blood gas results after which these patients may need controlled oxygen therapy or supported ventilation if there is severe hypoxaemia and/or hypercapnia with respiratory acidosis.

	Additional Comments	Recommendations
Cardiac arrest or resuscitation	Refer to resuscitation guidelines for choice of delivery device during active resuscitation. Give highest possible inspired oxygen concentration during CPR until spontaneous circulation has been restored.	**Recommendation E1**
Shock, sepsis, major trauma, drowning, anaphylaxis, major pulmonary haemorrhage, status epilepticus	Also give specific treatment for the underlying condition	**Recommendations E2-E4**
Major Head Injury	Early tracheal intubation and ventilation if comatose.	**Recommendation E5**
Carbon Monoxide Poisoning	Give as much oxygen as possible using a bag-valve mask or reservoir mask. Check carboxyhaemoglobin levels. A normal or high oximetry reading should be disregarded because saturation monitors cannot differentiate between carboxyhaemoglobin and oxyhaemoglobin, owing to their similar absorbances. The blood gas PaO_2 will also be normal in these cases (despite the presence of tissue hypoxia).	**Recommendation E6**

COPD Chronic obstructive pulmonary disease;
PaO_2 arterial oxygen tension

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F Oxygen therapy for specific conditions that frequently require oxygen therapy (see Tables 2 and 3 and online section 8.11 and 8.13)

Respiratory conditions

F1. In **acute asthma**, aim at an oxygen saturation of 94–98%. [Grade D]

F2. In cases of **pneumonia** who are not at risk of hypercapnic respiratory failure, aim at an oxygen saturation of 94– 98%. [Grade D]

F3. In acute **breathlessness due to lung cancer**, aim at an oxygen saturation of 94–98% unless there is coexisting COPD. See also 'Oxygen use in Palliative Care'. [Grade D]

F4. In **acute deterioration of pulmonary fibrosis or other interstitial lung diseases**, aim at an oxygen saturation of 94–98% or the highest possible if these targets cannot be achieved. [Grade D]

F5. In most cases of **pneumothorax**, aim at an oxygen saturation of 94–98% if the patient is not at risk of hypercapnic respiratory failure. [Grade D]

F6. In patients with pneumothorax having hospital observation without drainage, the use of high concentration oxygen (15 l/min flow rate via reservoir mask) is recommended unless the patient is at risk of hypercapnic respiratory failure. [Grade D]

F7. In **pleural effusion**, aim at an oxygen saturation of 94–98% (or 88–92% if the patient is at risk of hypercapnic respiratory failure). [Grade D]

F8. In **pulmonary embolism**, aim at an oxygen saturation of 94– 98% (or 88–92% if the patient is at risk of hypercapnic respiratory failure). [Grade D]

Non-respiratory conditions

F9. In **acute heart failure**, aim at an oxygen saturation of 94– 98% (or 88–92% if the patient is at risk of hypercapnic respiratory failure). [Grade D]

F10. Consider treatment with continuous positive airway pressure to relieve symptoms of heart failure if there is hypoxaemia or treatment with non-invasive ventilation if there is co-existent hypercapnia with acidosis. [Grade B]

F11. In **anaemia**, aim at an oxygen saturation of 94–98% or 88– 92% if the patient is at risk of hypercapnic respiratory failure. [Grade D]

Good Practice Point:
Correction of anaemia by blood transfusion should be based on national guidelines.

F12. In **sickle cell crisis** and acute chest syndrome, aim for an oxygen saturation of 94–98% or aim at the saturation level that is usual for the individual patient. [Grade D]

Good Practice Point regarding sickle cell crisis
Arterial or arterialised capillary blood gases should be sampled if there is any doubt about the reliability of oximetry during a sickle cell crisis.

F13. In **myocardial infarction and acute coronary syndromes**, aim at an oxygen saturation of 94–98% or 88–92% if the patient is at risk of hypercapnic respiratory failure. [Grade D]

F14. High concentrations of oxygen should be avoided in **stroke patients**, unless required to maintain normal oxygen saturation. Aim at an oxygen saturation of 94–98% or 88–92% if the patient is at risk of hypercapnic respiratory failure. [Grade D]

Good Practice Points regarding stroke management

- Oxygen saturation should be monitored at least every 4 hours throughout the day and night in patients with acute stroke and all episodes of hypoxaemia treated**.**
- Patients with hypoxaemia post stroke require medical review to establish and treat the cause.
- Oxygen should only be given once the airway has been cleared and at the lowest concentration necessary to achieve an oxygen saturation of 94–98% or 88–92% if the patient is at risk of hypercapnic respiratory failure.
- Oxygen should be given via nasal cannulae, unless there are clear indications for a different oxygen delivery system.
- Patients with stroke and cardio-respiratory comorbidities should be positioned as upright as possible, in a chair if possible. **(see recommendation A5)**
- Patients with a reduced level of consciousness after stroke should be nursed in the recovery position**.**

Suspected hyperventilation

Good practice points regarding patients with suspected hyperventilation

- Organic illness must be excluded before making a diagnosis of hyperventilation.
- Patients with a definite diagnosis of hyperventilation should have their oxygen saturation monitored. Those with normal or high SpO2 do not require oxygen therapy.
- Rebreathing from a paper bag can be dangerous and is NOT advised as a treatment for hyperventilation.

F15. In **most poisonings**, aim at an oxygen saturation of 94–98% unless the patient is at risk of hypercapnic respiratory failure. [Grade D]

F16. In **poisoning by paraquat and bleomycin**, give oxygen only if the saturation falls below 85% and reduce or stop oxygen therapy if the saturation rises above 88% [Grade D]

F17. In most **metabolic and renal disorders**, aim at an oxygen saturation of 94–98% unless the patient is at risk of hypercapnic respiratory failure. [Grade D]

Table 2 Serious illnesses requiring moderate levels of supplemental oxygen if the patient is hypoxaemic *Section 8.11*

The initial oxygen therapy is nasal cannulae at 2-6 l/min (preferably) or simple face mask at 5-10 l/min unless stated otherwise.

For patients not at risk of hypercapnic respiratory failure who have saturation below 85%, treatment should be commenced with a reservoir mask at 15 l/min and the recommended initial oxygen saturation target range is 94-98%. If oximetry is not available, give oxygen as above until oximetry or blood gas results are available. Change to reservoir mask if the desired saturation range cannot be maintained with nasal cannulae or simple face mask (and ensure that the patient is assessed by senior medical staff).

If these patients have co-existing COPD or other risk factors for hypercapnic respiratory failure, aim at a saturation of 88-92% pending blood gas results but adjust to 94-98% if the $PaCO_2$ is normal (unless there is a history of previous hypercapnic respiratory failure requiring NIV or IPPV) and recheck blood gases after 30-60 minutes.

	Additional Comments	Recommendation
Acute hypoxaemia (cause not yet diagnosed)	Reservoir mask at 15 l/min if initial SpO_2 below 85%, otherwise nasal cannulae or simple face mask. ***Patients requiring reservoir mask therapy need urgent clinical assessment by senior staff.***	**Recommendations D1-D3**
Acute Asthma Pneumonia Lung Cancer		**Recommendations F1-F3**
Deterioration of lung fibrosis or other interstitial lung disease	Reservoir mask at 15 l/min if initial SpO_2 below 85%, otherwise nasal cannulae or simple face mask	**Recommendation F4**
Pneumothorax	Needs aspiration or drainage if the patient is hypoxaemic. Most patients with pneumothorax are not hypoxaemic and do not require oxygen therapy. Use a reservoir mask at 15 l/min if admitted for observation without chest drainage. Aim at 100% saturation to accelerate clearance of pneumothorax.	**Recommendations F5-F6**
Pleural Effusions	Most patients with pleural effusions are not hypoxaemic. If hypoxaemic, treat by draining the effusion as well as giving oxygen therapy.	**Recommendation F7**
Pulmonary Embolism	Most patients with minor pulmonary embolism are not hypoxaemic and do not require oxygen therapy.	**Recommendation F8**
Acute Heart Failure	Consider CPAP or NIV in cases of pulmonary oedema.	**Recommendations F9-F10**
Severe Anaemia	The main issue is to correct the anaemia. Most anaemic patients do not require oxygen therapy.	**Recommendations F11-12**
Post-operative Breathlessness	Management depends on underlying cause.	**Recommendation J1**

COPD-chronic obstructive pulmonary disease; CPAP- continuous positive airway pressure; IPPV- intermittent positive pressure ventilation; NIV –non-invasive ventilation; $PaCO_2$ arterial carbon dioxide tension, SpO_2-arterial oxygen saturation measured by pulse oximetry

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Table 3 Conditions for which patients should be monitored closely but oxygen therapy is not required unless the patient is hypoxaemic *Section 8.13*

If hypoxaemic, the initial oxygen therapy is nasal cannulae at 2-6 l/min or simple face mask at 5-10 l/min unless saturation is below 85% (use reservoir mask) or if at risk from hypercapnia. (see below)

The recommended initial target saturation range, unless stated otherwise, is 94-98%.
If oximetry is not available, give oxygen as above until oximetry or blood gas results are available.

If patients have COPD or other risk factors for hypercapnic respiratory failure, aim at a saturation of 88-92% pending blood gas results but adjust to 94-98% if the $PaCO_2$ is normal (unless there is a history of respiratory failure requiring NIV or IPPV) and re-check blood gases after 30-60 minutes.

	Additional Comments	Recommendations
Myocardial infarction and Acute Coronary Syndromes	Most patients with acute coronary artery syndromes are not hypoxaemic and the benefits/harms of oxygen therapy are unknown in such cases. Un-necessary use of high concentration oxygen may increase infarct size.	***Recommendation F13***
Stroke	Most stroke patients are not hypoxaemic. Oxygen therapy may be harmful for non-hypoxaemic patients with mild-moderate strokes.	***Recommendation F14***
Hyperventilation or dysfunctional breathing	Exclude organic illness. Patients with pure hyperventilation due to anxiety or panic attacks are unlikely to require oxygen therapy. Re-breathing from a paper bag may cause hypoxaemia and is not recommended.	***See section 8.13.3***
Most poisonings and drug overdoses *(See Table 1 for Carbon Monoxide poisoning)*	Hypoxaemia is more likely with respiratory depressant drugs, give antidote if available. *e.g. Naloxone for opiate poisoning* Check blood gases to exclude hypercapnia if a respiratory depressant drug has been taken. Avoid high blood oxygen levels in cases of acid aspiration as there is theoretical evidence that oxygen may be harmful in this condition. Monitor all potentially serious cases of poisoning in a Level 2 or Level 3 environment (High Dependency Unit or Intensive Care Unit)	***Recommendation F15***
Poisoning with Paraquat or Bleomycin	Patients with Paraquat poisoning or Bleomycin lung injury may be harmed by supplemental oxygen. Avoid oxygen unless the patient is hypoxaemic. Target saturation is 85-88%.	***Recommendation F16***
Metabolic & Renal disorders	Most do not need oxygen (Tachypnoea may be due to acidosis in these patients)	***Recommendation F17***
Acute and sub-acute neurological and muscular conditions producing muscle weakness	These patients may require ventilatory support and they need careful monitoring which includes spirometry. If the patient's oxygen level falls below the target saturation, they need urgent blood gas measurements and are likely to need ventilatory support.	***Recommendation G4***
Pregnancy and Obstetric Emergencies	Oxygen therapy may be harmful to the foetus if the mother is not hypoxaemic.	***Recommendations H1-H4***

COPD-chronic obstructive pulmonary disease; IPPV- intermittent positive pressure ventilation; NIV –non-invasive ventilation; $PaCO_2$ arterial carbon dioxide tension, SpO_2-arterial oxygen saturation measured by pulse oximetry

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G Patients at risk of hypercapnic respiratory failure. See Table 4 and online Section 8.12

G1 (also A3). For most patients with known COPD or other known risk factors for hypercapnic respiratory failure (e.g. morbid obesity, cystic fibrosis, chest wall deformities or neuromuscular disorders), a target saturation range of 88–92% is suggested pending the availability of blood gas results. [Grade A for COPD, Grade D for other conditions]

G2. Some patients with COPD and other conditions are vulnerable to repeated episodes of hypercapnic respiratory failure. In these cases it is recommended that treatment should be based on the results of previous blood gas estimations during acute exacerbations. For patients with prior hypercapnic failure (requiring non-invasive ventilation or intermittent positive pressure ventilation) who do not have an alert card, it is recommended that treatment should be commenced using either nasal cannulae or a 24% Venturi mask at 2-4 l/min (or a 28% Venturi mask at 4 l/min if a 24% mask is not available) with an initial target saturation of 88–92% pending urgent blood gas results. These patients should be treated as a high priority by emergency services and the oxygen concentration should be reduced if the saturation exceeds 92%. [Grade D]

Good practice points for COPD and other conditions that may cause hypercapnic respiratory failure:

Diagnosis of COPD or suspected exacerbation of COPD

- If the diagnosis is unknown, patients over 50 years of age who are long-term smokers with a history of chronic breathlessness on minor exertion such as walking on level ground and no other known cause of breathlessness should be treated as if having COPD for the purposes of this guideline.
- Measurement of spirometry may confirm (or exclude) a diagnosis of airflow obstruction and the FEV1 level is a useful indicator of disease severity in COPD. Spirometry should be measured at least once during hospital admissions for suspected COPD.

Immediate management of patients with known or suspected COPD

- Patients with a significant likelihood of severe COPD or other illness that may cause hypercapnic respiratory failure should be triaged as very urgent on arrival in hospital emergency departments and blood gases should be measured on arrival in hospital.
- Prior to availability of blood gas measurements, use a 28% Venturi mask at 4 l/min or 24% Venturi mask or nasal cannulae at 2 l/min and aim for an oxygen saturation of 88–92%
- Patients with a respiratory rate >30 breaths/min should have the flow rate set to 50% above the minimum flow rate specified for the Venturi mask packaging to compensate for the patient's increased inspiratory flow. Increasing the oxygen flow rate into a Venturi mask does not increase the concentration of oxygen which is delivered.
- If the saturation remains below 88% in pre-hospital care despite a 28% Venturi mask, change to nasal cannulae at 2– 6 l/min or a simple face mask at 5 l/min with target saturation of 88–92% and alert the A&E department that the patient is to be treated as a high priority.

Initial hospital management of patients with exacerbation of COPD

- Patients with exacerbations of COPD need careful monitoring for hypercapnic (type 2) respiratory failure with respiratory acidosis which may develop in the course of a hospital admission even if the initial blood gases were satisfactory.
- The risk of respiratory acidosis in patients with hypercapnic respiratory failure is increased if the arterial oxygen tension is above 10.0 kPa due to previous excessive oxygen use.
- If following blood gas measurements the pH and PCO2 are normal, aim for an oxygen saturation of 94–98% unless there is a history of previous hypercapnic respiratory failure requiring non-invasive ventilation or intermittent positive pressure ventilation or if the

patient's usual oxygen saturation when clinically stable is below 94% (these patients should have a target range of 88-92%). Blood gases should be repeated at 30-60 minutes to check for rising PaCO2 or falling pH.

- Recheck blood gases after 30–60 min (or if there is evidence of clinical deterioration) for all patients with COPD or other risk factors for hypercapnic respiratory failure even if the initial PaCO2 measurement was normal.
- If the PaCO2 is raised but pH is ≥7.35 ([H+] ≤45 nmol/l), the patient has probably got long-standing hypercapnia; maintain target range of 88–92% for these patients. Blood gases should be repeated at 30-60 minutes to check for rising PaCO2 or falling pH.
- If the patient is hypercapnic (PaCO2 >6 kPa or 45 mm Hg) and acidotic (pH <7.35 or [H+] >45 nmol/l), consider non-invasive ventilation, especially if the acidosis has persisted for more than 30 min despite appropriate therapy.
- For patients using Venturi masks, consider changing from Venturi mask to nasal cannulae once the patient has stabilised.

Good practice point.

Management of hypercapnia or respiratory acidosis due to excessive oxygen therapy

- If a patient is suspected to have hypercapnia or respiratory acidosis due to excessive oxygen therapy, the oxygen therapy should not be discontinued but should be stepped down to 28% or 24% oxygen from a Venturi mask or 1-2 l/min via nasal cannulae depending on oxygen saturation and subsequent blood gas results.

G3. Initial oxygen treatment of **cystic fibrosis exacerbations** should be similar to the initial oxygen treatment of COPD exacerbations with target saturation 88-92% (see sections 8.12.1-8.12.2). [Grade D]

G4. In the initial management of **musculoskeletal and neurological disorders** with acute respiratory failure, aim at an oxygen saturation of 88–92% and measure blood gases to determine if non-invasive ventilation will be required. [Grade D]

Good practice point regarding patients with neurological disorders:

Patients with respiratory failure due to acute, sub-acute or chronic neurological disorders or muscle disease are likely to require non-invasive or invasive ventilator support rather than oxygen therapy.

G5. **Morbidly obese patients** (BMI > 40 Kg/m2), even without evidence of coexistent obstructive sleep apnoea are at risk of hypoventilation and should be given titrated oxygen to maintain a target saturation of 88-92% (Grade D)

G6. **Non-invasive ventilation** should be considered for hypercapnic patients with COPD at risk of hypercapnic respiratory failure, cystic fibrosis, neuro-muscular disorders or morbid obesity if the pH is <7.35 or [H+] >45 nmol/l. [Grade D]

Table 4 COPD and other conditions requiring controlled or low-dose oxygen therapy

Section 8.12

Prior to availability of blood gases, use a 28% Venturi mask at 4 l/min or nasal cannulae at 1-2 l/min and aim for an oxygen saturation of 88-92% for patients with risk factors for hypercapnia but no prior history of respiratory acidosis (Recommendation 4). Adjust target range to 94-98% if the PaCO2 is normal (unless there is a history of previous NIV or IPPV) and recheck blood gases after 30-60 minutes.		
	Additional Comments	**Recommendations**
COPD	May need lower range if acidotic or if known to be very sensitive to oxygen therapy. Ideally use "Alert cards" to guide therapy based on previous blood gas results. Increase flow by 50% if respiratory rate is above 30 breaths per minute.	**Recommendations G1-G2 and Section 8.12.1**
Exacerbation of Cystic Fibrosis	Admit to regional CF centre if possible, if not discuss with regional centre or manage according to protocol agreed with regional CF centre. Ideally use "Alert cards" to guide therapy. Increase flow by 50% if respiratory rate is above 30breaths per minute.	**Recommendations G1, G3, G6**
Chronic Neuro-Muscular Disorders	May require ventilatory support. Risk of hypercapnic respiratory failure.	**Recommendations G1, G4, G6**
Morbid Obesity		**Recomendations G1, G5, G6**

CF-Cystic fibrosis; COPD -chronic obstructive pulmonary disease; CPAP- continuous positive airway pressure; IPPV- intermittent positive pressure ventilation; NIV –non-invasive ventilation; PaCO2 arterial carbon dioxide tension, SpO2-arterial oxygen saturation measured by pulse oximetry

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H Oxygen use during pregnancy (see online section 8.14)

H1. Women who suffer from major trauma, sepsis or acute illness during pregnancy should receive the same oxygen therapy as any other seriously ill patients, with a target oxygen saturation of 94–98%. The same target range should be applied to women with hypoxaemia due to acute complications of pregnancy (e.g., collapse related to amniotic fluid embolus, eclampsia or antepartum or postpartum haemorrhage). [Grade D]

H2. Women with underlying hypoxaemic conditions (e.g., heart failure) should be given supplemental oxygen during labour to achieve an oxygen saturation of 94–98% unless they are at risk of hypercapnic respiratory failure (target range 88-92%). [Grade D]

H3. All women with evidence of hypoxaemia who are more than 20 weeks pregnant should be managed with left lateral tilt or manual displacement of the uterus to improve cardiac output and oxygen delivery. [Grade D]

H4. The use of oxygen supplementation during intrauterine fetal resuscitation during labour was widespread in the past but there is no evidence of benefit. There is weak evidence of harm to the foetus if supplemental oxygen is given for long periods during uncomplicated labour. Overall, the use of oxygen during labour is only required when there is evidence of maternal hypoxaemia (oxygen saturation less than 94%). [Grade D]

J Oxygen use in perioperative care and during procedures requiring sedation (see online sections 8.15-8.16)

J1. Hyperoxaemia is not recommended routinely in the perioperative and postoperative period to reduce the incidence of postoperative nausea and vomiting (Grade D)

J2. All procedures involving sedation warrant routine continuous monitoring of oxygen saturation via pulse oximetry prior and during the procedure, and in the recovery period, particularly fibre-optic bronchoscopy and upper GI endoscopy where a reduction in arterial oxygen saturation is common, particularly with concurrent use of sedation. [Grade C]

J3. Significant arterial oxygen desaturation (SpO_2<90% or or fall of 4% or more that is prolonged (>1 minute during endoscopy procedures) should be corrected by supplemental oxygen with the aim of achieving target oxygen saturations of 94-98%, or 88-92% in those at risk of hypercapnic respiratory failure. [Grade D]

J4. Complicated upper GI endoscopy or procedures in patients with cardiorespiratory comorbidity are especially likely to lead to hypoxaemia and may also lead to hypercapnia, especially if the patient is heavily sedated. It is recommended that blood gases should be measured if such patients should require prolonged oxygen administration. The routine administration of oxygen is not recommended as it may delay the recognition of respiratory failure. [Grade D]

J5. Constant clinical assessment of the patient is crucial at all stages of sedation procedures and monitoring of capnography or transcutaneous carbon dioxide levels may be a useful adjunct to identify early respiratory depression. [Grade D]

J6. During the recovery period after procedures requiring sedation, supplemental oxygen should be titrated to achieve target saturations of 94-98% in most patients and 88-92% in those at risk of hypercapnic respiratory failure (see 10.5.1). (Grade D)

Good Practice Points related to oxygen use in perioperative care

- A target saturation of 94-98% is recommended for most surgical patients except those at risk of type 2 respiratory failure when a range of 88-92% should be achieved.
- Pulse oximetry monitoring is recommended for postoperative patients despite the lack of evidence from randomised studies.
- Patients using **Patient Controlled Analgesia** should have two hourly oximetry observations because of the risk of hypoxaemia. Oxygen should be administered to keep patients within the appropriate target saturation range.
- A target saturation of 94-98% is advised in most patients having PCA except those at risk of type 2 respiratory failure when a range of 88-92% should be achieved.
- There is conflicting evidence concerning the balance of potential benefits and risks of **perioperative hyperoxaemia to reduce the risk of surgical site infection in elective surgery** and there is no evidence for this practice in patients having emergency surgical procedures. More trials are required for specific procedures and more information is required concerning long-term mortality risks to cancer patients.
- Oxygen should not be used routinely for this indication and not used outside of clinical trials except in specialised centres.

K Oxygen use in Palliative Care (see online section 8.17)

K1. Oxygen use in palliative care patients should be restricted to patients with severe hypoxaemia or patients who report significant relief of breathlessness from oxygen; In non-hypoxaemic patients, opioids and non-pharmacological measures should be tried before oxygen. (Grade B)

K2. In general, there is no role for the monitoring of oxygen saturation or PaO2 in comfort-focused terminal care at the end of life. If the patient appears comfortable, oxygen levels are irrelevant and should not influence care. (Grade D)

Good Practice Points related to oxygen use in palliative care

Oxygen therapy for the symptomatic relief of dyspnoea in palliative care patients is more complex than the simple correction of hypoxaemia. Consider the following issues:

- Consider early involvement of palliative care specialists.
- As dyspnoea is a multi-factorial sensation-a comprehensive assessment of contributing factors (such as anxiety) should be carried out.
- Opioids are effective for the relief of breathlessness in palliative care patients.
- A trial of non-pharmacological delivery of air to help relieve dyspnoea (e.g. hand held fan) is recommended prior to trial of oxygen.
- Oxygen use has to be tailored to the individual and a formal assessment made of its efficacy for reducing breathlessness and improving quality of life for that person.
- Oxygen therapy should not be continued in the absence of benefit.

L Mixtures of oxygen with other gases (Heliox and Entonox)

Use of helium-oxygen mixtures (Heliox) See online section 8.18

L1. There is insufficient evidence to support the use of Heliox either as an inhaled gas or as the driving gas for nebuliser therapy in adult patients with acute exacerbations of asthma or COPD except as part of randomised clinical trials or in exceptional circumstances. (Grade D)

L2. Heliox use for asthma or COPD patients should be considered only in severe exacerbations in patients who are not responding to standard treatment (and in COPD patients where there are contra-indications to intubation). (Grade D)

L3. A therapeutic trial of Heliox is reasonable in patients with mechanical upper airway obstruction or postoperative stridor. (Grade D)

M Use of nitrous oxide/oxygen mixtures (Entonox) for analgesia. (See online section 9.11)

M1. The use of Entonox gas mixture for analgesia should be avoided if possible in patients at risk of type 2 respiratory failure. [Grade D]

N CPAP and high flow nasal oxygen

Use of CPAP in the perioperative period and for pulmonary oedema (see online section 8.19)

N1. Patients with diagnosed sleep disordered breathing established on CPAP undergoing surgery should bring their machines with them and use them in the pre and post-operative period. If adequate saturations are not achieved despite CPAP therapy then assess for worsening ventilation with blood gases and oxygen should be entrained to achieve a saturation of 88-92% (Grade D)

N2. CPAP with entrained oxygen to maintain saturation 94-98% should be considered as an adjunctive treatment to improve gas exchange in patients with cardiogenic pulmonary oedema who are not responding to standard treatment in hospital care or in pre-hospital care. [Grade B]

Good Practice Point, High Flow Nasal oxygen

- High flow nasal oxygen should be considered as a potentially superior alternative to reservoir mask treatment in patients with acute hypoxaemic (type 1) respiratory failure.

P Patients with tracheostomy or laryngectomy (see section 10.3)

P1. When oxygen is required by patients with prior tracheostomy or laryngectomy, a tracheostomy mask (varying the flow as necessary) should achieve the desired oxygen saturation (tables 1–4). An alternative delivery device, usually a T-piece device fitted directly to the tracheostomy tube, may be necessary if the patient deteriorates. [Grade D]

Q Humidification of oxygen (see section 10.2)

Q1. Humidification is not required for the delivery of low-flow oxygen (mask or nasal cannulae) or for the short-term use of high-flow oxygen. It is not therefore required in pre-hospital care. Pending the results of clinical trials, it is reasonable to use humidified oxygen for patients who require high-flow oxygen systems for more than 24 h or who report upper airway discomfort due to dryness. [Grade D]

Q2. In the emergency situation, humidified oxygen use can be confined to patients with tracheostomy or an artificial airway although these patients can be managed without humidification for short periods of time (e.g., ambulance journeys). [Grade D]

Q3. Humidification may also be of benefit to patients with viscous secretions causing difficulty with expectoration. This benefit can be achieved using nebulised normal saline. [Grade D]

Q4. Bubble bottles which allow a stream of oxygen to bubble through a container of water should not be used because there is no evidence of a clinically significant benefit but there is a risk of infection. [Grade D]

Good practice points related to humidified oxygen therapy

- Patients requiring high flow rates or longer term oxygen might benefit from a large volume oxygen humidifier device, especially if sputum retention is a clinical problem.
- In the absence of an artificial airway the decision to humidify supplemental oxygen needs to be made on an individual basis but this practice is not evidence-based.

R Driving gas for nebulised treatments (see section 10.4)

R1. For patients with asthma, nebulisers should be driven by piped oxygen or from an oxygen cylinder fitted with a high-flow regulator capable of delivering a flow rate of >6 l/min. The patient should be changed back to his/her usual oxygen mask or cannulae when nebuliser therapy is complete. If the cylinder does not produce this flow rate, an air-driven nebuliser (with electrical compressor) should be used with supplemental oxygen by nasal cannulae at 2–6 l/min to maintain an appropriate oxygen saturation level. [Grade D]

R2. When nebulised bronchodilators are given to patients with hypercapnic acidosis, they should be given using an ultrasonic nebuliser or else a jet nebuliser driven by compressed air and, if necessary, supplementary oxygen should be given concurrently by nasal cannulae to maintain an oxygen saturation of 88–92%. The same precautions should be applied to patients who are at risk of hypercapnic respiratory failure prior to the availability of blood gas results and the oxygen saturation should be monitored continuously during treatment. Once the nebulised treatment is completed for patients at risk of hypercapnic respiratory failure, their previous targeted oxygen therapy should be reinstituted. [Grade D]

Good practice point: Driving gas for nebulised treatment in ambulances

- During treatment by ambulance staff oxygen-driven nebulisers should be used for patients with asthma and may be used for patients with COPD in the absence of an air-driven compressor system. If oxygen is used for patients with known COPD, its use should be limited to 6 min. This will deliver most of the nebulised drug dose but limit the risk of hypercapnic respiratory failure (section 10.4). Ambulance Services are encouraged to explore the feasibility of introducing battery powered, air driven nebulisers or portable ultrasonic nebulisers.

S Prescribing, oxygen therapy (see online section 11)

S1. Every healthcare facility should have a standard oxygen prescription document or, preferably, a designated oxygen section on all drug prescribing cards or guided prescription of oxygen in electronic prescribing systems. [Grade D]

S2. A prescription for oxygen should always be written, except in critical illness when it must be started immediately and documented retrospectively. [Grade D]

S3. Doctors and other prescribers should prescribe oxygen using a target saturation range (sections 8, 9 and 11) and sign the drug chart or electronic prescribing order. [Grade D]

S4. An oxygen target saturation range should be prescribed for all patients who are admitted to hospital. This will ensure that every patient will receive appropriate oxygen therapy if it should be required. It will also ensure that all clinicians are aware of the appropriate oxygen target range for every patient under their care. [Grade D]

Good practice points related to prescribing and administering oxygen therapy to patients

- Oxygen should be prescribed on the drug chart or electronic prescribing system using a target saturation range.
- In most emergency situations, oxygen is given to patients immediately without a formal prescription. The lack of a prescription should never preclude oxygen being given when needed in an emergency situation. However, a subsequent written record must be made of what oxygen therapy has been given to every patient in a similar manner to the recording of all other emergency treatment.

T Monitoring and adjusting therapy (see online sections 9-11)

T1. Pulse oximetry must be available in all locations where emergency oxygen is being used by health care professionals (see also the limitations of using pulse oximetry section 7.1.2). [Grade D]

T2. All documents which record oximetry measurements or blood gas results should state whether the patient is breathing air or a specified oxygen delivery device and flow rate. [Grade D]

T3. In all situations where repeated blood gas measurements are required, they should be measured as soon as possible, usually within 30 min of any treatment change, to determine if the proposed target saturations are appropriate. Consider the use of an indwelling arterial catheter if multiple samples are likely to be required. [Grade D]

T4. Adjustments should only be made by staff who have been trained to administer oxygen. If the oxygen saturation falls below the pre-specified range, the concentration of oxygen should be increased; if the saturation rises above this range, the oxygen concentration should be reduced. If the monitoring of oxygen saturation is performed by other staff (e.g., health care assistants), they should inform staff who are trained to administer oxygen if the oxygen saturation is above or below the target saturation. [Grade D]

Good practice points related to administration of oxygen therapy

- For hypoxaemic patients, oxygen therapy should continue during other treatments such as nebulised therapy. Clinicians should assess the clinical status of the patient prior to prescribing oxygen and the patient's condition should be reassessed frequently during oxygen use (see recommendations B1-B3).
- The administering healthcare professional should note the oxygen saturation before commencing oxygen therapy (see recommendation B3).
- The healthcare professional should commence oxygen therapy using an appropriate delivery system and flow rate as specified in sections 8, 9 and 10 of this guideline. The target oxygen saturation should be documented on the respiratory section of the observation chart.

- Whenever possible, patients should be given an oxygen information sheet (example in web appendix 6 of this guideline on the British Thoracic Society Website).

U Weaning and discontinuation of oxygen therapy

U1. Lower the oxygen concentration if the patient is clinically stable and the oxygen saturation has been in the upper zone of the target range for some time (usually 4–8 h). [Grade D]

U2. If the target saturation is maintained, the new delivery system and flow should be continued. Repeat blood gas measurements are not required. If the patient is stable the process can be repeated and the patient can eventually be weaned off oxygen (see section 12). [Grade D]

U3. Most stable convalescent patients will eventually be stepped down to 2 l/min via nasal cannulae prior to cessation of oxygen therapy. Patients at risk of hypercapnic respiratory failure may be stepped down to 1 l/min (or occasionally 0.5 l/min) via nasal cannulae or a 24% Venturi mask at 2 l/min as the lowest oxygen concentration prior to cessation of oxygen therapy. [Grade D]

U4. Oxygen therapy should be stopped once a patient is clinically stable on low-concentration oxygen and the oxygen saturation is within the desired range on two consecutive observations (but the prescription for a target saturation range should remain active in case of future deterioration). Oxygen should also be stopped if the patient has come to the end of a written protocol of timed oxygen (e.g. postoperatively). [Grade D]

U5. Oxygen saturation on air should be monitored for 5 min after stopping oxygen therapy. If it remains in the desired range it should be rechecked at 1 h. [Grade D]

U6. If the oxygen saturation and physiological ‘‘track and trigger’’ score (e.g. NEWS) is satisfactory at 1 h, the patient has safely discontinued oxygen therapy but saturation and physiology should continue to be monitored on a regular basis according to the patient’s underlying clinical condition. [Grade D]

U7. If the saturation falls below the patient’s target range on stopping oxygen therapy, recommence the lowest concentration that maintained the patient in the target range and monitor for 5 min. If this restores the saturation into the target range, continue oxygen therapy at this level and attempt discontinuation of oxygen therapy again at a later date provided the patient remains clinically stable. [Grade D]

U8. If a patient requires oxygen therapy to be restarted at a higher concentration than before to maintain the same target saturation range, the patient should have a clinical review to establish the cause for this deterioration. [Grade D]

U9. Some patients may have episodic hypoxaemia (e.g., after minor exertion or due to mucus plugging) after they have safely discontinued oxygen therapy. An on-going prescription for a target saturation range will allow these patients to receive oxygen as the need arises but transient asymptomatic desaturation does not require correction. [Grade D]

V Practical aspects of oxygen use in pre-hospital and hospital care and use of oxygen alert cards (see online sections 9-11)

V1. Emergency oxygen should be available in primary care medical centres, preferably using oxygen cylinders with integral high-flow regulators. Alternatively, oxygen cylinders fitted with high-flow regulators (delivering over 6 l/min) must be used. [Grade D]

V2. Trusts should take measures to eliminate the risk of oxygen tubing being connected to the incorrect wall oxygen outlet or to outlets that deliver compressed air or other gases instead of oxygen. Air flow meters should be removed from the wall sockets or covered with a designated air outlet cover when not in use. Special care should be taken if twin oxygen outlets are in use. [Grade D]

Good Practice Points related to practical aspects of oxygen therapy

Assessment and immediate oxygen therapy

- Chronically hypoxaemic patients with a clinical exacerbation associated with a 3% or greater fall in oxygen saturation on their usual oxygen therapy should be assessed in hospital with blood gas estimations. Arterial PO2 of <7 kPa equates to SpO2 below approximately 85%.
- The initial oxygen therapy to be used in the various clinical situations is given in tables 1–4.
- If there is a clear history of asthma or heart failure or other treatable illness, appropriate treatment should be instituted in accordance with guidelines or standard management plans for each disease.
- The oxygen saturation should be monitored continuously until the patient is stable or arrives at hospital for a full assessment. The oxygen concentration should be adjusted upwards or downwards to maintain the target saturation range.
- In most emergency situations oxygen is given to patients immediately without a formal prescription or drug order. The lack of a prescription should never preclude oxygen being given when needed in an emergency situation. However, a subsequent written record must be made of what oxygen therapy has been given to every patient (in a similar manner to the recording of all other emergency treatment).
- General practitioners or first responders visiting a patient's home should carry a portable pulse oximeter to assess hypoxaemia and guide use of oxygen if available.
- Those attending patients as an emergency in rural or remote areas should consider carrying a portable oxygen cylinder and appropriate delivery systems as part of their emergency equipment.

Oxygen alert cards for patients with hypercapnic respiratory failure

- Patients with COPD (and other at-risk conditions) who have had an episode of hypercapnic respiratory failure should be issued with an oxygen alert card and with a 24% or 28% Venturi mask. They should be instructed to show the card to the ambulance crew and emergency department staff in the event of an exacerbation.
- Oxygen alert cards with agreed content can be obtained via the British Thoracic Society (see Emergency Oxygen Guideline Section on BTS Website)
- The content of the alert card should be specified by the physician in charge of the patient's care, based on previous blood gas results.
- The primary care team and ambulance service should also be informed by the hospital COPD team that the patient has had an episode of hypercapnic respiratory failure and carries an oxygen alert card. The home address and ideal oxygen concentration or target saturation

ranges of these patients can be flagged in the ambulance control systems and information disseminated to ambulance crews when required.

- When possible, out-of-hours services providing emergency primary care services should be informed by the hospital COPD team or by the primary care team that the patient has had an episode of hypercapnic respiratory failure and carries an oxygen alert card. Use of oxygen in these patients will be guided by the instructions on the alert card.

W Practical aspects of oxygen dispensing, documentation and monitoring

W1. Nurses and others who dispense drugs in hospitals should sign the drug chart or electronic prescribing record at every drug round and check that the patient is receiving oxygen therapy. This is to check that the patient is within the target saturation and also to check whether weaning and discontinuation should be instituted. [Grade D]

W2. Most patients are prescribed an oxygen target range. If patients are on air at the time of the drug round, nurses should sign the drug chart using a code such as "A" for air and the observation chart should also be filled in using the code A for air (see chart 4, fig 4). [Grade D]

W3. All patients should have their oxygen saturation observed for at least five minutes after starting oxygen therapy or for patients who require an increased concentration of oxygen and after oxygen therapy has been decreased or stopped. [Grade D]

W4. If the oxygen saturation is above the target saturation range and the patient is stable, the delivery system or oxygen flow rate should be modified to return the saturation to within the target range. [Grade D]

W5. Patients who have a target saturation of 88–92% should have their blood gases measured within 30– 60 min. This is to ensure that the carbon dioxide level is not rising. This recommendation also applies to those who are at risk of developing hypercapnic respiratory failure but who have a normal PaCO2 on the initial blood gas measurement. [Grade D]

W6. Stable patients whose oxygen saturation is within their target saturation range of 94–98% do not need repeat blood gas measurements within 30– 60 min if there is no risk of hypercapnic respiratory failure and acidosis and may not need any further blood gas measurements. [Grade D]

W7. Stable patients on oxygen treatment should have SpO2 and physiological variables (e.g., NEWS) measured four times a day. [Grade D]

W8. In those who are unstable (e.g. NEWS score 7 or above), oxygen saturation should be monitored continuously and the patient may require level 2 or level 3 care on a high dependency unit or critical care unit. [Grade D]

W9. If the patient is clinically stable and the oxygen saturation is within the target range, treatment should be continued (or eventually lowered) depending on the clinical situation. [Grade D]

W10. Oxygen therapy should be increased if the saturation is below the desired range and decreased if the saturation is above the desired range (and eventually discontinued as the patient recovers). [Grade D]

W11. The new saturation (and the new delivery system) and flow rate should be recorded on the patient's observation chart after 5 min of treatment at the new oxygen concentration. Each change

should be recorded by the clinician trained to administer oxygen by signing the observation chart (only changes should be signed for). [Grade D]

W12. Repeat blood gas measurements are not required for stable patients who require a reduced concentration of oxygen (or cessation of oxygen therapy) to maintain the desired target saturation. [Grade D]

W13. Patients with no risk of hypercapnic respiratory failure do not always need repeat blood gas measurements after an increase in oxygen concentration. However, the patient requires clinical review to determine why the oxygen saturation has fallen. [Grade D]

W14. Patients at risk of hypercapnic respiratory failure (usually those with a target range of 88–92%; see table 4) require repeat blood gas estimation 30–60 min after an increase in oxygen therapy (to ensure that the carbon dioxide level is not rising). [Grade D]

W15. For patients with no risk of hypercapnic respiratory failure, monitoring by pulse oximeter is sufficient (repeated blood gases not required) provided the saturation remains in the desired range, usually 94–98%. [Grade D]

W16. If a patient's oxygen saturation is lower than the prescribed target range, first check all aspects of the oxygen delivery system and the oximeter device for faults or errors. [Grade D]

W17. If a patient's oxygen saturation is consistently lower than the prescribed target range, there should be a medical review and the oxygen therapy should be increased according to an agreed written protocol. [Grade D]

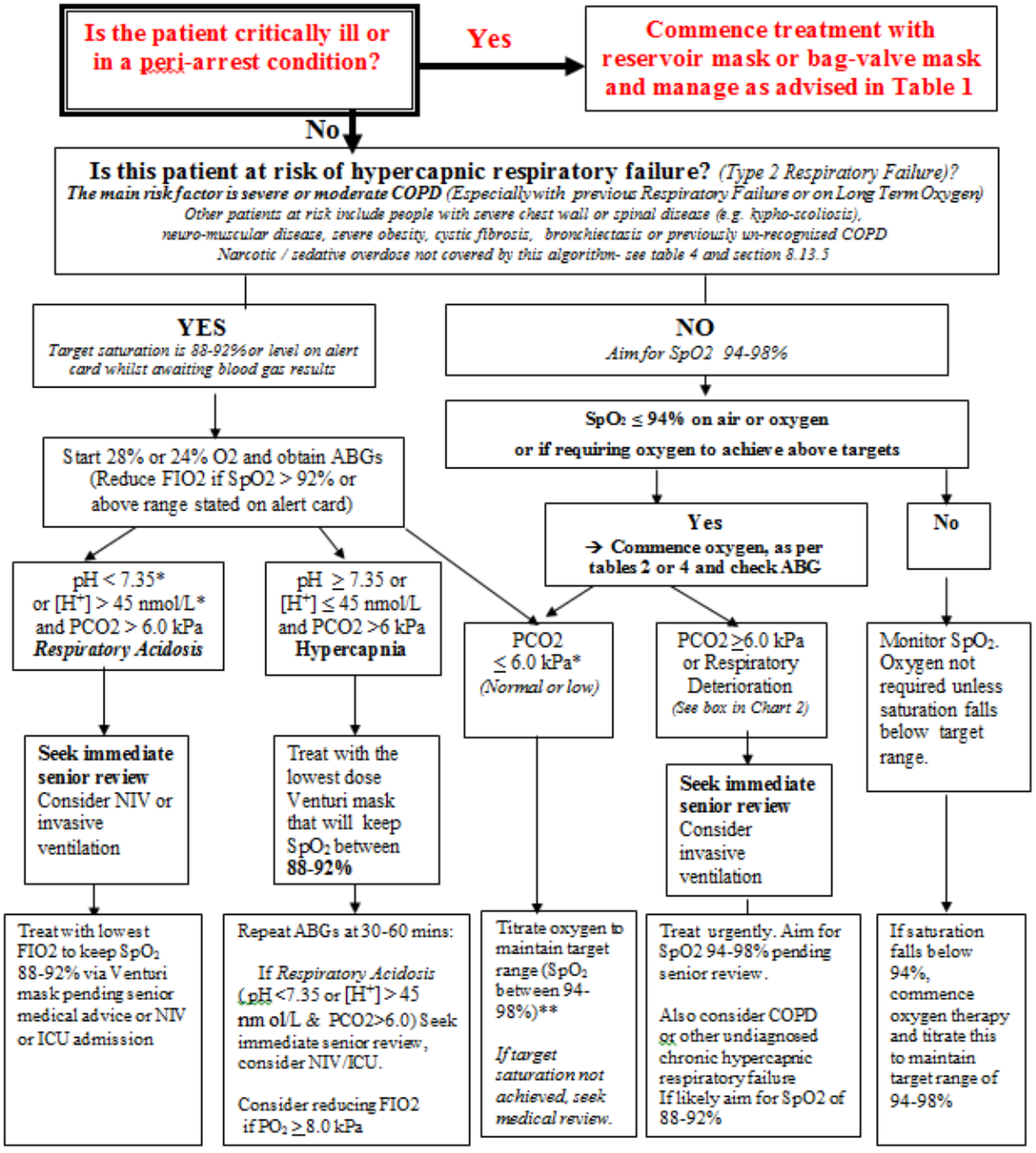
W18. If the oxygen saturation fails to rise following 5– 10 min of increased oxygen therapy or if there is clinical concern following medical review, then blood gas measurements should be repeated. [Grade D]

X Training in oxygen prescribing and use

X1. All clinicians prescribing oxygen should have appropriate training and access to written or electronic oxygen prescribing guidelines based on this national guideline. [Grade D]

X2. Every hospital should have a training programme to ensure that clinical staff are familiar with the hospital's oxygen administration policies. In view of the high number of adverse incidents related to oxygen therapy, it is recommended that all acute Trusts should include basic training in oxygen use in the mandatory training programmes for all clinical staff. [Grade D]

Chart 1 Oxygen prescription for acutely hypoxaemic patients in hospital



Any increase in FIO2 must be followed by repeat ABGs in 1 hour (or sooner if conscious level deteriorates)

* ***If pH is < 7.35 ([H+] > 45 nmol/L) with normal or low PaCO2, investigate and treat for metabolic acidosis and keep SpO2 94-98%***

****Repeat ABG in 30-60 mins for all patients at risk of Type 2 respiratory failure** *(even if initial PaCO2 is normal)*

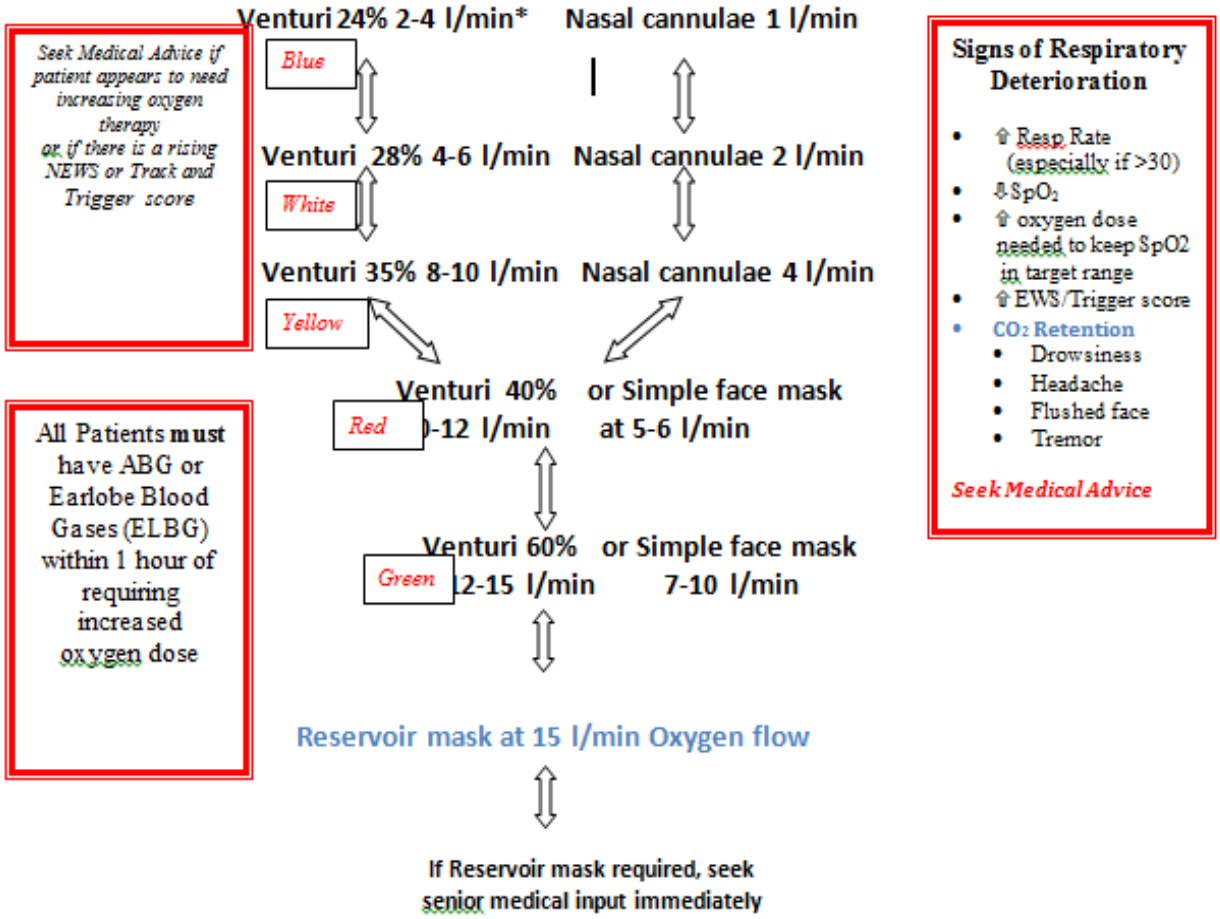
Chart 2

Flow chart for oxygen administration on general wards in hospitals

See patient's drug chart and Chart 1 and tables 1-4 for starting dose and target saturation
Choose the most suitable delivery system and flow rate

Titrate oxygen *up* or *down* to maintain the target oxygen saturation.

The table below shows available options for stepping dosage up or down. The chart does NOT imply any equivalence of dose between Venturi masks and nasal cannulae.
Allow at least 5 minutes at each dose before adjusting further upwards or downwards (except with major and sudden fall in saturation)
Once your patient has adequate and stable saturation on minimal oxygen dose, consider discontinuation of oxygen therapy.



Seek Medical Advice if patient appears to need increasing oxygen therapy or if there is a rising NEWS or Track and Trigger score

All Patients **must** have ABG or Earlobe Blood Gases (ELBG) within 1 hour of requiring increased oxygen dose

Signs of Respiratory Deterioration

- ⇧ Resp Rate (especially if >30)
- ⇩ SpO_2
- ⇧ oxygen dose needed to keep SpO2 in target range
- ⇧ EWS/Trigger score
- CO_2 Retention
  - Drowsiness
  - Headache
  - Flushed face
  - Tremor

Seek Medical Advice

**** For Venturi masks, the higher flow rate is required if the respiratory rate is >30***

Patients in a peri-arrest situation and critically ill patients should be given maximal oxygen therapy via reservoir mask or bag-valve mask whilst immediate medical help is arriving.

(Except for patients with COPD with known oxygen sensitivity recorded in patient's case notes and drug chart or in the EPR: keep saturation at 88-92% for this sub-group of patients)

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Table 5: SIGN evidence levels

SIGN LEVELS OF EVIDENCE

1++	High quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias
1+	Well-conducted meta-analyses, systematic reviews, or RCTs with a low risk of bias
1-	Meta-analyses, systematic reviews, or RCTs with a high risk of bias
2++	High quality systematic reviews of case control or cohort or studies High quality case control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal
2+	Well-conducted case control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal
2-	Case control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not causal
3	Non-analytic studies, e.g. case reports, case series
4	Expert opinion

Table 6: SIGN grades of recommendation

GRADES OF RECOMMENDATIONS

A At least one meta-analysis, systematic review, or RCT rated as 1++, and directly applicable to the target population; *or*

A body of evidence consisting principally of studies rated as 1+, directly applicable to the target population, and demonstrating overall consistency of results

B A body of evidence including studies rated as 2++, directly applicable to the target population, and demonstrating overall consistency of results; *or*

Extrapolated evidence from studies rated as 1++ or 1+

C A body of evidence including studies rated as 2+, directly applicable to the target population and demonstrating overall consistency of results; *or*

Extrapolated evidence from studies rated as 2++

D Evidence level 3 or 4; *or*

Extrapolated evidence from studies rated as 2+

Good practice points

✔ Recommended best practice based on the clinical experience of the guideline development group

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