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Oxygen Titration

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Summary of Abstracts

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Key Message

We found 7 evidence-based guidelines regarding oxygen titration in patients receiving oxygen therapy.

Research Question

What are the evidence-based guidelines regarding oxygen titration in patients receiving oxygen therapy?

Methods

Literature Search Methods

A limited literature search was conducted by an information specialist on key resources including Ovid MEDLINE, Cumulative Index to Nursing and Allied Health Literature (CINAHL), the Cochrane Database of Systematic Reviews, the websites of Canadian and major international health technology agencies, as well as a focused internet search. The search strategy consisted of both controlled vocabulary, such as the National Library of Medicine's MeSH (Medical Subject Headings), and keywords. The main search concept was oxygen therapy. Search filters were applied to limit retrieval to guidelines. The search was limited to English-language documents published between January 1, 2017, and November 24, 2022. Internet links were provided, where available.

Selection Criteria and Summary Methods

One reviewer screened literature search results (titles and abstracts) and selected publications according to the inclusion criteria presented in Table 1. Full texts of study publications were not reviewed. The Overall Summary of Findings was based on information available in the abstracts of selected publications. Open access full-text versions of evidence-based guidelines were reviewed when available, and relevant recommendations were summarized.

Table 1: Selection Criteria

Criteria	Description
Population	Patients in acute care settings receiving oxygen therapy
Intervention	Titration of oxygen
Comparator	Not applicable
Outcomes	Recommendations regarding oxygen titration (e.g., oxygen saturation targets, monitoring of oxygenation, weaning and discontinuation of oxygen)
Study designs	Evidence-based guidelines

Results

Seven evidence-based guidelines were identified regarding oxygen titration in patients receiving oxygen therapy.[1-7]

Additional references of potential interest that did not meet the inclusion criteria are provided in Appendix 1.

Overall Summary of Findings

Seven evidence-based guidelines about oxygen titration in patients receiving oxygen therapy were identified.[1-7] Six guidelines[1,3-7] provided recommendations for adults whereas 1 guideline[2] reported recommendations for the pediatric population. Six guidelines[1-3,5-7] provided recommendations regarding oxygen saturation targets for patients with varying conditions. In addition, 2 guidelines[1,7] reported recommendations about oxygen monitoring. Three guidelines[1,4,7] provided recommendations about weaning and discontinuation of oxygen. A detailed summary of guideline recommendations can be found in Table 2.

Table 2: Summary of Recommendations in Included Guidelines

Summary of recommendations	Quality of evidence, strength of recommendations and/or consensus agreement rate
Gottlieb et. al (2022) [1]	
"Recommendation 2.1: Pulse oximetry shall be available in all clinical situations where oxygen is used for medical purposes and shall be used for regularly monitoring the supplemental oxygen therapy." See: 3.1 Patient Assessment, p. 11	**Strength of recommendation:** Strong (Grade A) **Quality of evidence:** Low quality for mortality, moderate quality for hypoxemia and cardiovascular events **Consensus agreement rate:** 100%
"Recommendation 6.2: Monitoring of oxygen by blood gas analyses should be performed in the following in-patient groups: • Critically ill patients, e.g., those **having** shock or metabolic disorders • Ventilated patients • Patients with severe hypoxemia (> 6 L O_2/min, or FiO_2 > 0.4) • Patients at risk of hypercapnia (e.g., COPD, severe asthma, obesity with BMI > 40 kg/m^2 • Patients where no reliable pulse oximetry signal can be obtained) No routine blood gas measurements should be done in patients who are stable and do not fall into any of the above-mentioned patient groups." See: 3.1 Patient Assessment, p. 12	**Expert consensus** **Consensus agreement rate:** 92%

Summary of recommendations	Quality of evidence, strength of recommendations and/or consensus agreement rate
"Recommendation 2.4: Venous blood gas analysis shall not be used to monitor oxygen therapy. Venous blood gas analyses are able to exclude hypercapnia only at a $pvCO_2$ < 45 mm Hg." See: 3.1 Patient Assessment, p. 12	**Strength of recommendation:** Strong (Grade A) **Quality of evidence:** Moderate quality for hypoxemia **Consensus agreement rate:** 100%
"Recommendation 3.3: Oxygen shall be administered, monitored and controlled by staff trained in oxygen therapy. Patients shall be informed about the oxygen therapy." See: 3.3 Sources of Oxygen, p. 14	**Expert consensus** **Consensus agreement rate:** 100%
"Recommendation 4.1: The target saturation range of acute oxygen therapy for non-ventilated patients not at risk of hypercapnia shall be between 92 and 96% as measured by pulse oximetry." See: 3.6 Oxygen Target Ranges in Acute Conditions, p. 15	**Strength of recommendation:** Strong (Grade A) **Quality of evidence:** Moderate quality for mortality and functional outcome **Consensus agreement rate:** 100%
"Recommendation 4.2: The target arterial oxygen saturation range for ventilated patients shall be 92–96%. In addition to arterial blood gas analysis, oxygen saturation measurement by pulse oximetry shall be used to guide the oxygen delivery if compliance is acceptable (deviation of up to 2%) and in the prehospital setting." See: Target Oxygen Saturation Ranges for Patients at Risk of Hypercapnia, p. 19 ; Fig. 2, p. 18	**Strength of recommendation:** Strong (Grade A) **Quality of evidence:** Moderate quality for mortality and low quality for adverse events **Consensus agreement rate:** 100%
"Recommendation 4.3: Oxygen shall be prescribed for acutely ill, nonventilated patients at risk of hypercapnia (e.g., COPD) for a target saturation range of 88–92% as measured by pulse oximetry. Oxygen therapy shall not be delivered or shall be reduced in this situation if the saturation is above 92% and shall only be started again if the saturation drops below 88%." See: 3.8 Target Oxygen Saturation Ranges for Ventilated Patients, p. 18	**Strength of recommendation:** Strong (Grade A) **Quality of evidence:** Moderate quality mortality and low quality for intubation **Consensus agreement rate:** 100%
"Recommendation 4.4: Patients with acute respiratory distress, increased respiration rate or drop in oxygen saturation >3% from the baseline who have oxygen saturation levels ≥92% as measured by pulse oximetry should be subject to thorough clinical assessment, including blood gas analysis, as these may be signs of an acute illness." See: 3.9 Compliance with Oxygen Therapy Target Ranges, p. 21	**Expert consensus** **Consensus agreement rate:** 85%
"Recommendation 4.7: If an SpO_2 level of 92% is not achieved despite oxygen flow rates of more than 6 L/min, patients shall be assessed without delay by a physician experienced in the diagnosis and treatment of acute respiratory failure or critical illness." See: 3.10 Intractable Hypoxemia, p. 21	**Expert consensus** **Consensus agreement rate:** 100%
"Recommendation 5.5: The same principles and oxygen therapy target ranges that apply for other hypoxemic patients also apply for adults with infectious diseases transmissible by aerosols (e.g., SARS-CoV 2)." See: 3.16 Oxygen Therapy in COVID-19 and Other Infectious Lung Diseases, p. 27	**Strength of recommendation:** Strong (Grade A) **Quality of evidence:** Moderate quality for mortality **Consensus agreement rate:** 100%

Summary of recommendations	Quality of evidence, strength of recommendations and/or consensus agreement rate
"Recommendation 4.12: In all procedures involving conscious sedation with the objective of maintaining spontaneous breathing, the patient's oxygen saturation shall be continuously monitored via pulse oximetry prior to and during the procedure, and in the recovery period." See: 3.18 Oxygen Use during Procedures Involving Conscious Sedation, p. 28	**Expert consensus** **Consensus agreement rate:** 93%
Recommendations listed below can be found in 4.1 High-Flow Oxygen Therapy (p. 29) • "Recommendation 5.6: In hospitalized patients with acute hypoxic pulmonary failure without hypercapnia, high-flow oxygen therapy should be initiated at a flow rate of 6 L O_2/min delivered via nasal cannula/mask if the oxygen saturation drops below 92%." • "Recommendation 5.7: Patients on high-flow oxygen should be closely reevaluated and HFNC discontinuation criteria defined."	**Expert consensus** **Consensus agreement rate:** 100%
Recommendations listed below can be found in 4.3 Monitoring and Documentation of Oxygen Therapy (p. 30) • "Recommendation 6.3: Patients on high-flow oxygen should be closely reevaluated and HFNC discontinuation criteria defined." • "Recommendation 6.4: Patients should be monitored for clinical symptoms and oxygen saturation pulse oximetry for 5 min after starting, adjusting or stopping oxygen therapy."	**Expert consensus** **Consensus agreement rate:** 100%
Recommendations listed below can be found in 4.4 Discontinuation of Oxygen Therapy (p. 31 to 32) • "Recommendation 7.1: Oxygen delivery should be reduced when a patient is clinically stable and oxygen saturation is above the target range or has been within target range for several hours." • "Recommendation 7.2: Oxygen therapy should be discontinued in patients not at risk of hypercapnia who have been clinically stable and within the target range for several hours under 2 liters O_2/min. The lowest volume administered before stopping oxygen therapy in patients at risk of hypercapnic respiratory failure should be 1 L/min (or 0.5 L/min, as necessary)." • "Recommendation 7.4: O_2 delivery should not be adjusted if a patient experiences a transient (less than 1 min) asymptomatic drop in oxygen saturation below target range after oxygen therapy has been stopped." • "Recommendation 7.5: If a patient cannot be weaned from oxygen, O_2 therapy should be continued even after discharge. These patients should be re-evaluated a few weeks after initiation of the oxygen therapy to review the indication for long-term oxygen therapy."	**Expert consensus** **Consensus agreement rate:** 100%
Napolitano et. al (2021)[2]	
Recommendations listed below can be found in Table 2 (p. 6) and Oxygenation Targets (p. 9) • "In hospitalized pediatric patients suffering from bronchiolitis, evidence supports an oxygenation target of 90% or greater." • "In hospitalized pediatric patients suffering from respiratory diseases outside of bronchiolitis, establishing a patient/disease oxygen therapy target upon admission is best practice, but a specific target cannot be recommended."	**Quality of evidence:** C (collective experience of the committee) **Median appropriateness score:** 7

Summary of recommendations	Quality of evidence, strength of recommendations and/or consensus agreement rate
Piraino et. al (2021)[3]	
"The committee supports an optimal SpO2 range of 94–98% for most patients requiring supplemental oxygen, a range of 88–92% for patients with COPD who require supplemental oxygen." See: Table 2, p. 6; Specific Oxygenation Targets in Actually Ill Adults, p. 8	**Quality of evidence:** C (based on the collective experience of the committee) All committee members responded 7
"The committee recommends an SpO2 range of 94–98% for critically ill patients." See: Table 2, p. 6; Specific Oxygenation Targets in Critically Ill Adults, p. 8	**Quality of evidence:** C (based on the collective experience of the committee) All committee members responded 7
Chawla et. al (2020)[4]	
"We recommend that NIV may be used to wean high risk patients from invasive mechanical ventilation as it reduces re-intubation rate." See: Recommendation, p. 7	**Strength of recommendation:** Weak (Grade B) **Quality of evidence:** 2
"We recommend that weaning from NIV may be done by a standardized protocol driven approach of the unit." See: Recommendations, p. 13	**Strength of recommendation:** Weak (Grade B) **Quality of evidence:** 2
"We recommend that any of three weaning strategies may be adopted for weaning NIV in COPD patients." See: Recommendations, p. 14	**Strength of recommendation:** Weak (Grade B) **Quality of evidence:** 2
Cottey et. al (2019)[5]	
"If SpO_2 is less than 92%, supplemental oxygen should be titrated to achieve an SpO_2 of greater than 92%; and if flow rates of greater than 5 L/min are required, then urgent evacuation and critical care support should be requested."	Not available
Siemieniuk et. al (2018)[6]	
"The panel makes a strong recommendation that, if supplemental oxygen is administered, clinicians ensure a maximum SpO_2 of 96%." See: Upper limit of oxygen therapy, p. 8	**Strength of recommendation:** Strong
"For patients with myocardial infarction or stroke, the panel makes a strong recommendation against initiating supplemental oxygen when the initial SpO_2 is >92%." See: Lower limit of oxygen therapy, p. 8	**Strength of recommendation:** Strong
"The panel makes a weak recommendation against initiating oxygen in these patients with a SpO_2 of 90-92%." See: Lower limit of oxygen therapy, p. 8	**Strength of recommendation:** Weak

Summary of recommendations	Quality of evidence, strength of recommendations and/or consensus agreement rate
O'Driscoll et. al (2017)[7]	
Recommendations listed below can be found in A Achieving desirable oxygen saturation ranges in acute illness (p. 1 to 2) and 6.7 Target oxygen saturation in acute illness (p. 32): • "A1: This guideline recommends aiming to achieve anormal or near-normal oxygen saturation for all acutely ill patients apart from those at risk of hypercapnic respiratory failure." • "A2: The recommended target saturation range for acutely ill patients not at risk of hypercapnic respiratory failure is 94–98%." • "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."	**Strength of recommendations:** SIGN Grade D (evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+)
A3 (also G1): "For most patients with known chronic obstructive pulmonary disease (COPD) or other known risk factors for hypercapnic respiratory failure (eg, morbid obesity, cystic fibrosis (CF), chest wall deformities or neuromuscular disorders or fixed airflow obstruction associated with bronchiectasis), a target saturation range of 88–92% is suggested pending the availability of blood gas results." See: A Achieving desirable oxygen saturation ranges in acute illness, p. 2; G Patients at risk of hypercapnic respiratory failure, p. 7 to 8; 6.7 Target oxygen saturation in acute illness, p. 32; 8.12 Recommended oxygen therapy for patients who may be vulnerable to medium or high concentration of oxygen, p. 47	**Strength of recommendation:** • COPD: SIGN Grade 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) • Other conditions: SIGN Grade D (evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+)

Recommendations listed below can be found in C Arterial and capillary blood gases (p. 3) and 8.4 Which patients require blood gas measurements? (p. 39):
• "C3: Blood gases should be checked in the following situations:
  ○ All critically ill patients.
  ○ Unexpected or inappropriate fall in SpO_2 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 participants during sleep).
  ○ Deteriorating oxygen saturation (fall of ≥ 3%) or increasing breathlessness in a patient with previously stable chronic hypoxaemia (eg, severe COPD).
  ○ Most previously stable patients who deteriorate clinically and require increased fraction of inspired oxygen (FiO_2) to maintain a constant oxygen saturation.
  ○ Any patient with risk factors for hypercapnic respiratory failure who develops acute breathlessness, deteriorating oxygen saturation, drowsiness or other features of carbon dioxide retention.
  ○ Patients with breathlessness who are thought to be at risk of metabolic conditions such as diabetic ketoacidosis or metabolic acidosis due to renal failure.
  ○ Any other evidence from the patient's medical condition that would indicate that blood gas results would be useful in the patient's management (eg, an unexpected change in 'track and trigger' systems such as a sudden rise of several units in the
	Strength of recommendations:
	SIGN Grade D (evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+)

Summary of recommendations	Quality of evidence, strength of recommendations and/or consensus agreement rate
NEWS or an unexpected fall in oxygen saturation of 3% or more, even if within the target range)"	
Recommendations listed below can be found in E Oxygen therapy in critical illness (p. 6 to 7) and 8.10 Recommended oxygen therapy for major medical emergencies and critical illness (p. 41 to 42): • "E1: Use the highest feasible inspired oxygen for ventilation during cardiopulmonary resuscitation. Once spontaneous circulation has returned and arterial blood oxygen saturation can be monitored reliably, aim for a target saturation range of 94–98% and take an ABG sample to guide ongoing oxygen therapy. If the blood gas shows hypercapnic respiratory failure, reset the target range to 88–92% or consider mechanical ventilation." • "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." • "E3: In cases of drowning, aim at an oxygen saturation of 94–98% once spontaneous circulation is restored." • "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 for an oxygen saturation of 94–98% or 88–92% if the patient is at risk of hypercapnic respiratory failure." • "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." • "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 arterial oxygen tension (PaO_2)."	**Strength of recommendations:** SIGN Grade D (evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+)
Recommendations listed below can be found in F Oxygen therapy for specific conditions that frequently require oxygen therapy (p. 7) and 8.11 Serious illnesses requiring moderate levels of supplemental oxygen if the patient is hypoxaemic (p. 43 to 45): • "F1: In acute asthma, aim at an oxygen saturation of 94–98%." • "F2: In cases of pneumonia who are not at risk of hypercapnic respiratory failure, aim at an oxygen saturation of 94–98%." • "F3: In acute breathlessness due to lung cancer, aim at an oxygen saturation of 94–98% unless there is coexisting COPD." • "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." • "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." • "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)."	**Strength of recommendations:** SIGN Grade D (evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+)

Summary of recommendations	Quality of evidence, strength of recommendations and/or consensus agreement rate
• "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)." • "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)." • "F11: In anaemia, aim at an oxygen saturation of 94–98% or 88–92% if the patient is at risk of hypercapnic respiratory failure." • "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." (p. 7 and 45)	
Recommendations listed below can be found in F Oxygen therapy for specific conditions that frequently require oxygen therapy (p. 7) and 8.13 Common medical emergencies for which oxygen therapy is indicated only if hypoxaemia is present (p. 50 to 52): • "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." • "F14: High concentrations of oxygen should be avoided in patients with stroke, 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." • "F15: In most poisonings, aim at an oxygen saturation of 94–98% unless the patient is at risk of hypercapnic respiratory failure." • "F16: In poisoning by paraquat and poisoning by bleomycin, give oxygen only if the saturation falls below 85% and reduce or stop oxygen therapy if the saturation rises above 88%." • "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." • "F18: For patients with cluster headaches, oxygen should be administered using a flow of at least 12 L/min from a reservoir mask and home oxygen should be provided."	**Strength of recommendations:** SIGN Grade D (evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+)
Recommendations listed below can be found in G Patients at risk of hypercapnic respiratory failure (p. 8 to 9) and 8.12 Recommended oxygen therapy for patients who may be vulnerable to medium or high concentration of oxygen (p. 47 to 49): • "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 NIV or intermittent positive pressure ventilation) who do not have an alert card, it is recommended that low-concentration oxygen treatment should be started using a 24% Venturi mask at 2–3 L/min (or a 28% Venturi mask at 4 L/min or nasal cannulae at 1–2 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% but increased if it falls below 88%." • "G3: Initial oxygen treatment of CF exacerbations should be similar to the initial oxygen treatment of COPD exacerbations with target saturation 88–92%." • "G4: In the initial management of musculoskeletal and neurological disorders with acute respiratory failure or acute-on-chronic respiratory failure, aim at an oxygen saturation of 88–92% and measure blood gases to determine if NIV will be required."	**Strength of recommendations:** SIGN Grade D (evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+)

Summary of recommendations	Quality of evidence, strength of recommendations and/or consensus agreement rate
• "G5: Morbidly obese patients (body mass index (BMI)>40 kg/m^2), even without evidence of coexistent obstructive sleep apnoea (OSA) are at risk of hypoventilation and should be given titrated oxygen to maintain a target saturation of 88–92%." • "G6: NIV should be considered for hypercapnic patients with COPD, CF, neuromuscular disorders or morbid obesity who are at risk of hypercapnic respiratory failure if the pH is <7.35 or [H^+]>45 nmol/L."	
Recommendations listed below can be found in H Oxygen use during pregnancy (p. 9) and 8.14 Obstetric emergencies and labour (p. 53): • "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 (eg, collapse related to amniotic fluid embolus, eclampsia or antepartum or postpartum haemorrhage)." • "H2: Women with underlying hypoxaemic conditions (eg, 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%)."	**Strength of recommendations:** SIGN Grade D (evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+)
Recommendations listed below can be found J Oxygen use in perioperative care and during procedures requiring conscious sedation (p. 9), 8.16 Use of oxygen during endoscopy and other procedures involving conscious sedation (p. 57), 10.5.1 Perioperative and postoperative care (p. 69): • "J3: Significant arterial oxygen desaturation (SpO_2<90% or fall of 4% or more that is prolonged (>1 min 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." • "J6: During the recovery period after procedures requiring conscious 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."	**Strength of recommendation:** SIGN Grade D (evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+)
"T1: Pulse oximetry must be available in all locations where emergency oxygen is being used by healthcare professionals." See: T Monitoring and adjusting oxygen therapy, p. 11; 9.1 Pulse oximetry and availability of oxygen, p. 60; Monitoring and adjusting therapy, p. 76	**Strength of recommendation:** SIGN Grade D (evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+)
Recommendations listed below can be found in T Monitoring and adjusting oxygen therapy (p. 11) and Monitoring and adjusting therapy (p. 76): • "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 using the abbreviations shown in table 5." • "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." • "T4: Adjustments should only be made by registered staff who have been trained to administer oxygen. If the oxygen saturation falls below the prespecified 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 unregistered staff (eg, healthcare assistants), there must be a clear	**Strength of recommendations:** SIGN Grade D (evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+)

Summary of recommendations	Quality of evidence, strength of recommendations and/or consensus agreement rate
protocol in place which requires that they should inform staff who are trained to administer oxygen if the oxygen saturation is above or below the target saturation."	
Recommendations listed below can be found in U Weaning and discontinuation of oxygen therapy (p. 12) and 11.3.7 When to lower oxygen therapy (p. 78): • "U1: Lower the oxygen concentration if the patient is clinically stable and the oxygen saturation is above the target range or if it has been in the upper zone of the target range for some time (usually 4–8 hours)." • "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."	**Strength of recommendations:** SIGN Grade D (evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+)
Recommendations listed below can be found in U Weaning and discontinuation of oxygen therapy (p. 12) and 12.1 How to discontinue oxygen therapy for stable patients (p. 78): • "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." • "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). It may be appropriate to alter the target range following senior review in patients with chronic cardiopulmonary disease who either have saturations <94% when stable or in whom it is deemed sensible to discharge from hospital with saturations <94% pending an outpatient oxygen assessment. Oxygen should also be stopped if the patient has come to the end of a written protocol of timed oxygen (eg, postoperatively)." • "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 hour." • "U6: If the oxygen saturation and physiological 'track and trigger' score (eg, NEWS) is satisfactory at 1 hour, the patient has safely discontinued oxygen therapy. However, saturation and physiology should continue to be monitored on a regular basis according to the patient's underlying clinical condition." • "U7: If the saturation falls below the patient's target range on stopping oxygen therapy, restart 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." • "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." • "U9: Some patients may have episodic hypoxaemia (eg, after minor exertion or due to mucus plugging) after they have safely discontinued oxygen therapy. An ongoing 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."	**Strength of recommendations:** SIGN Grade D (evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+)

Summary of recommendations	Quality of evidence, strength of recommendations and/or consensus agreement rate
Recommendations listed below can be found in W Practical aspects of oxygen dispensing, documentation and monitoring (p. 13) and Practical aspects of oxygen dispensing, documentation and monitoring (p. 76 to 77): • "W3: All patients should have their oxygen saturation observed for at least 5 min after starting oxygen therapy or for patients who require an increased concentration of oxygen and after oxygen therapy has been decreased or stopped." • 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." • "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 PCO_2 on the initial blood gas measurement." • "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 unless there should be further deterioration including symptoms or signs of possible hypercapnia." • "W7: Stable patients on oxygen treatment should have SpO_2 and physiological variables (eg, NEWS) measured four times a day." • "W8: In those who have signs of critical illness (eg, NEWS 7 or above), oxygen saturation should be monitored continuously and the patient may require level 2 or 3 care on a HDU or critical care unit." • "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." • "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)." • "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)." • "W12: 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)." • "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." • "W14: Patients at risk of hypercapnic respiratory failure (usually those with a target range of 88–92%; see table 4) require repeat blood gas assessment 30–60 min after an increase in oxygen therapy (to ensure that the carbon dioxide level is not rising)." • "W15: For patients with no risk of hypercapnic respiratory failure, monitoring by pulse oximeter is sufficient (repeated blood gases not required) provided the patient is clinically stable and the oxygen saturation remains in the desired range, usually	**Strength of recommendations:** SIGN Grade D (evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+)

Summary of recommendations	Quality of evidence, strength of recommendations and/or consensus agreement rate
94–98%." • "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." • "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." • "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."	

CF = cystic fibrosis; COPD = chronic obstructive pulmonary disease; COVID-19 = coronavirus disease 2019; FiO_2 = fraction of inspired oxygen; HFNC = high-flow nasal cannula; L/min = litres per minute; MI = myocardial infarction; NEWS = National Early Warning Score; NIV = noninvasive ventilation; O_2 = oxygen; PaO_2 = partial pressure of oxygen in arterial blood; PCO_2 = carbon dioxide tension; SARS-CoV 2 = severe acute respiratory syndrome coronavirus 2; SIGN = Scottish Intercollegiate Guideline Network; SpO_2 = oxygen saturation measured by pulse oximetry.

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Appendix 1: References of Potential Interest

Guidelines and Recommendations

Alternative Population — Community Settings

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See: Key points #10 (p. 2); Patients with severe chronic lung disease or other conditions at risk of hypercapnoeic failure (p. 2); Reduction and discontinuation of oxygen therapy (p. 3).