This quick reference guide should be read alongside the main guideline, and section numbers refer to the text of the main guideline.

Revised SIGN Grading for grades and levels of Evidence: see Box 1 of main guideline.

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AIMS AND TARGET AUDIENCE

The aims of these guidelines are to present the evidence base for the practice of administering supplemental oxygen to children outside hospital, and to make recommendations for best practice. For many aspects, high quality evidence is lacking and suggestions are made based on clinical experience. It is hoped the guideline will highlight areas where research is needed to further inform clinicians.

The target audience is clinicians who prescribe home oxygen for children, principally those in hospital practice. It is also intended for other professionals involved with the whole process, which may include community paediatricians, paediatric neurodisability specialists, nurse specialists, school nurses, occupational therapists and physiotherapists; this is reflected by the multidisciplinary nature of the guideline committee.

DEFINITIONS

Although domiciliary refers to the home, in the context of oxygen therapy, it refers to delivery of supplemental oxygen outside the hospital, as it may also be used outside the home, especially by children. Modes of delivery fall into several categories (figure 1).

Long term oxygen therapy (LTOT) is defined as the provision of oxygen for continuous use at home for patients with chronic hypoxaemia (due to any cause) in order to maintain target oxygen saturations. It may be required 24 hours per day (continuous LTOT) or during periods of sleep only (sleep-related LTOT). The latter may be given at night alone (nocturnal LTOT), or in young children, for daytime naps as well.

Portable oxygen therapy is LTOT outside the home (or in the garden). It refers to the provision of oxygen that can be wheeled on a trolley or pram, worn in a backpack or carried. When carried by the patient it is termed ambulatory oxygen. All children on LTOT require facilities for portable oxygen unless they only use it at night. There are no situations where a child receives portable oxygen that is not part of an LTOT regimen. Children are rarely house-bound and it is important to enable them (and their parents) to go outside the home in order to lead as normal a family life as possible.

Intermittent oxygen therapy describes a less common situation, whereby the child receives oxygen in an episodic manner, but because of the recurrent nature of the underlying condition, oxygen needs to be permanently available in the child’s home.

► An example would be a child with neurodisability who requires oxygen for aspiration pneumonia being treated at home, and who usually receives it for 1–2 weeks every few months. This is known as intermittent LTOT.

► In another situation, an acutely hypoxaemic child may receive oxygen for a short while for an emergency situation at home e.g. life-threatening asthma waiting for an ambulance. This is known as intermittent emergency oxygen therapy.

Hypoxaemia refers to low oxygen tension or partial pressure in the blood. Hypoxia is less specific and refers to lack of oxygen in a particular compartment, e.g. alveolar or tissue hypoxia. It is usually as a result of hypoxaemia (hypoxamic hypoxia), decreased tissue blood flow (stagnant hypoxia), anaemia (anaemic hypoxia) or an inability of the tissues to utilise oxygen (histotoxic hypoxia).

SUMMARY OF BACKGROUND FACTS

Normal oxygen saturations (section 2.4)

► Oximeters from different manufacturers may give different oxygen saturation readings depending on whether fractional or functional oxygen saturation is being measured.

► The median baseline saturation in healthy term infants during the first year of life is 97–98%.

► In only 5% of healthy infants is the arterial oxygen saturation measured by pulse oximetry (SpO₂) less than 90% for more than 4% of the time.

► The median baseline SpO₂ in healthy children aged 1 year or more is 98%, with a 5th centile of 96–97%.

► A healthy child aged 5–11 years spends no more than 5% of the time below a SpO₂ of 94% while asleep.

Consequences of chronic low oxygen saturation (section 2.5)

► Hypoxaemia causes pulmonary hypertension but the precise severity and duration of hypoxaemia needed to do this are not known. The factors affecting individual susceptibility are also unknown.

► SpO₂ levels above 94–95% appear to reduce pulmonary hypertension, while levels below 88–90% may cause pulmonary hypertension. This does not apply to children with congenital cardiac defects and idiopathic pulmonary arterial hypertension.

► Hypoxia may have adverse effects on cognition and behaviour at SpO₂ levels of 85% or below, but the effects of milder hypoxia are less clear.

► In infants with chronic neonatal lung disease (CNLD), SpO₂ below 90% is associated with an increased risk of apparent life-threatening events, while SpO₂ of 93% or more is not.

► In infants with CNLD, SpO₂ less than 92% may be associated with suboptimal growth.

► In infants with CNLD, SpO₂ of 90% or less impairs sleep quality, but SpO₂ above 93% does not.

SUMMARY OF RECOMMENDATIONS

Consequences of excess oxygen therapy (section 2.6)

► Excess arterial and intra-alveolar oxygen concentrations are toxic in preterm infants and must be avoided by appropriate monitoring and adhering to the target SpO₂ level; there are no data in older children. [D]

INDICATIONS FOR LONG TERM OXYGEN THERAPY (SECTION 3)

Chronic neonatal lung disease (section 3.1) (figure 2)

► Supplementary oxygen should be given to infants with chronic neonatal lung disease:
  a) to reduce or prevent pulmonary hypertension, reduce intermittent desaturations, reduce airway resistance, and promote growth. [C]
  b) as it is likely to be beneficial for neurodevelopment in infants with CNLD. [D]
  c) as it may reduce the associated risk of sudden unexplained death in infancy. [D]
d) as oxygen at home is preferable to a prolonged hospital stay for both quality of life and psychological impact for the infant, parents and family. [D]
e) as it saves days in hospital due to earlier discharge despite a significant readmission rate. [C]

Other neonatal lung conditions (Section 3.2)
► Home LTOT should be offered to infants with other oxygen-dependent neonatal lung conditions who are otherwise ready for hospital discharge. [✓]

Congenital heart disease (section 3.3)
► Home oxygen should not be used for cyanotic congenital heart disease unless accompanied by other respiratory problems. [✓]
► In acyanotic heart disease there is no role for LTOT. [✓]

Pulmonary hypertension (Section 3.4)
► In idiopathic pulmonary hypertension, supplementary oxygen is recommended for sleep-associated desaturations and for emergency use. [D]
► In pulmonary hypertension associated with congenital cardiac defects, some children may gain symptomatic benefit and a small open study has suggested it may improve survival. However there is a lack of good evidence that LTOT is of benefit and it is not recommended. [D]
► LTOT is recommended for pulmonary hypertension secondary to pulmonary disease. [D]

Intrapulmonary shunting (Section 3.5)
► The benefits of LTOT in non-cardiac intrapulmonary shunting are unknown with no relevant publication, however it should be considered if it leads to symptomatic improvement. [✓]

Recurrent cyanotic-apnoeic episodes (Section 3.6)
► LTOT should be considered for infants and children who have recurrent cyanotic-apnoeic episodes, severe enough to require cardiopulmonary resuscitation, assuming any anaemia has been corrected. [D]

Interstitial lung disease (Section 3.7)
► LTOT should be offered to hypoxic children with interstitial lung disease who are otherwise ready for hospital discharge. [✓]

Obliterative bronchiolitis (Section 3.8)
► LTOT should be offered to hypoxic children with obliterative bronchiolitis who are otherwise ready for hospital discharge. [✓]

Cystic fibrosis (Section 3.9)
► LTOT should be considered for hypoxic children with cystic fibrosis as a means to improve school attendance [B], and for those who obtain symptomatic relief. [D]
► In cystic fibrosis, monitoring of CO₂ levels should be carried out when oxygen therapy is initiated. [C]

Obstructive sleep apnoea (Section 3.10)
► In obstructive sleep apnoea, continuous positive airway pressure (CPAP) or occasionally non-invasive ventilation (NIV) is the therapy of choice if the upper airway obstruction can not be relieved surgically. If this is not possible, LTOT should be used to improve the SpO₂, but CO₂ levels need to be monitored at initiation of treatment. [C]

Chronic hypoventilation (Section 3.11)
► LTOT should be given in addition to ventilatory support if there is a hypoxaemic component of hypoventilation (assuming the child is optimally ventilated). On occasions when ventilatory support is not possible, supplemental oxygen may be the only alternative. [✓]

Sickle cell disease (Section 3.12)
► LTOT should be considered for children with sickle cell disease and persistent nocturnal hypoxia to reduce the risk of stroke and painful crises. [C]

Palliative care (Section 3.13)
► LTOT should be considered for hypoxaemic children undergoing palliative care who obtain symptomatic relief from supplemental oxygen. [✓]

SPECIAL SITUATIONS (SECTION 4)

Intermittent LTOT (Section 4.1)
► In children with neurodisability, oxygen may be given in the presence of hypoxia secondary to an acute lower respiratory tract infection. Children will usually be hospitalised, but where families opt for home treatment, facilities for home oxygen may be required if the infections are recurrent. [✓]
► The use of home oxygen in children with severe neurodisability and low SpO₂ should be driven by quality of life issues rather than oxygen saturation targets. [✓]

Intermittent emergency oxygen therapy (Section 4.2)
► Although most children with asthma should receive bronchodilators via a spacer device, for those using a home nebuliser, unless there is a significant co-morbidity or the child has life-threatening acute exacerbations, it should be run off room air. [✓]
► Intermittent acute oxygen therapy at home should be considered for the few children with recurrent episodes of severe life-threatening asthma, as a temporary therapy prior to ambulance transfer to hospital. [✓]
► Intermittent acute oxygen therapy at home is not routinely recommended for seizures as there is no evidence that it reduces their duration, reduces harm from prolonged seizures nor improves quality of life for the child or family. [✓]

Miscellaneous situations (section 4.3)
► Infants with bronchiolitis requiring oxygen (SpO₂ less than or equal to 92%) should be admitted to hospital, and can be considered for discharge when their SpO₂ is above 94% and they no longer require oxygen (for at least 8–12 hours). [✓]

ASSESSMENT OF NEED FOR LTOT & TARGET OXYGEN SATURATIONS (SECTION 5)
► Suitability for home oxygen therapy should be assessed by a specialist with appropriate experience. [✓]
► Pulse oximetry should be used for assessing children rather than arterial blood sampling. [C]
HOME OXYGEN IN CHILDREN

ORDERING AND PROVISION OF OXYGEN (EQUIPMENT) (SECTION 6)

- The decision that a child requires home oxygen and its ordering should be undertaken by paediatric specialists rather than primary care. [✓]
- Oxygen concentrators should be provided for LTOT, unless it is likely that the child will only require low flow oxygen for a short while. [✓]
- Whilst low weight cylinders are easier to handle, they empty quicker. Parent choice should be considered. [✓]
- Portable equipment should be available for all children as part of the provision of home oxygen unless oxygen is only required at night. [✓]
- Continuously delivered liquid oxygen cannot be used at flows less than 0.25 l/min, although breath activated systems can allow lower flows. It has limited applications for children, so is generally not recommended. [✓]
- Low flow meters are preferable, so very low flow meters are not recommended. [✓]
- Oxygen conservers are not indicated for young children but can be considered for older children capable of triggering the device. [✓]
- Humidification should be considered for high oxygen flows when given by facemask, especially for cystic fibrosis; a cold water bubble-through humidifier may be adequate for this purpose. [✓]
- When oxygen is given via a tracheostomy, heated humidification is generally recommended; a heat-moisture exchanger with an oxygen attachment may be an adequate alternative. [✓]
- Nasal cannulae are preferable for infants and young children for flows of 2 l/min or less. Patient choice should be considered for older children. [✓]
- There is no evidence on whether the routine use of a saturation monitor at home is of benefit or harm, and it cannot be recommended. Nevertheless some clinicians and parents may find it helpful in certain circumstances. [✓]

DISCHARGE PLANNING (SECTION 7)

- A comprehensive, written, parent held discharge plan with multi-disciplinary follow-up is recommended to ensure a safe and smooth transition into the community, and to avoid repeated or unnecessary hospitalisations. [✓]
- Children can be discharged from the neonatal unit when their oxygen requirement is stable with mean SpO₂ of 93% or above, and without frequent episodes of desaturation. This usually corresponds with an oxygen flow of 0.5 l/min or less. [D]
- The SpO₂ should not fall below 90% for more than 5% of the artefact-free recording period. [✓]
- There should be no other clinical conditions precluding discharge and the child must be medically stable. [✓]
- Careful preparation with a structured educational program should be implemented. [D]

FOLLOW UP AFTER DISCHARGE (SECTION 8)

Withdrawal of supplemental oxygen (section 8.2)

- Once the oxygen requirement is down to 0.1 l/min, consideration should be given to withdrawing supplemental oxygen. [✓]
- The same target saturations used to decide initiation of supplementation should be used for withdrawal purposes, i.e., 93% or above. [✓]
- Children can be weaned from continuous low flow oxygen to night-time and naps only, or remain in continuous oxygen throughout the 24 hours until the child has no requirement at all. It is not possible to recommend which strategy is superior. [✓]
- Oxygen equipment should be left in the home for at least 3 months after the child has stopped using it. If this is in a winter period, it is usually left until the end of winter. [✓]
- In CNLD, failure to reduce oxygen supplementation after 1 year should lead to a specialist review to rule out concomitant conditions. [✓]

OXYGEN OUTSIDE THE HOME (SECTION 9)

- An appropriately trained individual should be present whilst the child is using the oxygen, but this does not necessarily have to be a school nurse or health professional. [✓]
- Children will need higher oxygen flows during air flight or at high altitude, which should be determined by a fitness-to-fly test. [B]
- If a child has stopped supplemental oxygen within the last 6 months, they will need a fitness to fly test. [✓]

POTENTIAL DISADVANTAGES (SECTION 10)

- Parental/carer smoking must be strongly discouraged. [✓]
- Parents/carers (and older children) must be made aware of the potential hazards of home oxygen. [✓]
- It is critical that parents and carers receive sufficient emotional support from their family, friends and the healthcare services. [✓]
Long term oxygen therapy (LTOT) is the provision of oxygen for continuous use at home for patients with chronic hypoxaemia. It may be required 24 hours per day (continuous LTOT) or during periods of sleep only (sleep-related LTOT). The latter may be given at night alone (nocturnal LTOT), or in young children, for daytime naps as well (daytime LTOT).

Outside the home (includes in the garden) = portable oxygen

Inside the home: (essentially 24 hours/day)

Continuous LTOT

Sleep-related LTOT (nocturnal and day time naps)

Intermittent LTOT

Long term emergency oxygen therapy

Home oxygen for hypoxaemia

Outside the home (Outside the garden)

Intermittent LTOT

Continuous LTOT

Long term oxygen therapy

Intermittent emergency oxygen therapy

Outside the home (includes in the garden) = portable oxygen

Inside the home
Figure 2: LTOT pathway for an infant with chronic neonatal lung disease

Infant with Chronic Neonatal Lung Disease (post menstrual age ≥ 36 weeks)

Assess need for supplemental O₂ to maintain target saturations of 93% and above

Exclude other treatable causes

Ensure fulfils all discharge criteria

Educate parents / carers

Order LTOT + ambulatory oxygen (concentrator with large cylinder back-up & portable cylinders)

Oxygen installed in home

Check parents’ / carers’ understanding of installed equipment

Ensure community team & GP aware of discharge date

Child discharged home

Follow up by community team within 24 hours

Continued assessments at home
SpO₂ monitoring at least 4 weekly
Hospital clinic visits

Improvement in clinical state?

Yes

Gradual withdrawal of supplemental O₂

In air for 3 months with normal SpO₂ recordings 1 month apart

Refer to respiratory specialist if no improvement at 1 year

No

Inform oxygen supplier to remove equipment from home

Section 3.1
Sections 5.1, 5.2
Section 7.1.1
Section 7.2
Appendix 2
Sections 2.1, 6.1, 6.2
Section 7.2
Section 8.1
Section 8.2