National Neonatal Network

Scotland

Clinical Guideline

Home Oxygen Therapy for Neonates

Disclaimer

This guideline is not intended to be construed or to serve as a standard of care. Standards of care are determined on the basis of all clinical data available for an individual case and are subject to change as scientific knowledge and technology advance and patterns of care evolve. Adherence to guideline recommendations will not ensure a successful outcome in every case, nor should they be construed as including all proper methods of care or excluding other acceptable methods of care aimed at the same results. The ultimate judgement must be made by the appropriate healthcare professional(s) responsible for clinical decisions regarding a particular clinical procedure or treatment plan. This judgement should only be arrived at following discussion of the options with the patient, covering the diagnostic and treatment choices available. It is advised, however, that significant departures from the national guideline or any local guidelines derived from it should be fully documented in the patient's case notes at the time the relevant decision is taken.

Version: 1.0

Date of ratification: 11th March 2022

Review date: March 2025

Ratified by: National Neonatal Guideline Oversight Group

Introduction
This document is applicable to all medical, midwifery/ nursing and AHP staff working with neonates in Scotland, in hospital or community.

The majority of babies discharged from the neonatal unit on home oxygen have bronchopulmonary dysplasia (BPD) and this guidance is primarily aimed at babies with this diagnosis.

Long Term Oxygen Therapy is also required for babies secondary to a variety of other conditions. These include meconium aspiration syndrome, pneumonia, pulmonary hypoplasia, pulmonary hypertension, congenital heart disease with pulmonary hypertension, and some neuromuscular diseases. Much of the advice in this guideline is applicable to these infants also but their care requires more individual planning.

Contents

Short Summary

Who should undergo oxygen saturation testing?

- All infants who remain in supplementary oxygen when they are otherwise ready for home
- Infants born at <32 weeks gestation, with a diagnosis of BPD, who have discontinued oxygen therapy within 2 weeks of the expected date of discharge OR who have significant respiratory symptomatology at that time
- Infants of any gestation who required > 28d of respiratory support who have discontinued supplementary oxygen, within 2 weeks of the expected date of discharge

When should testing occur?

Saturation testing for babies with BPD should occur when the infant has met the following criteria

- They are 36wks corrected gestational age (CGA) or greater
- Medically stable.
- Have satisfactory growth.
- Have an O2 dependency of no more than 0.5 L/min via nasal cannula.
- Can maintain a mean SpO_2 of 93% or greater, during most activities, without frequent or prolonged desaturation episodes, *as assessed by bedside saturation monitoring*.
- They have had stable O2 requirements for the preceding week.
- Systemic steroids, where prescribed, have been discontinued at least 1 week prior to testing.
- They have had no recent changes to other medications that may affect respiratory function *e.g. diuretics, inhaled steroids.*
- Feeding orally by breast/bottle for at least 48 hours.
  Unless home nasogastric feeds are part of the discharge plan.
- Free of apnoeic episodes and off caffeine citrate therapy for >7days

Testing Description:

- Duration: 12 – 24 hours – must include periods of sleep and wakefulness
- Minimum equipment: Saturation monitor capable of data download and analysis
- Location: In the local neonatal unit
- Oxygen flow during test:
  - In air if O2 recently discontinued
  - An increment of 0.1 L/min equal to, or higher, than the most recent flow rate required as judged by bedside testing. If ideal flow is unclear use 2 different flow rates for periods of 12h each. E.g. 0.1 L/min and 0.2 L/min
- Clinical evaluation:
  1. Inform nurses in room that oxygenation study ongoing
  2. Record any change to position, feeding or cares in an activity diary
  3. Document background (e.g. Handling / choking spell) if any significant desaturation events

Interpretation of results

Infants who are in air or a fixed oxygen level would pass their oxygen study if:

1. Mean SpO2 ≥ 93% in air, or chosen fixed oxygen level.
2. SpO2 does not fall below minimum* for more than 5% of the total oxygen study time.
3. There are no significant† desaturation/bradycardia episodes
   †*Deep* (>10%) *or prolonged* (>3min) *episodes unrelated to movement or technical artefacts*

Where these criteria are not met:

1. If mean saturation < 93%, consider repeating test in 0.1 L/min higher oxygen flow
2. If there an unacceptable number or severity of desaturations, consider and treat other diagnosis (GORD, immaturity, central apnoeas, airway control etc). Repeat test after incidents settle

Discharge Planning (complete discharge checklist)

- **Perform an "air challenge"** – 30 mins breathing air. Ensure SpO2 does not fall <80%
- **Offer Vaccination** – 1st dose Palivizumab (if criteria met). Influenza if > 6 months old
- **Consider additional Investigations – If in high levels of Oxygen (>0.5 L/min) OR if there are significant respiratory symptoms.**
  - CXR,
  - Capillary gas,
  - ECG/ECHO (for pulmonary hypertension)
  - FBC (for anaemia – top up if Hb < 85g/l)
- **Monitoring –** Apnoea monitor only at consultant request
- **Rooming in -** for 1-2 days before discharge
- **Liaison Visit –** within 24h of discharge
- **Illness following discharge –** Ensure parents understand when and where to seek help if infant becomes unwell

Weaning/follow up protocol

- Clinical review at intervals of ≤4 weeks should determine that the patient is well, achieving adequate growth, and does not have significantly increased work of breathing.
- Apply a saturation monitor and observe saturation values in a resting state for > 15 mins. If the mean saturation values are ≥93% the baby should be observed for the remainder of the visit (at least 15 min) with the oxygen flow rate reduced by 0.1L/min. If the baby was previously in 0.1L/min then they should be observed in room air.
- If the baby remains well saturated in the reduced flow rate (mean saturation ≥93%) then the baby should remain on this flow rate for the duration of a 12-24 hour saturation recording. Parents should be given instructions to resume the previous oxygen flow rate if they have concerns about their baby's breathing or if saturation levels fall consistently below 90%

Outcomes

- **Satisfactory recording -** The mean SpO2 during the recording is ≥93%, with < 5% of the artefact free recording being below minimum*, and with no significant desaturation episodes.
  Action - The patient should remain on the reduced oxygen flow rate and be reviewed within 4 weeks
- **Evidence of potential hyperoxia –** The mean saturation during the recording is ≥96% with no significant desaturation episodes.
  Action - The patient should remain on the reduced oxygen flow rate and consideration given to an early reassessment with a further reduction in the oxygen prescription
- **Inadequate saturation during sleep -** Satisfactory daytime recording but Mean saturations falling to <93% during sleep, or >5% of recording is below minimum*, or there are prolonged or frequent desaturation episodes.
  Action - The patients should be returned to the previous oxygen flow rate during sleep OR for 24h per day, at the discretion of the clinical team. Further reassessment within 4 weeks
- **Unsatisfactory recording –** The mean saturation on the reduced oxygen flow rate is <93% OR >5% of the recording is below baseline OR there are prolonged or frequent desaturation episodes.
- ***Action - The patient should be returned to their original oxygen flow rate and arrangements made for reassessment within 4 weeks***

N.B. – repeated failure to be able to wean the oxygen prescription over a 6 month period may require further investigation or discussion with the respiratory team.

Full Guideline

Background

Bronchopulmonary Dysplasia (BPD) / Chronic Lung Disease (CLD) is the main indication for home oxygen therapy in neonatal care. The principle aim of managing these infants is to prevent harm from chronic hypoxemia and to improve relevant symptoms. There are many benefits of supplemental oxygen (Long Term Oxygen Therapy, LTOT)) for infants with BPD which include;

- Reducing or preventing pulmonary hypertension, reducing intermittent desaturations and reducing airway resistance
- Promoting growth
- Improved neurodevelopment outcome in infants with CLD
- Reduction in the risk of sudden unexplained death in infancy
- Avoiding a prolonged hospital stay which has a positive influence on quality of life and psychological impact for the infant, parents and family. Additionally, this will improve cot capacity within the neonatal unit.

This evidence is summarised in – (*BTS guidelines for home oxygen in children 2009)*

The use of supplemental oxygen at home facilitates early and safe discharge from the neonatal unit to a normal stimulatory environment whilst reducing prolonged hospitalisation. Early discharge significantly reduces the risk of nosocomial infection as well as promoting parental bonding.

These benefits must be balanced against the potential for increased pulmonary inflammation and injury that may be caused by supplementary oxygen. The need to continue supplementing oxygen requires frequent reassessment to ensure that oxygen is weaned appropriately, and discontinued promptly, when no longer required. This has the additional benefit in reducing the burden of care for the family.

Diagnosing BPD

The definition of BPD used by the **National Neonatal Audit Project (NNAP)** and in this guidance is:

The need for respiratory support, (including ventilation, CPAP or High Flow Nasal Therapy), and/or an oxygen requirement, at 36 weeks menstrual age (PMA).

This definition is used as a marker of severity of disease as it has been shown to be a sensitive and specific predictor of chronic respiratory morbidity (Jobe AH & Bancalari E 2001).
More recently, Isayama et al (2017), found that Oxygen/ Respiratory support at 40 weeks PCA was a better predictor of serious respiratory morbidity and neurodevelopmental outcomes at 18-21 months of age. However, this definition has not found common usage

It is important to ensure that the diagnosis of BPD / CLD is robust. This will ensure reliable benchmarking of the incidence of BPD between different neonatal units. Also, the diagnosis of BPD / CLD has important implications for future medical care. Some babies may remain on low levels of non-invasive respiratory support (high flow nasal therapy or CPAP), and/or low levels of supplementary oxygen (<0.1L/min), solely because there has been no recent attempt to stop these therapies. It is therefore recommended that a trial of withdrawal of these therapies is attempted in such babies, shortly prior to 36 weeks PCA. This guideline does not recommend a formal oxygen reduction test however.

Preterm infants who cannot be weaned from their respiratory support by 36 weeks Post Menstrual Age (PMA), will have a diagnosis of BPD recorded. This diagnosis and its implications should be discussed with the parents. If the additional criteria noted below are met then the option of Home Oxygen Therapy can be raised.

Recommended criteria for discharge on Home Oxygen

Babies should **generally** be considered for home oxygen when they have met the following criteria;

- They are 36wks corrected gestational age (CGA) or greater
- Medically stable.
- Have satisfactory growth.
- Have an O2 dependency of no more than 0.5 L/min via nasal cannula.
- Can maintain a mean SpO_2 of 93% or greater, during most activities, without frequent or prolonged desaturation episodes, *as assessed by bedside saturation monitoring*.
- They have had stable O2 requirements for the preceding week.
- Systemic steroids, where prescribed, have been discontinued at least 1 week prior to testing.
- They have had no recent changes to other medications that may affect respiratory function *e.g. diuretics, inhaled steroids.*
- Feeding orally by breast/bottle for at least 48 hours.
  Unless home nasogastric feeds are part of the discharge plan.
- Free of apnoeic episodes and off caffeine citrate therapy for >7days

N.B. babies who fall outside these parameters (e.g. flow rates >0.5L/min or <36 weeks corrected age) ***may*** *be considered for home oxygen therapy but require individualised planning.*

Saturation Targets for Home Oxygen Therapy *(Babies with BPD)*

To provide safe and effective oxygen therapy both hypoxia and hyperoxia must be controlled.

Hypoxia - SpO2 levels of ≤ 85% may have adverse effects on cognition and behaviour but the effects of less severe hypoxia are less clear. Similarly, SpO2 of <92% may be associated with suboptimal growth. Evidence suggests impaired sleep quality at SpO2 ≤90% but not at 93%. Also, saturations of 94-95% appear to reduce pulmonary hypertension while levels of 88-90% may contribute to the development of pulmonary hypertension. Therefore, aim is to maintain mean oxygen saturations ≥93%.

Recommendation
To reduce the risk of hypoxia, maintain a mean SpO2 ≥93% with less than 5% of the artefact free recording being below minimum*.

**** Minimum Saturation –*** *There is insufficient evidence to define the lowest minimum saturation level for safe discharge. The British Thoracic society, The European Respiratory Society and The Thoracic society of Australia & New Zealand recommend that less than 5% of the recording should fall below a minimum saturation of 90%. The American Thoracic Society recommend a more conservative approach, recommending that less than 5% of the recording should fall below 93%. In the absence of sufficient evidence to recommend the best option, either approach may be adopted by individual units. Consideration may be given to discussing this treatment choice with families prior to initiating home oxygen treatment.*

Hyperoxia – Higher levels of pAO2 may lead to pulmonary toxicity and should be avoided. Maintaining higher levels of SpO2 (96-99%) in 2 studies *(STOP-ROP 2000, Askie LM et al. 2003)* increased the risk of adverse pulmonary events including pneumonia and/or exacerbations of chronic lung disease and the need for oxygen, diuretics, and hospitalization at 3 months of corrected age. Saturation monitoring is not an effective tool with which to monitor hyperoxia, due to the non-linear relationship between SpO2 and paO2. Babies on supplementary oxygen with a high mean SpO2 may be inadvertently hyperoxic.

Recommendation
To reduce the risk of hyperoxia in babies on oxygen therapy, attempt to wean or stop the oxygen prescription if the mean SpO2 is ≥96%

When should a saturation study be performed?

Recommendation

An oxygen saturation study should be undertaken around 1-2 weeks prior to the planned date of discharge when it is anticipated that the baby will have met the other criteria listed above. This will allow sufficient time to arrange oxygen installation if required

Babies who remain in supplementary oxygen.

These babies should have their oxygen flow rate fixed in anticipation of the oxygen study. This will usually be at the next increment of 0.1 L/min* of oxygen above the highest variable flow rate recorded over the preceding 24h. If the baby maintains a mean SpO2 of 93% or greater on this flow rate then the saturation study may proceed.
(**home oxygen can only be prescribed in increments of 0.1 L/min*).

Babies who have recently discontinued supplementary oxygen.

A saturation study, undertaken in air, should also be undertaken for the following groups of babies who have discontinued supplementary oxygen within the 2 weeks prior to discharge OR who have significant ongoing respiratory symptoms

- Babies diagnosed with chronic lung disease (O2 or respiratory support after 36 weeks)
- Babies with other diagnoses who required more than 28 days of respiratory support

N.B. Saturation studies can be undertaken at any time after discontinuation of oxygen but are best performed at least 1-2 weeks prior to anticipated discharge so that home oxygen can be organised if they fail the study in room air

How to conduct the study

Recommendation

The duration of a pulse oximetry study should be 12-24 hours. It should be assessed at all levels of activity including feeding and sleeping. Activities such as feeding, changing, sleeping, crying / agitation etc, should be recorded in an activity diary, to aid interpretation.

The test is conducted in a fixed flow of oxygen in most cases. If the level of supplementary oxygen required is unclear, the clinician may decide to undertake a split test (e.g. half the test in 0.1 L/min and half at 0.2 L/min, OR half the test in air and half the test at 0.1 L / min). In this cases the pulse oximetry study must be conducted over 24 hours with each flow being tested for 12h.

The saturation monitor used should be able to download information for analysis. The analysis must be able to provide sufficient data to interpret the study as outlined below. This will include the mean saturation and an analysis of the cumulative time spent below each saturation percentage. A timed graphical display of the saturation, heart rate and perfusion along with the patient diary will help with interpretation of desaturation episodes and eliminate those which are artefactual.

Interpretation of the Pulse Oximetry Study for babies with BPD

Satisfactory study – Mean oxygen saturation is maintained at ≥93% for the duration of the study. The cumulative time spent below minimum* should be less than 5% of the artefact-free recording period.
There should be no prolonged (> 3min) or deep (>10%) dips in the saturation which do not correlate with activities, such as crying or cares, as recorded in the patient diary.

N.B. When interpreting a saturation study result it should be noted that normal preterm and term babies will have dips in oxygen saturations and these will be displayed as an absolute number of dips ≥4% below baseline per hour. The number of "dips" reduces with increasing gestational age and clinical condition, but shallow dips in saturations which do not increase the total time under baseline SpO2 can be tolerated.

Unsatisfactory study - low mean saturation – Mean saturation of 92 % or less, and/or >5% of the cumulative time below minimum* saturation. No prolonged (>3min) or deep (>10%) dips in the saturation which do not correlate with activities in the patient diary. These infants may benefit from a repeat test with an increase in the oxygen flow rate.

Unsatisfactory study – deep or prolonged desaturation episodes – Mean oxygen saturation is maintained at ≥93% for the majority of the study but deep/prolonged desaturation episodes are identified. Time spent below minimum* may or may not exceed 5%. Dips which are deep, or prolonged, should be interpreted carefully and generally indicate that the infant is not yet ready for discharge. Additional investigation may be warranted to look for specific remedial causes such as e.g. reflux, anaemia or airway obstruction. However, if no other cause can be found for these episodes then it would usually be appropriate to delay discharge and repeat the test after an interval. As the mean saturation is ≥93% it is usually not appropriate to simply increase the oxygen flow rate.

Provision of Home Oxygen

The supply of home oxygen equipment is co-ordinated centrally by Dolby Vivisol. An electronic oxygen request from (SHOOF) should be completed by an authorised person. This duty may be delegated to a pharmacist or nursing member of the LTOT team but the oxygen flow rate must be determined by a neonatal/respiratory consultant. The SHOOF should specify that a 10 Litre oxygen cylinder is required with variable flow rate and request a carry case for the 2 Litre portable oxygen cylinder. The table below indicates the likely duration of supply from a single cylinder (static and portable)
N.B. Some existing patients will have oxygen concentrators, however these are being phased out due to supply issues.

Dolby engineers will carry out a home visit to ascertain the home conditions for oxygen. Their visit is normally arranged directly between parents and Dolby. Dolby will also provide equipment training to parents and carers and are responsible for maintenance and for dealing with equipment failures.
If an interpreter is required for oxygen training this should be specified on the SHOOF form with language information. Dolby Vivisol will arrange for an interpreter.

Home conditions must be satisfactory and preferably should have a telephone. Parents must be advised about smoking cessation, to inform their home and car insurers, and precautions while travelling with oxygen cylinders. Parents and older children in the family must be made aware of the potential hazards of home oxygen. It is essential that parents and carers receive sufficient emotional support from their family, friends and health care services.

A checklist is provided (*Appendix)* to ensure all steps have been taken in preparation for safe discharge

Maximum Duration of supply from Static and Portable cylinders

10 Litre static cylinder		**2 Litre portable cylinder**	
Flow rate (L/min)	**Max duration**	**Flow rate (L/min)**	**Max duration**
0.1 L/min	16 Days 16 Hours	0.1 L/min	3 Days 8 Hours
0.2 L/min	8 Days 8 Hours	0.2 L/min	1 Day 16 Hours
0.3 L/min	5 Days 13 Hours	0.3 L/min	1 Day 2 ½ Hours
0.4 L/min	4 Days 4 Hours	0.4 L/min	20 Hours
0.5 L/min	3 Days 8 Hours	0.5 L/min	16 Hours
0.6 L/min	2 Days 18 ½ Hours	0.6 L/min	13 Hours
0.7 L/min	2 Days 9 Hours	0.7 L/min	11 Hours

Discharge planning

When oxygen requirements have been established and the oxygen prescription sent, the infant should continue with this fixed flow rate until discharge, unless there is a clinical deterioration.

The parents should be provided with a link to the Bliss resource "Going home on Oxygen"

Air Challenge

Recommendation
Prior to discharge an "air challenge" should be undertaken to determine the infant's likely response to accidental discontinuation of oxygen, due to equipment failure or dislodged nasal prongs.

> **Performing an air challenge –** Whilst still on continuous SpO2 monitoring, remove the baby's Oxygen supply for 30 minutes. The baby should be able to maintain a SpO2 of > 80% for the 30 minutes of the test.
> Following the air challenge, SpO2 monitoring may be discontinued in preparation for discharge. Apnoea monitoring may also be discontinued if the baby is off caffeine and is free of apnoea (see separate guidance)
>
> *If the SpO2 fails below this level then this would indicate a higher risk of morbidity should there be a technical problem with the oxygen supply at home. This would need to be taken into account as part of discharge planning*.

Vaccination

Recommendation
All babies on home oxygen should be considered for Palivizumab during the RSV season, with the first dose being administered before discharge - please see national Immunisation guidelines for more information.

Infants >6 months should also be offered influenza vaccination. - please see national Immunisation guidelines for more information.

N.B. If the infant is less than 6 months of age, immunisation of parents/carers for Influenza may be considered. This should be discussed with their General practitioner.

As part of discharge planning all families should be given general advice about hygiene, to reduce the risk of viral infection.

Additional investigations

Recommendation
Infants with more significant BPD (Those with higher levels of supplementary oxygen, ongoing symptomatology or those requiring diuretics or inhaled steroids) the following investigations should be considered before discharge.
(BTS guidelines for home oxygen in children 2009)

- CXR
- Capillary pCO2
- ECG/ECHO to look for signs of right heart strain or pulmonary hypertension[4].

If there is evidence of pulmonary hypertension a referral should be made to the cardiology service for more detailed assessment

Monitoring for anaemia

British Society for Haematology Guidelines for transfusion for foetuses, neonates and older children 2016 recommends maintaining a Haemoglobin level of > 85g/l for preterm babies who still require supplementary oxygen. A FBC should be measured shortly before discharge unless the baby has previously been seen to have a stable or rising Haemoglobin value >85g/l.

Recommendation
Any babies with Hb <85g/l should be considered for a top up transfusion prior to discharge with ongoing monitoring of the haemoglobin level in the outpatient setting.

Home saturation monitors & apnoea monitor?

Saturation (SpO2) monitors are not recommended for babies being discharged on LTOT. Saturation studies as outlined in this guideline have demonstrated stable oxygen requirements before discharge and the parents are instructed not to alter the oxygen flow rate. If the baby's colour or breathing pattern worsen the parents should be instructed to seek urgent medical review – see breathing management plan

Infants with BPD have not been shown to be at increased risk of acute, life-threatening episodes (Gray PH, Rodgers Y 1994), therefore LTOT in an otherwise stable infant is not an indication for the routine use of a home apnoea monitor.

Recommendation
Saturation monitors are not recommended for babies on LTOT. Apnoea monitors should not be offered routinely for babies going home on oxygen therapy, but may be recommended for more complicated cases at consultant discretion

Rooming in and liaison visiting

Recommendation
To support transition from the neonatal unit to home, parents should be encouraged to room-in with their infant 24-48 hrs prior to discharge home.

Recommendation
Following discharge the liaison team / home oxygen team should arrange a home visit within 24 hours.

The timing of discharge from hospital should take into account the availability of liaison services to undertake an early visit, usually within 24 hours of the baby going home.
In the immediate period after discharge, liaison visits may need to be frequent to provide the level of support that some parents may require. At each visit the infant's progress will be monitored with particular attention to respiratory, cardiac & neurological systems and to growth

Breathing Management Plan / Hospital access arrangements

Parents should be directed to the Bliss resource "If your baby is unwell when you go home"
They may also be given the Bliss leaflet "Going home from the Neonatal Unit"
They should be given instructions on what to do if their infant's breathing or colour deteriorates. This may take the form of a documented **"breathing management plan"** by local arrangement.

Arrangements should also be made to allow for easy access for infants, on home oxygen, to a local paediatric ward or observation unit. In hospitals with a co-located paediatric wards, parents may be issued an open access letter and arrangements made for the parents to have a walk round so as to be familiar with the surroundings and staff. For units without a co-located paediatric ward, parents need clear instructions about where to take their child in case of a clinical deterioration. This will include the location of the paediatric hospital and where they should go to arrange medical review – e.g. A&E / assessment unit.

All parents should be given a copy of their baby's Badger summary / Discharge letter, containing details of their neonatal course and current therapy, which the parents should take with them to the hospital, to ensure that the receiving team have details of their medical history and home oxygen therapy

Weaning Home Oxygen

There is a lack of robust evidence in literature regarding weaning strategies which has contributed to significant practice variability. The following recommendations are intended to reduce variability between different neonatal units in Scotland.

The EPICURE study showed that the median duration of oxygen requirement for babies on LTOT was just 2.5 months after their expected date of delivery. Frequent re-evaluation is therefore recommended to facilitate early discontinuation in such infants.

Recommendation
Infants on Home Oxygen for BPD should be reviewed at intervals of four weeks or less. This review should assess whether it is possible to wean, or discontinue oxygen therapy. For other conditions, the frequency of review will be dictated by the infant's clinical progress.

Clinical review, either by a clinician or by the home care team, should determine that the patient is well, achieving adequate growth, and does not have significantly increased work of breathing. Should this be the case, the home oxygen team (local arrangements vary) should apply a saturation monitor and observe saturation values in a resting state for at least 15mins. If the mean saturation values are $\geq$93% the baby should be observed for a similar period with the oxygen flow rate reduced by 0.1L/min. If the baby was previously in 0.1L/min then they should be observed in room air.

If the baby remains well saturated in the reduced flow rate (mean saturation $\geq$93%) then the baby should remain on this flow rate for the duration of a 12-24 hour saturation recording. The local team will determine arrangements for uplift of the saturation monitor the following day and arrangements for downloading the saturation recording. This recording should be reviewed as soon as possible by the consultant / home oxygen team so that the parents may be given advice about ongoing oxygen requirements. A number of different results and outcomes are possible

- **Satisfactory recording -** The mean SpO2 during the recording is $\geq$93%, with < 5% of the artefact free recording being below minimum*, and with no significant desaturation episodes.
  Action - The patient should remain on the reduced oxygen flow rate and be reviewed within 4 weeks

- **Evidence of potential hyperoxia –** The mean saturation during the recording is $\geq$96% with no significant desaturation episodes.
  Action - The patient should remain on the reduced oxygen flow rate and consideration given to an early reassessment with a further reduction in the oxygen prescription

- **Inadequate saturation during sleep -** Satisfactory daytime recording but with saturations falling to $\leq$92% during sleep.
  Action - The patients should be returned to the previous oxygen flow rate during sleep OR for 24h per day, at the discretion of the clinical team. Further reassessment within 4 weeks

- **Unsatisfactory recording –** The mean saturation on the reduced oxygen flow rate is <93% OR >5% of the recording is below minimum* OR there are prolonged or frequent desaturation episodes.
  Action - The patient should be returned to their original oxygen flow rate and arrangements made for reassessment within 4 weeks.

  N.B. – repeated failure to be able to wean the oxygen prescription may require further investigation or discussion with the respiratory team.

Uplifting of Oxygen equipment

Recommendation
In uncomplicated cases, without ongoing respiratory symptoms, and following a satisfactory saturation study in air, arrangements should be made for the oxygen equipment to be uplifted without delay.

N.B. In the unlikely event of a subsequent respiratory deterioration the supplier (Dolby) can now re-install within 24 hours if oxygen was needed again.

Where supplementary oxygen has been required for extended periods, or where the infants has residual respiratory symptoms, then the oxygen may be left in the home for an additional month, or more, before arranging uplift. In such cases an additional oxygen saturation study in air, performed after oxygen has been discontinued for a month, may provide additional reassurance before removing the oxygen equipment from the house.

Following discontinuation of treatment, a consultant or home oxygen team member needs to inform the suppliers that the equipment is no longer required by emailing the company mailto:shoof.dv@nhs.net

Further Investigations for infants who do not follow usual weaning course

EPIcure study showed that for babies, who went home on oxygen, the median length of oxygen requirement after 40 weeks postmenstrual age was 2.5 months and 75th centile was 8.5 months. Only, <3% of these children are in oxygen at 1 year of age. Persistent requirement or failure to wean supplementary oxygen warrants clinical review to rule out concomitant conditions like trachea-bronchomalacia, large airway stenosis, gastro-oesophageal reflux, recurrent aspiration, sleep related upper airway obstruction, unsuspected congenital heart disease, cystic fibrosis, granuloma formation in airway.

Recommendation
Where infants who cannot be weaned from their supplementary oxygen within 6 months corrected age, or who have significant ongoing symptomatology, referral to a paediatric consultant with an interest in respiratory medicine for ongoing care should be considered.

Guidance for Infants Going on Holiday

Parents should be advised to discuss any travel plans with home oxygen team before booking.
For holidays in the UK, Dolby Vivisol can arrange for supplies of oxygen to be available at the holiday destination. They are unable to arrange supplies for holidays out with the UK and parents are responsible for arranging their child's oxygen therapy.

Recommendation
All infants on supplementary oxygen, and those whose supplementary oxygen was discontinued in the preceding 6 months should have a "fitness to fly" test before travelling.

"Fitness to fly" assessment

Travel in a commercial aircraft involves cabin pressures equivalent to an altitude of up to 2400m, equivalent to 15% inspired oxygen. Infants with CNLD who have normal SpO2 in air may desaturate to below 80% in 15% oxygen. The current recommendations suggest that a fall in SpO2 below 90% during 20 minutes of such experimental hypoxia is an indication for either delaying the air travel or providing supplemental oxygen to the infant during the air travel. The exact requirements for the oxygen can be determined during the test. The assessments can be arranged via the respiratory physiology laboratories in the regional children's hospitals.
Availability and charges for supplying oxygen during the flights vary depending on the airlines and they need to be informed in advance.

Teaching Package for Home Oxygen for Neonates

BABY'S NAME:-..... Date started:

D.O.B:-..... Date completed:

CHI NUMBER:-.....

CONSULTANT:-.....

HOSPITAL:- ……..

Criteria for home oxygen

Infants need to be feeding independently and have adequate weight gain.

Parents need to provide informed verbal consent following discussions with the neonatal team that they are willing to provide continuing care of oxygen within the community setting with support from health to manage this care.

Infants need to be stable in the flow of oxygen set by Neonatal Consultant with no bradycardias or desaturations requiring adjustment to the set flow. Neonatal Consultant will set the prescribed flow and order the installation of oxygen by completing a SHOOF form.

In the week leading up to discharge, ensure package is completed and that parents are happy with progress and feeling confident regarding assessing their infants respiratory effort and health. Ensure that parents are happy with oxygen equipment and especially changing and securing nasal prongs. Discontinue continuous monitoring

Discharge date to be determined once oxygen has been put into the home by Dolby Vivisol and all relevant parties are informed of the use of oxygen.

Goal for Parents/Carers	Nursing actions/considerations	Date achieved	Comments & signature
Understanding of Chronic Lung Disease	Explanation/Discussion of Chronic Lung Disease		
Consent to continue home oxygen therapy in the home environment	Explain the need for home oxygen and what caring for a baby on home oxygen entails, with the stress on the fire risk. Provide parents with information resource.		
Knowledge of flow rate that oxygen is to run at in the home environment	-Neonatal Consultant to set rate of oxygen flow. Oxygen flow set to.....l/min - Date SHOOF form submitted ...../...../.....		
All necessary equipment installed in the home environment – Dolby Vivisol will explain to family how to work and store equipment safely	Parents to inform nursing staff once the oxygen cylinders and portable cylinders are in the home.		
Oxygen to be stored and transported safely – Parents to inform their car insurance that they will be transporting oxygen	Parents have informed nursing staff that car insurance has been updated on ...../...../.....		
Oxygen to be stored and transported safely – Parents to inform their home insurers (or Landlord if in Private Let) that there will be oxygen stored within the home	Parents have informed nursing staff that home insurance has been contacted and updated ..../...../.....		
Parents to alert electrical supplier and gas supplier of need for home oxygen	Parents to inform nursing staff once utility suppliers have been contacted and informed ...../...../.....		
Ability to assess infants respiratory rate and breathing and recognise respiratory difficulties Parents to build confidence in their observations of their	Explain respiratory rate, colour, recession, perfusion and associated changes with activity – particularly feeding Encourage parents to observe for this so that they gain an insight in what is their infants individual respiratory pattern		

infant			
Goal for Parents/Carers	Nursing actions/considerations	Date achieved	Comments & signature
Knowledge of actions to take in an emergency situation	Ensure parents have access to a phone for alerting emergency services. Discuss signs of the deteriorating infant, discuss checking equipment is working adequately and about increasing oxygen flow if needed until medical assessment		
Parents trained how to initiate CPR	Parents watch BLISS DVD on CPR and give hands-on training using a mannequin Parents encouraged to ask any questions		
Parents aware of positioning for good air entry	Explanation/advice regarding safe positioning and cot elevation in the community.		
Knowledge on reducing the risk of Cot Death	Provide and discuss Lullaby Trust Safe Sleep for Preterm Infants resource		
Parents familiar with use of apnoea monitor (if clinically indicated) *N.B. Apnoea monitors are not routinely provided unless there are additional clinical indicators. (Consultant decision)*	*If issued with monitor:* -Parents taught how to use apnoea monitor if clinically indicated -Monitor and supply of disposables issued		
Parents to be aware of potential for readmission for hospital care	Ensure parents understand that any readmission will be to a Children's Ward - Ensure parents are aware of where their local children's ward is located Open access to be arranged if applicable locally		
Maintain a safe environment within the home for home oxygen safety	-Discuss dangers of smoking/home candles/gas stoves and cookers. -Sign post to smoking cessation services if parent's consent		
Parents aware of how to reorder supplies	Liaison service will advise parents who to contact for additional supplies after discharge and ensure that at least 1 weeks supply are provided at discharge		

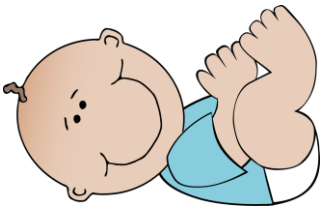
Parents aware that they are entitled to apply for DLA (Disability Living Allowance) and blue badge	Liaison service to discuss and support parents prior to discharge with this process		
Parents to feel confident in the set up and maintenance of home oxygen equipment	-Ensure parents know how to ensure nasal prongs are patent and care of nasal prongs -Ensure parents know how to change oxygen flow meters for oxygen cylinder -Ensure parents know how to check oxygen flow		

Nursing needs prior to discharge once date for discharge determined

Activity	Date Accomplished / Comments	Signature
Baseline Oxygen Saturation Study obtained		
Safe sleep from Lullaby Trust provided and discussed		
Prescription's for medicines/specialised formulas organised		
Health Visitor informed		
GP informed (ensure registered with GP)		
Physio and any other allied professionals informed i.e. dietician, SALT		
Ensure teaching package for parents has been completed		
Offer parents opportunity to room in with infant		
Home Visit with liaison		

service arranged		
Out Patient appointment arranged		

N.B. For more complex cases, a multi-disciplinary team meeting may be appropriate prior to discharge, inviting the input from all agencies listed above, who are involved in ongoing care of the infant



Home oxygen discharge process

Home oxygen need identified - discussed with parents

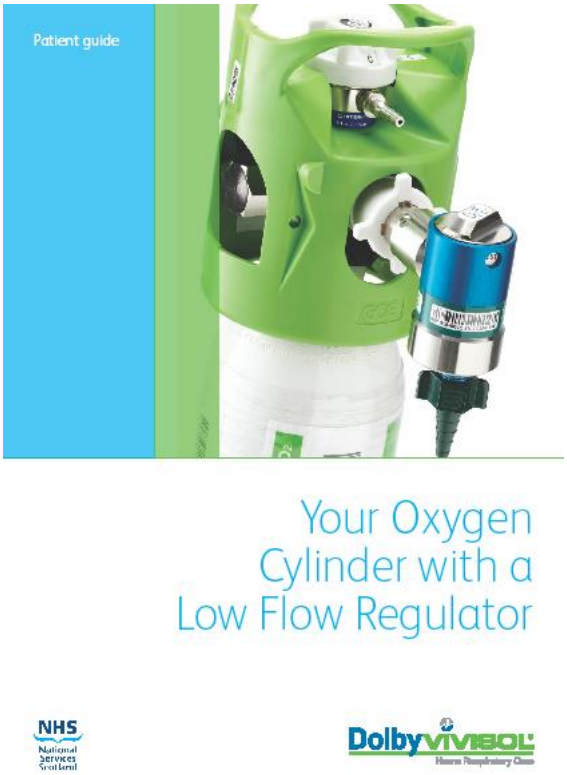
Oxygen set by Neonatal Consultant

SHOOF completed on Dolby Vivisol site

Parents provided with Home Oxygen information package and Teaching Package for Home O2 completed

Patient discharged with follow up from liaison service in the community

Patient Guide – Your Oxygen Cylinder with a Low Flow Regulator



LINK TO PDF

References:

BTS Guidelines for Home Oxygen in Children. I M Balfour-Lynn, D J Field, P Gringras, B Hicks, E Jardine, R C Jones, A G Magee, R A Primhak, M P Samuels, N J Shaw, S Stevens, C Sullivan, J A Taylor, C Wallis, *Thorax*, 64.2, (2009), ii1-ii26.

AHA/ATS Guideline – Paediatric Pulmonary Hypertension 2015. Abman SH, Pediatric Pulmonary Hypertension. Guidelines from the American Heart association and American Thoracic Society. *Circulation; 132: pp 2037-2099*

Respiratory management of infants with chronic neonatal lung disease beyond the NICU: A position statement from the Thoracic Society of Australia and New Zealand* 2020 Nitin Kapur, Gillian Nixon, Philip Robinson, John Massie, Bernadette Prentice, Andrew Wilson, Sandra Schilling, Jacob Twiss & Dominic A Fitzgerald . Respirology; 2020: 25, 880–888

European Respiratory Society guideline on long-term management of children with bronchopulmonary dysplasia. Duijts L, van Meel ER, Moschino L, et al. Eur Respir J 2020; 55: 1900788

Jobe AH, Bancalari E, 'Bronchopulmonary Dysplasia', *American Journal of Respiratory and Critical Care Medicine*, 163.7, (2001), 1723-1729.

Isayama T, Shoo K. Lee, Junmin Yang, David Lee, ; Sibasis Daspal, Michael Dunn, ; Prakesh S. Shah, (2017) 'Revising the definition of bronchopulmonary dysplasia effect of Changing panoply of Respiratory support for preterm neonates', *JAMA Pediatrics,* 171(3), pp. 271-279

The STOP-ROP Multicenter Study Group. Supplemental therapeutic oxygen for prethreshold retinopathy of prematurity (STOP-ROP), a randomized, controlled trial. I: Primary outcomes. Pediatrics. 2000;105;295–310

Askie LM, Henderson-Smart DJ, Irwig L, Simpson JM. Oxygen-saturation targets and outcomes in extremely preterm infants. N Engl J Med 2003;349(10):959-67.

Gray PH, Rogers Y (1994) 'Are infants with bronchopulmonary dysplasia at risk for sudden infant death syndrome?', *Pediatrics,* 93(5), pp. 774-777.

Sara B. DeMauro, Erik A. Jensen, Carla M. Bann, Edward F. Bell, Anna Maria Hibbs, Susan R. Hintz and Scott A. Lorch. Home Oxygen and 2-Year Outcomes of Preterm Infants With Bronchopulmonary DysplasiaPediatrics May 2019, 143 (5) e20182956; DOI: https://doi.org/10.1542/peds.2018-2956

Group Membership

Tim Adams (Consultant Paediatrician, NHS Ayrshire and Arran)

Sean Ainsworth (Neonatal Consultant NHS Fife)

Jane Anderson (Senior Charge Nurse, NHS Lothian)

Shetty Bhushan (Consultant Neonatologist, NHS Tayside)

Elizabeth Black (Community Neonatal Nurse, NHS Fife)

Duncan Boyd (Consultant Neonatologist, NHS GGC)

Dominic Cochrane (Consultant Neonatologist, NHS GGC)

Jonathan Coutts (Consultant Neonatal and Respiratory Paediatrician, NHS GGC)

Tanya Dunbar (SCN Neo Outreach NHS Tayside)

Lesley Jackson (Consultant Neonatologist, NHS GGC, Lead Clinician SPN Neonatal Network)

Beata Kamusella (Consultant Neonatologist, NHS Fife)

Vijender Kistareddy (Consultant Neonatologist, NHS Grampian)

Gopala Krishnan (Consultant Neonatologist, NHS Lanarkshire)

Mary Law (Neonatal Nurse, NHS Lanarkshire)

Louise Leven (Consultant Neonatologist, NHS GGC)

Sarah Logue (Community Neonatal Liaison Nurse NHS Fife)

Andrew MacLaren (Consultant Neonatologist RHC GGC, ScotSTAR)

Fiona Martin (Community Liaison Nurse NHS Lanarkshire)

Lorraine McGrory (Consultant Neonatologist NHS Lanarkshire)

Catriona Middleton (Consultant Paediatrician, NHS Grampian)

Jennifer Mitchell (Consultant Neonatologist, NHS GGC)

Dominic O'Reilly (Consultant Paediatrician, NHS Forth Valley)

Joyce O'Shea (Consultant Neonatologist, NHS GGC)

Colin Peters (Consultant Neonatologist, NHS GGC, ScotSTAR, MCQIC)

Andrew Powls (Consultant Neonatologist, NHS GGC)

David Quine (Consultant Neonatologist, NHS Lothian)

Lauren Shaw (Neonatal Grid Trainee, NHS Tayside)

Asma Yasmeen (Consultant Neonatologist, NHS Fife)

Laura Stewart (Consultant Neonatologist, NHS Fife)