PREVENTION AND MANAGEMENT OF BRONCHOPULMONARY DYSPLASIA

Background

- The incidence is inversely proportional to the gestational age and birth weight.
- The incidence varies according to the diagnostic criteria used.
- Infants born with a birth weight <1250 g account for 97% of all BPD.
- Approximately 30% of all very low birth weight babies develop BPD

Definition

- BPD is a clinical diagnosis defined by oxygen dependence for a specified time period after birth accompanied by characteristic radiological findings: clearing of radio-opacity into a cystic, bubbly pattern.
- Currently, the most widely used clinical definition is characteristic radiological findings with the need for supplemental oxygen at 36 weeks corrected gestational age for babies at least 28 days old.
- It is possible to categorise patients according to severity of BPD and by using a room-air challenge test at 36 weeks corrected gestational age.

BPD Severity	Definition	Incidence
None	O_2 treatment < 28 d and breathing room air at 36 weeks PMA or discharge home, whichever comes first	23%
Mild	O_2 treatment at least 28 d and breathing room air at 36 weeks PMA or discharge home, whichever comes first	30%
Moderate	O_2 treatment at least 28 d and receiving <30% O_2 at 36 weeks PMA or discharge home, whichever comes first	30%
Severe (type 1)	O_2 treatment at least 28 d and receiving ≥ 30% O_2 or nasal CPAP/HHFNC at 36 weeks PMA	16%
Severe (type 2)	O_2 treatment at least 28 d and receiving mechanical ventilation at 36 weeks PMA	1%

Risk Factors

- Chorioamnionitis
- Male sex
- Low gestational age and birthweight or small for gestational age
- Cardiopulmonary resuscitation following birth
- Core body temperature < 35°C on admission to the neonatal unit
- Invasive ventilation commenced within 24 hours of birth
- Need for surfactant treatment
- Treatment for a patent ductus arteriosus
- Clinical sepsis with or without positive blood cultures
- Formula milk feeding (exclusively or in combination with breast milk)

Prevention of BPD in Antenatal Care

- For more detailed guidance please see Obstetric Guidelines

Key Points:

- Consider progesterone therapy and cervical cerclage
- Aim for in-utero transfer ≤ 34+6 weeks
- Consider use of cervical length and fibronectin measurements to prevent unnecessary use of tocolytics and/or antenatal steroids

- Use tocolytics to allow time for transfer and steroid treatment
- Give a single course of antenatal corticosteroids to all women at risk of preterm delivery from 22+0 – 34+6 weeks gestation
- Give a repeat course of steroids in threatened preterm birth before 32+0 weeks gestation if the first course has been administered at least 1 – 2 weeks earlier.
- Consider antibiotics to delay preterm delivery and reduce neonatal morbidity PPROM
- Give magnesium-sulfate for neuroprotection to all women between who are in established preterm labour or having a planned preterm birth within 24 hours from 22+0 – 31+6 weeks gestation

Prevention of BPD in the Delivery Room

- For more detailed guidance please see Delivery Room Guideline

Key Points:

- Delayed clamping or x4 milking of the cord
- Environmental temperature should be 26 - 28^{o}C
- Plastic bag wrapping under radiant warmer for babies < 30 weeks gestation.
- By 5 minutes after birth aim for saturations of 85% and HR >100/minute.
- Initial FiO_2 0.3 for babies < 28 weeks gestation, air to 0.3 for 28 – 31+6 weeks gestation and air for 32+0 weeks gestation and above
- Heating and humidification of gases during delivery room stabilisation
- Oxygen for resuscitation should be controlled with a blender and adjustments guided by pulse oximetry
- Avoid positive pressure breaths and in spontaneously breathing babies, stabilise with CPAP of 8 cmH_2O via T-piece
- Intubation and gentle positive pressure lung inflations with 20 – 25 cmH_2O (preterm infant) peak inspiratory pressure should be used for persistently apnoeic or bradycardic infants.
- Preterm babies intubated at birth should be given surfactant and then extubated as soon as possible

Prevention and Management of BPD in the Early Hours and First Week of Life

- For a more detailed respiratory guidance please see Non-Invasive Respiratory and Invasive Respiratory Support Guidelines

Key Points:

- Target oxygen saturation limits of 84 – 94% if < 34+0 weeks in first 28 days of life
- A FiO_2 >0.4 in the first hours after birth is a reasonable predictor of subsequent CPAP/HHFNC failure
- If needed, administer surfactant 200 mg/kg in first 4 hours of life by LISA (≥ 1.2 kg; see LISA Guideline) or InSurE (< 1.2 kg) technique to babies stable on NCPAP/HHFNC
- Volume Targeted Ventilation is the preferred choice of invasive respiratory support at 5 ml/kg, short inspiratory time (0.3 – 0.35s), PEEP 5 - 6 cmH_2O for lung recruitment without causing over-distension; only if conventional ventilation fails, consider HFOV
- Aim for $FiO_2 \leq 0.4$ and blood gas with pH 7.30 - 7.35, PaO_2 6.5 - 9.5 kPa, $PaCO_2$ 6.5 - 8.5 kPa; avoid pH > 7.45 and $PaCO_2$ < 4.5 kPa or pH < 7.2 and $PaCO_2$ > 10 kPa, e.g. in severe BPD
- Start caffeine to all infants at birth < 32+0 weeks
- Consider early targeted PDA treatment (see PDA Management Guideline)
- Avoid fluid overload and delay sodium supplementation until good urine output
- Extubate to bubble CPAP/HHFNC as soon as possible
- Start **early hydrocortisone** as per unit formulary if

- ventilated at 5 days of life and FiO_2 >40% or PCO_2 >8.5kPa
- CXR changes of hyper-expansion and/or patchy areas of density and emphysema
- history of chorioamnionitis/early neonatal sepsis

- Screen ventilated babies who cannot be extubated for Ureaplasma and if positive, treat with azithromycin.
- Do not routinely use opiates and avoid midazolam sedation.
- Encourage the use of breast milk instead of formula

Management of BPD After the First Week of Life

- For a more detailed guidance please see Non-Invasive Respiratory and Invasive Respiratory Support Guideline as well as Enteral and Parenteral Nutritional Care Guideline

Key Points

- Target oxygen saturation limits of 84–94% if < 34+0 weeks in first 28 days of life and then 89-96% when > 28 days; > 94% once 36+0 weeks gestation
- Aim for FiO_2 ≤ 0.4 and blood gas with pH 7.30 - 7.35, PaO_2 6.5 - 9.5 kPa, $PaCO_2$ 6.5 - 8.5 kPa; avoid pH > 7.45 and $PaCO_2$ < 4.5 kPa or pH < 7.2 and $PaCO_2$ > 10 kPa, e.g. in severe BPD
- In severe BPD (> 28 days of life) consider a larger tidal volumes (7 - 12ml/kg), longer inspiratory times (≥ 0.5s) and slower rates down to 20 bpm
- Continue Caffeine treatment at least until 32+6 weeks gestation
- Start **dexamethasone** as per unit formulary to aid extubation if FiO_2 > 0.6. Wean as rapidly as possible. Dexamethasone may also be used as a rescue treatment.
- Start **late hydrocortisone** as per unit formulary if FiO2 > 0.4 irrespective of mode of respiratory support or if already received one dexamethasone course. If an extended low dose treatment is deemed necessary switch to hydrocortisone dose for adrenal hypoplasia as per unit formulary (consider random cortisol and Synacthen Test)
- Consider bronchodilators, inhaled corticosteroids, mucolytic therapies (e.g. inhaled dornase) and physiotherapy for acute respiratory decompensation due to airway hyperreactivity and persistent small airway disease
- Consider diuretics to improve compliance and pulmonary mechanics in the short term thus aiding extubation and weaning off respiratory support or preventing re-intubation; long term use of diuretics is not recommended
- Consider Sildenafil for pulmonary hypertension based on ECHO (PAP > 30mmHg or other marker) or if there is persistent FiO_2 > 0.6 despite steroid treatment and after ruling out and treating other comorbidities (upper airway problems, aspiration, gastro-oesophageal reflux disease, PDA, pulmonary vein stenosis, cardiac shunts and/or dysfunction). Discuss with respiratory and cardiology (Dr Sadia Quyam) team before commencing treatment. Watch for systemic hypotension and re-assess monthly with ECHO
- Consider referral to ENT/Paed Surgeons, if there is a suggestion of dynamic airways obstruction because of tracheomalacia or bronchomalacia, and/or fixed lesions such as subglottic or tracheal stenosis, granulomas and complete cartilage; increase PEEP whilst waiting for assessment
- Consider use of high energy formula to help reduce fluid overload and gastro-oesophageal reflux in severe cases aiming for a fluid intake of approx. 130-150 ml/kg/day and a caloric intake of 130 kcal/kg/day with a protein intake of 4 g/kg/day;

seek dietetic support monitor length weekly in addition to weight and head circumference

- Consider referral to SALT/GI-Team/Paed Surgeons if there is suspicion of chronic aspiration and/or severe gastro-oesophageal reflux disease; consider gastrostomy feeding/fundoplication

Assessment for BPD and Referral to the Respiratory and HDU Team

- Review any premature infant born < 30+0 weeks' gestational age at 34+0 weeks' corrected gestational age for the presence of BPD defined as:
  - persistent parenchymal lung disease with radiographic confirmation
  - criteria for Yellow/Orange/Red Zone for > 3 consecutive days to maintain oxygen saturation between 90 and 95% (saturation limits 89 – 96%)

Grade	Mechanical Ventilation	SIPAP/NCPAP/ HHFNC (≥ 3 l/min)	HHFNC (< 3 l/min)	Low Flow NC* (≤ 1l/min)
0	No	No	No	No
I	No	Yes, in air	Yes, in $FiO_2 \leq 0.3$	Yes, in $FiO_2 \leq 0.4$
II	Yes, in air	Yes, in $FiO_2 \leq 0.3$	Yes, in $FiO_2 > 0.3$	Yes, in $FiO_2 > 0.4$
III	Yes, in O_2	Yes, in $FiO_2 > 0.3$		

* Please refer to the Non-Invasive Respiratory Support Guideline for further details about low flow cannula and oxygen concentration

Red Zone: Will need prolonged hospital admission with mechanical ventilation or any mode of non-invasive respiratory support.
Refer to the Respiratory Team and RACH HDU at 34 weeks corrected gestational age.

Orange Zone: Unlikely to need prolonged hospital admission with any mode of non-invasive respiratory support, but likely to be discharged home in oxygen.
Refer to the Respiratory Team at 34 weeks corrected gestational age.

Yellow Zone: Unlikely to need prolonged hospital admission with any mode of non-invasive respiratory support and unlikely to be discharged home in oxygen.
Refer to the Respiratory Team at 36 weeks corrected gestational age if still requiring oxygen.

Green Zone: Does not need oxygen.
Do not refer to the Respiratory Team.

Note: Refer early to the Respiratory Team for atypical respiratory cases e.g. neuromuscular disorders and upper airway problems.

Management of Established BPD and Transfer to HDU RACH

- Optimise all aspects of care in all babies in the Red/Orange/Yellow:
  - consider upper airway problems
  - assess for pulmonary hypertension at 36 completed weeks
  - consider trial of diuretics / inhaled steroids
  - consider aspiration, manage GORD and nutritional requirements
  - complete repair of inguinal hernia at 36 weeks
- Review progress with respiratory team for babies in the Red/Orange Zone. Joint review of babies with their families on the baby unit should be encouraged
- Babies in the Red Zone will be transferring to the HDU and should remain on the non-invasive respiratory device they are on at 34+0 weeks.
- Babies in the Orange Zone can be weaned in line with Non-Invasive Respiratory Support Guideline until 36 weeks and then reassessed. Aim to stabilise on a reasonable level of respiratory support agreed with the respiratory team and avoid aggressive weaning at this stage as it is unlikely to improve the clinical status
- Perform Room Air Challenge in all babies in the Yellow Zone at 36+0 weeks CGA:
  - Reduce supplemental oxygen stepwise by 0.01 l/min to room air under continuous monitoring including saturation monitoring.

- If saturations remain > 94% for 60 minutes, then no BPD is present:
  - no referral to the Respiratory Team required
  - discharge home if remains off oxygen for one week
  - arrange appointment in neonatal clinic and neurodevelopmental follow-up
- BPD is present, if saturations do not remain ≥94% for 60 min in Room Air Challenge:
  - referral to the Respiratory Team required
  - undertake an overnight oximetry study in at least 0.1 l/min (study and clinical up-date to be e-mailed to the neonatal and respiratory consultant involved)
  - organise a multidisciplinary discharge planning meeting

  Note: For a 12 hour oximetry study the average SpO2 should be ≥94% with sufficient artefact free trace to allow proper interpretation

- The optimal timing of tracheostomy for ventilated infants with severe BPD will be determined after discussion among care providers and the family (should be >4kg)
- Early referral to the Evelina LTV team is advised if unable to manage on CPAP; they may consider reviewing a baby in Brighton.

Follow-up

- The local Community Paediatric Nursing team provides regular support to parents particularly in the period after discharge. Their role includes:
  - arranging overnight oximetry studies
  - liaising with the respiratory medical team
  - organising RSV immunisations
- An open access arrangement to the Children's Emergency Department (CED) is recommended. A copy of the discharge summary should be given to parents and sent electronically to CED
- Bronchopulmonary Dysplasia Clinic - initial appointment within 8 weeks, continued until off oxygen supplementation; discharged back to neonatal clinic after one additional appointment off oxygen
- Other relevant follow up if needed – Physiotherapy, Dietician, SALT
- Neurodevelopmental assessment:
  - Monitor in BPD Clinic along with Physiotherapy and SALT checks as needed
  - Refer from the BPD Clinic to the local CDC as needed
  - Preterm infants (<30 weeks gestation) booked at Brighton or PRH will be offered routine neurodevelopmental assessments in baby clinic at 12 and 24 months corrected age
  - For out of area babies, refer to the local Paediatrician or CDC for developmental checks when discharged from BPD clinic

Immunisation

- Using the RSV immunisation planner identify high risk preterm infants with moderate or severe BPD born ≤34+0 weeks and on oxygen or respiratory support at 36 weeks corrected gestational age
- Find the RSV immunisation planner in Metavision, the Microguide or NHS - RSV
- Babies with moderate to severe BPD who are discharged between the months of October to March (beginning of week 40 to end of week 8) should be offered Palivizumab prior to discharge and then monthly (max. 5 doses)
- A respiratory consultant (authorised user of Blueteq System) needs to ensure approval for immunisation and funding from NHS England. They will also need to prescribe immunisations for the RSV Clinic and send this to the Paediatric Pharmacist

- If discharge is more than a few days away from the next RSV clinic than an ad hoc immunisation should be agreed and administered on the baby unit prior to discharge.
- Further treatment may be considered in the second year if the child remains on medication for chronic lung disease.

Multidisciplinary Discharge Planning Meeting for Babies with BPD

Organising the planning meeting

Neonatal outreach nurse to facilitate

The following should be present:

- Parents
- Respiratory and neonatal consultants
- Community paediatric nurse
- Neonatal and or outreach nurse
- Health visitor
- Other health professionals such as: dietician, SALT, physio and social worker.

The discharge planning meeting

Neonatal consultant leads the meeting and provides a summary of care to date

Agree and confirm the following:

- ☐ Discharge date
- ☐ Home visit completed
- ☐ Home oxygen delivery date set
- ☐ Home oxygen level set
- ☐ Date of first home visit by Community Paediatric Nurse
- ☐ Plan for next overnight oximetry study
- ☐ Discharge medications
- ☐ RSV immunisations arranged
- ☐ Completion of screening and immunisations
- ☐ Parent training completed
- ☐ Follow-up plans in place

Preparing for discharge

Neonatal nursing team should check:

- ☐ Baby registered with a GP
- ☐ Health Visitor up-dated
- ☐ Family and social issues addressed
- ☐ Home visit arranged to check on suitability for home oxygen

Neonatal medical and nursing team in agreement with respiratory team:

- Set level of NC oxygen (≥ 0.1l/min) for discharge according to 12 hour oximetry study. Do not wean.
- Complete documentation (HOOF, IHORM and HOCF)
- Step down monitoring and simplify medications in agreement with the respiratory team.
- Complete screening and immunisations
- Confirm need and arrangements for RSV immunisation.

BPD FORMS:
Can be found at:
http://www.dolbyvivisol.com/services/healthcare-professionals/home-oxygen-services/england/ihorm-and-hoof-part-a/
or in the Team Drive under Referral Forms - External
HOOF = Home Oxygen Order Form
IHORM = Initial Home Oxygen Risk Mitigation Form
HOCF = Home Oxygen Consent Form.