NEWBORNS WITH RESPIRATORY DISTRESS: MANAGEMENT IN SPECIAL CARE NURSERIES (SCNs)

PRACTICE GUIDELINE

This document reflects what is currently regarded as safe practice. However, as in any clinical situation, there may be factors which cannot be covered by a single set of guidelines. This document does not replace the need for the application of clinical judgment to each individual presentation.

<table>
<thead>
<tr>
<th>Approved by:</th>
<th>Newborn Care Centre Committee</th>
</tr>
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<tbody>
<tr>
<td>Date Effective:</td>
<td>November 2016</td>
</tr>
<tr>
<td>Team Leader:</td>
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<tr>
<td>Review Period:</td>
<td>3 years</td>
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</tbody>
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Page 1 of 38
This Guideline may be varied, withdrawn or replaced at any time.
DOCUMENT SUMMARY/KEY POINTS

The purpose of this guideline is to provide support, education and guidance for clinicians to achieve the best possible respiratory care of newborns in Special Care Nurseries (SCNs) Level 1-4 services in NSW (GL2016_081 NSW Maternity and Neonatal Service Capability Framework). This guideline provides support to all non-tertiary facilities and services caring for newborns. It would be appropriate for Local Health Districts (LHDs) to develop local protocols based on the attached clinical practice guideline (CPG).

Key points / take-home messages:
This guideline reflects current expert consensus as a safe and appropriate approach to the management of newborn infants with respiratory distress in Special Care Nurseries (SCNs). However, in any clinical situation there may be factors that cannot be included in a single guideline.
This document should be used as a guide rather than as a complete authoritative statement of the procedures to be followed with respect to each individual newborn. It does not replace the need to apply clinical judgment to the presentation of each newborn and to consult on escalation of care within the local facility or LHD or for transfer to a higher level of care such as a tertiary Neonatal Intensive Care Unit (NICU).
CHANGE SUMMARY

Not applicable: New document
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1. BACKGROUND

This clinical practice guideline Newborn Infants with Respiratory Distress: Management in Special Care Nurseries was prepared by a multidisciplinary clinical reference group (see Appendix B) under the auspice of the NSW Pregnancy and newborn Services Network (NSW PSN).

Respiratory distress in term, near-term and preterm newborns is the leading cause for admission to a SCN, representing approximately 5% of all live births. Causes of respiratory distress are diverse and the range of treatments available is broad.

Clinical management within an individual SCN will depend upon its capabilities in accordance with the NSW Maternal and Newborn Service Capability Framework and the NSW Health Guide to the Role Delineation 2016 (e.g. medical, nursing and infrastructure).

1.1 Aims

- To achieve the best possible respiratory care and long term outcomes of newborns cared for in all SCNs in NSW
- To support clinicians in their knowledge and management of newborns presenting with respiratory distress at birth, during the physiological transition to extrauterine life or during the first few days after birth
- To support clinicians with the decision making process around in-utero and ex-utero transfer and the timing of consultation for newborns needing a higher level of care.

There may be factors that cannot be covered by a single guideline; hence, this guideline does not replace the need for access to the best available professional clinical judgment. It does not provide a stringent set of rules and should not be used by clinicians as if it were a complete authoritative statement. Each newborn should be individually evaluated and a clinical decision made on the most appropriate management to achieve the best clinical and long term developmental outcome possible.

For all newborns presenting with clinical signs of respiratory distress, consultation with a clinician with paediatric skills is strongly recommended. This will vary according to geographic location and may include a general or specialist paediatrician, a general practitioner who regularly cares for newborns or a clinician experienced at least at the level of a paediatric registrar.

1.2 Exclusions

This guideline is not intended to guide the resuscitation of newborns nor the administration of supplemental oxygen beyond the first few days of life.
**ABBREVIATIONS and KEY DEFINITIONS**

<table>
<thead>
<tr>
<th>Abbreviation / Terminology</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Apnoea</td>
<td>A pause in breathing of more than 20 seconds, or less than 20 seconds if associated with bradycardia</td>
</tr>
<tr>
<td>CPAP</td>
<td>Continuous positive airway pressure</td>
</tr>
<tr>
<td>CXR</td>
<td>Chest X-Ray</td>
</tr>
<tr>
<td>Early Term</td>
<td>Infant Born at 37-38 completed weeks of gestation</td>
</tr>
<tr>
<td>ETT</td>
<td>Endotracheal tube</td>
</tr>
<tr>
<td>FiO₂</td>
<td>Percentage of inspired oxygen</td>
</tr>
<tr>
<td>HHFNC</td>
<td>Humidified High Flow Nasal Cannulae</td>
</tr>
<tr>
<td>HMD</td>
<td>Hyaline Membrane Disease</td>
</tr>
<tr>
<td>HFNC</td>
<td>High Flow Nasal Cannulae</td>
</tr>
<tr>
<td>INSURE</td>
<td>Intubation-surfactant-extubation</td>
</tr>
<tr>
<td>IPPV</td>
<td>Intermittent positive pressure ventilation</td>
</tr>
<tr>
<td>Late Preterm</td>
<td>34.0 to 36.6 completed weeks of gestation</td>
</tr>
<tr>
<td>MAS</td>
<td>Meconium Aspiration Syndrome</td>
</tr>
<tr>
<td>MIST</td>
<td>Minimally invasive surfactant therapy</td>
</tr>
<tr>
<td>nCPAP</td>
<td>Nasal continuous positive airway pressure</td>
</tr>
<tr>
<td>Neonate</td>
<td>The first 28 days of life</td>
</tr>
<tr>
<td>Newborn</td>
<td>The first 48 hours of life</td>
</tr>
<tr>
<td>NETS NSW</td>
<td>Newborn and paediatric Emergency Transport Service NSW &amp; ACT</td>
</tr>
<tr>
<td>NICU</td>
<td>Neonatal Intensive Care Unit</td>
</tr>
<tr>
<td>Pedi-Cap™</td>
<td>CO₂ detector</td>
</tr>
<tr>
<td>PPHN</td>
<td>Persistent Pulmonary Hypertension of the Newborn</td>
</tr>
<tr>
<td>Preterm</td>
<td>A baby born before 37 completed weeks of gestation</td>
</tr>
<tr>
<td>RDS</td>
<td>Respiratory Distress Syndrome, also known as Hyaline Membrane Disease</td>
</tr>
<tr>
<td>SCN</td>
<td>Special Care Nursery</td>
</tr>
<tr>
<td>SpO₂</td>
<td>Arterial oxyhaemoglobin saturation measured non-invasively by pulse oximetry</td>
</tr>
<tr>
<td>SNOOC</td>
<td>NSW Health Standard Newborn Observation Chart: Special Care Nursery/Postnatal Ward under 1 month (corrected)</td>
</tr>
<tr>
<td>Term</td>
<td>A baby born at 37 or more completed weeks gestation</td>
</tr>
<tr>
<td>TPN</td>
<td>Total Parenteral Nutrition</td>
</tr>
<tr>
<td>TTN</td>
<td>Transient tachypnoea of the newborn</td>
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2. ANTENATAL TRANSFERS and UNIT CAPABILITY

Timely in-utero transfer should be considered in cases where newborn respiratory support above an SCN's clinical capabilities or neonatal intensive care is likely to be required.

At 34 weeks gestation, 13-27% of newborns will require respiratory support with CPAP or ventilation. At 32 weeks gestation, 26-66% of newborns will require CPAP or ventilation. At 32 weeks gestation, full feeds are not established by day 5 in 20% of newborns and in those born at 34 weeks this is 4%3.

The NSW Maternity and Neonatal Service Capability Framework1 provides guidance on the recommended level of maternal and neonatal services required to birth women at different gestational ages.

Women at risk of preterm delivery who present to a facility that does not normally care for newborns of that gestational age should be transferred, if safe to do so, to the appropriate level of care in the tiered network.

Should an unavoidable preterm birth occur below the gestation a facility normally provides care for, the clinical needs of the newborn and the resources and capabilities of the SCN will determine whether transfer to a higher level of care is necessary. Discussion with the appropriate referral centre must take place.

Every Special Care Nursery has a designated Level 5/6 hospital under the Tiered Maternity and Neonatal Network responsible for providing perinatal advice.

- Immediate obstetric care and in-utero transfer advice should be obtained from the obstetric Registrar/Consultant at your designated tertiary referral centre
- The designated tertiary referral centre should provide initial advice and support irrespective of their capacity to accept an in utero or ex utero transfer. The NSW Perinatal Advice Line (PAL) supports the tiered maternal and neonatal networks with the provision of expert clinical advice for the management of women who may require in utero transfer to a higher role delineated hospital, and can assist in identifying appropriate available neonatal and maternal resources.

PAL may be contacted through the Newborn and paediatric Emergency Transport Service NSW & ACT (NETS NSW) automated phone system on 1300 36 2500

2.1 At risk of OR unavoidable preterm birth

1. Antenatal steroids decrease the risk of respiratory distress syndrome, intraventricular haemorrhage and necrotising enterocolitis in preterm newborns4,5. The benefit is greatest in newborns less than 34+6 weeks gestation whose mothers receive the first dose of steroids between 1-7 days before birth6. Steroids may also reduce the need for transfer to a higher level facility for infants born at less than 37 weeks gestation6.

2. Tocolytics can delay birth enabling in utero transfer where appropriate to a tertiary perinatal care centre and time for antenatal steroids to take effect7.

3. Antibiotics for preterm premature rupture of membranes may also reduce the risk of birth and significant maternal and neonatal sepsis8.
4. If in-utero transfer is not possible and birth within 4 hours is considered likely, magnesium sulphate for fetal neuroprotection should be considered for a pregnancy of less than 30 completed weeks of gestation, but only after consultation with the relevant tertiary centre or PAL obstetrician. Magnesium sulphate for fetal neuroprotection should not be administered during transfer.

3. EX-UTERO TRANSFERS

There are many different causes of respiratory distress in newborns. The need to transfer depends upon the newborn’s condition, the course of the illness and upon each SCN’s capabilities in terms of staffing, skills, training and expertise. The following provide indications for calling NETS NSW to discuss transfer according to whether the SCN has capability of providing support with nasal Continuous Positive Airway Pressure (nCPAP) or more than 2 litres/min of Humidified High Flow Nasal Cannulae (HHFNC).

3.1 SCNs NOT trained/accredited in using nCPAP or HHFNC

Newborns who require ongoing CPAP support (of any type, including Fisher Paykel® Neo Puff™) or greater than 2 litres per minute of HHFNC beyond 30 minutes usually require management in a nursery with the appropriate resources and training (see Appendix A). Nasal CPAP or HHFNC of more than 2 litres per minute may be used as per these guidelines for acute stabilisation while waiting for NETS retrieval. However, it is expected that all newborns receiving such intervention will be transferred (see section 3.3 for algorithm).

In addition, NETS NSW should be contacted to discuss management if any of the following occur:

- the newborn requires more than 30% inspired oxygen to maintain SpO₂ in the target range of 91 - 95% for more than an hour
- the pCO₂ on a blood gas is greater than 60mmHg on two successive occasions more than an hour apart
- the pH is less than 7.25 on two successive occasions more than an hour apart
- Meconium Aspiration Syndrome, Hypoxic Ischaemic Encephalopathy or Pulmonary Hypertension is suspected.

3.2 SCNs trained in using nasal CPAP or HHFNC

See section 3.4 for algorithm and Appendix A for training information.

Indications for commencing nCPAP are included later in this document (see section 7). Discussion with a neonatologist through NETS NSW should occur in the following situations:

- clinical features to suggest the need for surfactant and or mechanical ventilation
- oxygen requirements of more than 40% to maintain saturations of 91 - 95% for more than an hour after initiation of nCPAP/HHFNC
• the pCO₂ on a blood gas is greater than 60mmHg on 2 successive occasions more than an hour apart
• the pH is less than 7.25 on two successive occasions more than an hour apart
• recurrent apnoeic episodes that require stimulation
• evidence of other system involvement e.g. hypotension
• birth weight less than 1500g and need for prolonged parenteral nutritional support predicted
• nCPAP persisting beyond 72 hours
• nCPAP with agitation that cannot be relieved by simple measures including wrapping, nesting, skin to skin or non-nutritive sucking
• insufficient nursing or medical resources.

The Tiered Maternity and Neonatal Networks can be contacted via NETS NSW Phone: 1300 362 500
A senior paediatrician should receive advice from a senior neonatology colleague

Contacting NETS NSW does not mean a retrieval will be activated, but will assist you in contacting the appropriate personnel for advice and planning of ongoing management. Changes in the newborn’s condition should also be communicated through NETS NSW.
3.3 Algorithm - Management of respiratory distress in SCNs with NO nCPAP capability

- Woman presents AT RISK of OR IN preterm labour
  - Consider: Antenatal steroids
  - +/- Antibiotics
  - +/- Tocolytics
  - +/- Magnesium Sulphate

- Is hospital capable of looking after mother and newborn?
  - Yes
    - Newborn’s SpO₂ greater than 90%?
      - Yes
        - Commence supplemental oxygen. Aim to keep SpO₂ 91 – 95%
      - No
        - Discuss with Tertiary Perinatal Centre through NETS NSW 1300 362 500
    - No
      - Supplemental oxygen requirement >30%
        - OR CO₂ greater than 60mmHg on two blood gasses
        - OR pH less than 7.25 on two blood gasses

- Is delivery imminent? ^
  - No or uncertain
    - Contact NETS NSW 1300 362 500
      - Discuss stabilisation plans, which may include surfactant and transfer
  - Yes
    - Contact NETS NSW 1300 362 500

- If designated centre unable to accept, Perinatal Advice Line (PAL) should be contacted via the NETS NSW automated phone system on 1300 362 500

This Guideline may be varied, withdrawn or replaced at any time.
3.4 Algorithm - Management of respiratory distress in SCNs WITH nCPAP capability

- **Respiratory Distress/high risk of RDS (HMD)?**
  - **Yes**
    - **Woman presents AT RISK of OR IN preterm labour**
      - **Consider:** Antenatal steroids
        - +/- Antibiotics
        - +/- Tocolytics
        - +/- Magnesium Sulphate

  - **No**
    - **SpO2 greater than 90%?**
      - **Yes**
        - **Commence nCPAP**
        - **Titrate oxygen according to SpO2**
        - **Aim to keep SpO2 91 – 95%**
      - **No**
        - **Is supplemental oxygen required beyond 1 hour?**
          - **Yes**
            - **Supplemental Oxygen requirement > 40% OR CO2 greater than 60 on 2 blood gasses OR pH less than 7.25 on 2 blood gasses**
          - **No**
            - **Discuss with Tertiary Perinatal Centre through NETS NSW 1300 36 2500**

- **Commence supplemental oxygen. Aim to keep SpO2 91 – 95%**
4. RECOGNITION, DIFFERENTIAL DIAGNOSIS and INVESTIGATION of RESPIRATORY DISTRESS

Newborns seek to minimize their work of breathing while maintaining adequate oxygenation and appropriate levels of carbon dioxide (adequate gas exchange). Respiratory distress implies the presence of one or more signs of increased work of breathing.

Any cause of a low level of oxygenation or a high level of carbon dioxide will lead to signs of respiratory distress.

Respiratory distress may result in abnormal signs of cardiovascular or neurological function.

Table 1. Clinical signs indicating respiratory distress

<table>
<thead>
<tr>
<th>General clinical signs</th>
<th>Associated clinical signs frequently found in newborns with respiratory distress</th>
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<tbody>
<tr>
<td><strong>Tachypnoea</strong></td>
<td>Respiratory rate greater than 60 breaths per min. (See Between the Flags Standard Newborn Observation Chart: Postnatal / Special Care Nursery) 14</td>
</tr>
</tbody>
</table>
| **Tracheal tug and chest recession:** Supraclavicular, sternal intercostal, abdominal | ▪ Secondary to negative pressure occurring during inspiration  
▪ The neonatal chest wall is very compliant and signs of recession are easily seen  
▪ Usually indicative of less compliant lungs |
| **Nasal flare**    | ▪ Enlargement of the opening of the nostrils during inspiration  
▪ Substantially reduces airway resistance  
▪ Newborns are obligatory nose breathers |
| **Grunt**          | ▪ Noise caused by expiration against partially closed glottis  
▪ The purpose is to prevent airway collapse and is a newborn's way of generating Positive End Expiratory Pressure. Its regularity with each breath on expiration helps to distinguish it from crying  
▪ Increases end expiratory pressure and improves oxygenation in the short term, then the newborn will tire |
| **Cyanosis**       | ▪ Central cyanosis involves the mucosal surfaces. Likely to indicate a problem with gas exchange  
▪ Peripheral cyanosis involves the hands and feet. May be secondary to perfusion  
▪ Visual assessment is unreliable, especially at birth  
▪ A pulse oximeter (ideally with probe placed on the right hand - preductally) provides an immediate, non-invasive, accurate way of assessing arterial oxygen saturation and should be used in all newborns with signs of respiratory distress to determine the need for supplemental oxygen |

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Pulmonary causes of respiratory distress

There are a number of different respiratory disorders that occur in preterm and term newborns. All have one or more signs of respiratory distress and it can be difficult to distinguish between them particularly in their early phases.

An accurate history, examination and relevant targeted investigations are essential in guiding management.

4.1 Differential diagnosis

4.1.1 Adaptation or Transition

A number of processes must take place to ensure the newborn can undertake gas exchange, which as a fetus was carried out by the placenta.

The lungs must move from their fluid filled status and develop a functional residual capacity. Circulatory changes include: removal of a low resistance circulation (the placenta), closure of the ductus venosus, the ductus arteriosus and the foramen ovale. Pulmonary vascular resistance continues to fall gradually over days to weeks.

- Transition is frequently associated with signs of respiratory distress.
- The longer the signs of respiratory distress persist beyond an hour of age the greater the likelihood that the newborn has a respiratory disorder and is not in transition.
- The more abnormal the signs of respiratory distress the greater the likelihood that the newborn has a respiratory disorder and is not in transition.

4.1.2 Transient Tachypnoea of the Newborn (TTN)

Rapid clearance of fluid contained in the fetal lung is required to enable adequate gas exchange in the newborn. Hormonal changes that take place prior to and during labour appear to be important in this process.

TTN is the most common form of respiratory distress, constituting more than 40% of cases. It is usually a benign condition that term or near term newborns have immediately after birth, particularly following elective caesarean section without labour.

- The peak of the illness is typically reached by 4 hours of age.
- Resolution usually occurs within 12 -24 hours but may be more prolonged.
The Chest X-Ray findings of prominent perihilar streaking and fluid in the horizontal fissure are quite different to that seen in respiratory distress syndrome helping to distinguish the two conditions.

Differentiation from meconium aspiration or pneumonia may be difficult.

4.1.3 Persistent pulmonary hypertension of the newborn (PPHN)

The failure of transition from fetal to neonatal circulation is known as persistent pulmonary hypertension of the newborn or persistent fetal circulation.

This may be triggered by one, or a combination of the following: hypoxia, cold stress, acidosis, direct lung injury and sepsis.

These in turn may be secondary to any of the specific respiratory disorders described below especially Meconium Aspiration Syndrome.

Helpful signs include:

- a wide variation between pre ductal (right hand) and post ductal (left hand or feet) SpO₂ levels
- a loud pulmonary component of the second heart sound
- swinging saturations
- if no underlying lung disease is present the lung fields may appear oligaemic (decreased pulmonary vascular markings) on Chest X-Ray.

4.1.4 Respiratory Distress Syndrome (Hyaline Membrane Disease)

A progressive illness caused by inadequate or abnormal production of surfactant leading to a progressive reduction in lung compliance.

It is the commonest cause of respiratory distress in preterm newborns.

It is characterized by increasing work of breathing, hypoxaemia and respiratory acidosis.

Risk factors include:

- prematurity
- low birth weight
- male gender
- maternal diabetes
- perinatal asphyxia
- lack of antenatal steroids
- absence of labour.

Newborns present with signs of respiratory distress syndrome at birth or within a few hours of life.

Usually reaches its peak by 36 hours of life and the illness resolves as endogenous surfactant production recovers and a diuresis occurs.
Typical radiological findings are small volume lungs with a bilateral and symmetrical uniform haziness and reticulogranular appearance, and the presence of air bronchograms. It may be difficult to discriminate from congenital pneumonia.

There is Level 1 evidence that antenatal steroids given to the mother decreases the incidence and severity of RDS\(^4,5\).

Antenatal steroids are most effective if given more than 24 hours and no longer than 14 days before birth\(^6\).

Symptoms and signs may improve dramatically with the administration of surfactant and there is a reduced incidence of air leak\(^16\).

### 4.1.5 Meconium Aspiration Syndrome (MAS)

While approximately 12% of newborns pass meconium in-utero causing meconium stained amniotic fluid, MAS affects only about 3-5% of these. Although sterile, the meconium is locally irritative, obstructive, and a medium for bacterial culture. These effects often lead to secondary problems of air leak (pneumothorax, pneumomediastinum), inactivation of surfactant, and the development of persistent pulmonary hypertension.

- To develop MAS most newborns appear to require both the presence of meconium as well as perinatal asphyxia
- It is most common in term or post-term newborns

- A Chest X-Ray may show patchy changes signifying areas of collapse distal to the obstruction, mixed with areas of hyper-expansion secondary to the ball valve effect.
4.1.6 Pneumothorax (Air leak)

A pneumothorax can be a cause of respiratory distress.
Approximately 1% of healthy term newborns and up to 6% of premature newborns will have a pneumothorax at birth.

Air leak may be spontaneous, a complication of RDS, pneumonia and MAS or secondary to mechanical ventilation including nCPAP.

**Helpful signs include:**
- asymmetric chest movements (if the pneumothorax is large)
- reduced air entry on the side of the pneumothorax
- increased translucency on the side of the pneumothorax (especially in premature newborns).

4.1.7 Tension Pneumothorax

A progressive pneumothorax leads to mediastinal shift and eventually impairs cardiovascular output. **It requires urgent life-saving treatment.**

Mostly occurs in newborns undergoing intermittent positive pressure ventilation.

**Helpful signs include:**

*All of the above PLUS:*
- bradycardia
- rapidly increasing oxygen requirement
- weak pulses
- poor perfusion capillary refill time (more than 2 seconds)
- hypotension
- heart sounds have moved.

---

A tension pneumothorax is a neonatal emergency. It causes respiratory compromise, decreased venous return to the heart and results in decreased cardiac output and hypotension. **Immediate needle aspiration is required before timely chest tube placement.**

Although a Chest X-Ray is shown below, if a tension pneumothorax is suspected treatment should **NOT** be delayed in order to obtain a Chest X-Ray.
4.1.8 Infection (sepsis or pneumonia)\textsuperscript{8,16}

Common pathogens include Group B Streptococcus and gram negative enteric rods.

- Tachypnoea is a frequent sign of neonatal infection
- Tachypnoea may be the only sign of infection
- May present with temperature instability (which may include hypothermia)

May also have signs of shock including:

- tachycardia
- prolonged capillary refill times (more than 2 seconds)
- hypotension (a mean BP less than the newborn’s gestational age in the first 48 hours is abnormal).\textsuperscript{17}

Newborns should be treated for infection based on clinical history (risk factors for infection) and/or the presence of any sign of respiratory distress.

If the newborn has no sepsis risk factors and clinical condition is improving (decreased oxygen need and resolving respiratory distress), it is reasonable to withhold antibiotic therapy and to monitor. Any worsening of the newborn’s condition warrants the commencement of antibiotics.

4.1.9 Space occupying lesion (diaphragmatic hernia, congenital cystic adenomatous malformation)

These are rare causes of respiratory distress. Diaphragmatic hernia occurs in approximately 1:3000 newborns equating to 24-35 per year in NSW\textsuperscript{18}.

If present, these lesions may cause severe respiratory distress.

Often these lesions are identified antenatally on ultrasound scan.

![Left sided CDH](https://example.com/cdh_image.png)
4.1.10 Pleural Effusion

Pleural effusion is a rare cause of respiratory distress in newborns and is often associated with hydrops or isolated chylothorax. Prognosis depends on underlying causation.

4.2 Non Pulmonary Causes of Respiratory Distress

Other systems may lead to respiratory distress. Their description is beyond the scope of this guideline. A general list of headings with some examples includes:

4.2.1 Congenital heart disease:
- cyanotic (Tetralogy of Fallot) - usually blue, no respiratory distress
- acyanotic (Coarctation of the Aorta, Hypoplastic Left Heart Syndrome) - mostly present after 48 hours of age.

4.2.2 Metabolic Acidosis:
- infection
- metabolic abnormalities.

4.2.3 Upper Airway obstruction:
- choanal atresia (opening the mouth opens the airway)
- Pierre Robin Sequence (small retrognathic chin. Chin lift will open airway).

4.2.4 Anaemia:
- fetomaternal transfusion
- haemolysis.
4.3 Investigations

Investigations are only helpful in the context of a thorough history and examination.

4.3.1 Chest X RAY

- One of the most helpful investigations to establish the cause of respiratory distress.
- Should be arranged as part of the initial workup to guide management.
- It is appropriate to wait until 4 hours of age to take the Chest X-Ray provided the distress is not severe, and is not increasing.
- If Chest X-Ray is taken earlier than this it may be difficult to distinguish between TTN and RDS.
- A Chest X-Ray (actual image) can be emailed by the radiographer to NETS NSW at help@nets.health.nsw.gov.au.

4.3.2 Blood Gases

Whenever possible, periodic blood sampling will provide objective evidence of the newborn’s acid base status.

- A venous or free flowing capillary sample will almost always provide adequate information on CO₂ levels. The newborn’s need for supplemental oxygen is guided by the oxygen saturation level.
- A capillary sample taken from a poorly perfused foot will significantly overestimate the level of CO₂ and give a falsely low pH and high lactate. Where possible a venous or arterial sample is preferred.
- The frequency of sampling will depend upon the newborn’s condition, progress over time and the previous result.
- Assuming facilities are available it is recommended that a blood gas be collected on all newborns who:
  - have any oxygen requirement beyond an hour or two of age
  - require more than 30% oxygen to maintain their SpO₂ in the target range of 91 to 95%.

<table>
<thead>
<tr>
<th>NOTE</th>
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<tbody>
<tr>
<td>The trend in the newborn’s pH and CO₂ is just as important as any individual result</td>
</tr>
</tbody>
</table>

It is recommended that NETS NSW be contacted to discuss management if the:

- CO₂ is greater than 60mmHg on 2 successive occasions more than an hour apart
- pH is less than 7.25 on 2 successive occasions more than an hour apart.

4.3.3 Full Blood Count and Blood Cultures

A full blood count (FBC) may help in differentiating the cause of respiratory distress and may escalate the level of concern.

Where possible, a FBC should be taken in association with a blood culture in all newborns whose respiratory distress persists beyond an hour or two of age, where there are risk factors and/or where antibiotics are to be commenced.
A normal FBC does NOT exclude infection as the cause of respiratory distress. Therefore, the decision to commence antibiotics should not be determined by its result.

In infection:  the total white cell count may be elevated, normal OR reduced
the platelet count may be low or decrease over time.

In MAS:  the white cell count and platelet count may also be normal or low.

In general, the FBC is normal in RDS, pneumothorax and TTN.

**Blood cultures** should be taken from all newborns prior to commencing antibiotics if possible. Ideally, 1ml of blood is placed into an **aerobic culture** bottle\(^{19}\). Antibiotic administration should not be delayed where blood cultures cannot be obtained.

Once antibiotics are commenced they should be continued at least until the culture is negative (36 to 48 hours).

The majority of blood cultures will become positive within 36 to 48 hours.

### 4.3.4 C- reactive protein (CRP)

The CRP is a marker of infection.

The CRP takes time to rise and is best deferred until the newborn is older than 6 hours of age. When used in conjunction with the FBC, blood culture and the newborn's clinical condition, the CRP may assist in determining when to cease antibiotics.

Two normal CRP tests; the first sample obtained 8-24 hours after birth and the second sample 24 hours later makes the chances of neonatal sepsis extremely unlikely. The test has a negative predictive accuracy of 99.7%\(^{20}\).

### 4.3.5 ESR

The Erythrocyte Sedimentation Rate has no role in determining whether a newborn is septic.

### 4.3.6 Electrolytes

The electrolyte measurement at birth generally reflects maternal rather than the newborn’s renal function, except in significant perinatal hypoxic ischaemia.

Electrolytes should be collected if respiratory distress persists at 12 to 24 hours of life and then collected daily if the newborn is receiving intravenous fluids.

Electrolytes may indicate dehydration or acidosis as the cause of respiratory distress. The newborn tries to correct metabolic acidosis with increased respiratory rate (e.g. renal failure or inborn error of metabolism).

### 5. BASIC SUPPORTIVE MEASURES

Basic supportive measures include oxygen saturation targets, oxygen supplementation and general medical and nursing care.

The following sections outline recommended practices in the provision of supplemental oxygen and the general care undertaken in the management of newborns with respiratory distress on arrival to the nursery. It assumes the newborn has an adequate respiratory rate and effort.

### 5.1 Oxygen Saturation Targets

Ensuring the newborn has an oxygen level within the normal range is one of the mainstays of treatment for respiratory distress. Too much oxygen may be as harmful as too little.

- The visual assessment of a newborn’s oxygen saturation (SpO\(_2\)) is unreliable\(^{21}\).
The newest generation SpO2 monitors that have low averaging times and a high sensitivity are the most accurate and responsive and should be used where possible\textsuperscript{22}.

The concentration of oxygen should be titrated according to the newborn’s SpO2 aiming for 91 to 95\%\textsuperscript{23}.

Too much oxygen leads to free radical production, retinopathy of prematurity and long term harm\textsuperscript{23}.

Setting a uniform target within an SCN in late preterm and term newborns significantly reduces their exposure to oxygen.

There is no evidence for using different SpO2 targets in specific subpopulations of newborns such as those with meconium aspiration, PPHN, a pneumothorax, or those born preterm.

If PPHN is suspected, preductal (right hand) SpO2 should be used to guide oxygen requirements.

Compliance with keeping newborns within a range of saturation targets outside of clinical trials is poor.

Setting alarm limits close to the desired target limits, is likely to help avoid hypoxia and hyperoxia.

5.1.1 Recommendations for all SCNs:

1. Individual SCNs should have a uniform approach to the management of newborns with respiratory distress

2. The upper target limit for SpO2 should be less than or equal to 95%

3. The lower target limit for SpO2 should be greater than or equal to 91%

4. While a newborn requires oxygen, set the lower alarm limits at 89\% and the upper alarm limits at 96\%. The upper alarm limit is close to the upper target limit to discourage ongoing inappropriate use of oxygen

5. If available, SpO2 data should be downloaded intermittently to assist with compliance.

5.2 Supplementary Humidified Oxygen

Providing the correct amount of oxygen begins at birth and is dependent upon the newborn’s need for, and response to, resuscitation.

Oxygen may be delivered in a variety of ways: Head Box, Low Flow oxygen, closed Thermal Support System (Oxygen Crib) and Humidified Low Flow Nasal Cannula System (gas flows of 1-2 litres per minute). The use of non-humidified gas delivered in any form is not recommended.

Supplementary, non-humidified, oxygen has been shown to cause atelectasis\textsuperscript{25}.

Supplementary oxygen alone may not be an adequate treatment for respiratory distress when the underlying cause is surfactant deficiency and there is need for pressure support.

Always consider cyanotic congenital heart disease in a newborn with hypoxaemia not corrected by a FiO\textsubscript{2} greater than 40. Discuss with a neonatologist via NETS NSW if required.

Headbox Oxygen is generally well tolerated. However, when prolonged oxygen administration is required, head box oxygen does have limitations including mobility and overheating particularly in bigger newborns. Head box oxygen, when humidified, is not associated with increased risk of airway obstruction by mucous or gastric distension. If not humidified smaller newborns may be cold-stressed. Access to the newborn for cares and family contact is reduced compared to humidified low flow oxygen.
A minimum flow rate of 10 litres per minute is required to prevent hypercarboxaemia secondary to re-inspiration of carbon dioxide.

Crib oxygen (oxygen is delivered directly into the crib) is used for administration of small to moderate oxygen levels. Achieving oxygen concentrations above 30% is often difficult owing to leakage.

For both Headbox and Crib Oxygen:
- pre-blended oxygen air mix is used to achieve the desired concentration
- humidification of gases is required as it avoids cold stress and dysfunction of the muco-ciliary elevator
- an oxygen analyser is placed close to the newborn’s face inside the headbox/crib. It should be calibrated prior to initiation and at the commencement of each shift.

Humidified Low Flow Nasal Cannulae (up to 2 litres per minute) may be used as a method of providing ongoing oxygen therapy. A humidifier, disposable circuit and prongs are required with the latter appropriately fitted according to the manufacturer’s instructions.

An oxygen blender will be required to titrate the concentration of oxygen according to the newborn’s oxygen saturation.

5.3 General medical and nursing care

General Care

| Hypothermia leads to both surfactant dysfunction and increased oxygen consumption |

Newborns should be nursed on an open bed warmer or closed incubator, in a thermo-neutral environment, using servo-control to maintain an abdominal skin temperature of 36.2°C - 36.5°C (axillary temperature is maintained between 36.5°C and 37°C.) as this is associated with the lowest oxygen consumption and metabolic rate.26,27

- The newborn’s position should be changed every 3 to 6 hours as this is essential to neurodevelopmental and respiratory outcomes and also allows for a thorough assessment of skin integrity by caregivers
- the newborn should be positioned to optimise airway patency
- developmental boundaries which promote flexion, comfort and containment should be utilized including nesting, non-nutritive sucking, facilitated sucking and sucrose for procedure related pain relief
- general hygiene measures such as nappy changes should coincide with general observations and axillary temperature when indicated
- hepatitis B vaccine and Vitamin K are administered at birth according to NSW Health policies
- parents should be provided with information regarding the condition and planned management of their newborn in accordance with the philosophy of family centred care.28
5.3.1 Observations and Monitoring

Observations should be documented and acted upon according to the Between the Flags Program Standard Newborn Observation Chart: Postnatal / Special Care Nursery. Observations should be recorded at least hourly until stable then as per local guidelines. Observations should be more frequent on arrival to the nursery, at times of change in management and during times of clinical deterioration:

- heart rate
- respiratory rate
- respiratory effort, including signs of increased work of breathing
- oxygen saturations (SpO₂) using Nellcor™ or Massimo™ technology
- axillary temperature hourly until stable then at least every four hours.

5.3.2 Newborns requiring supplemental oxygen

The following additional recorded observations should be undertaken at least hourly:

- oxygen flow rate
- oxygen concentration, using a calibrated oxygen analyser where available
- humidifier temperature where humidification of inspired gases is used.

5.3.3 Suctioning

- Suctioning is generally not done routinely unless on nCPAP. Nasal suctioning may traumatisate the nasal mucosa and lead to reactive oedema and nasal obstruction. It can also cause vagal stimulation resulting in bradycardia and apnoea.
- if oral suction is required:
  - use a large bore suction catheter (size 10-12 Fg)
  - pass it no more than 5cm from the lips of a full term newborn.
- if nasal suction is required:
  - use a size 6Fg or 8Fg
  - measure the distance from the tragus of the ear to the tip of the newborn’s nose and pass the catheter this distance
  - gently suction secretions, taking no longer than 5-6 seconds
  - the negative pressure used should not exceed 100 mmHg.

5.3.4 Orogastric tube

A distended abdomen may cause increased pressure on the diaphragm and exacerbate the newborn’s respiratory distress. This is common in newborns who have required bag and mask resuscitation.

- Use a size 8Fg catheter
- measure the distance from the nose-ear-mid-umbilicus (midpoint between the xiphoid process and the umbilicus)
- insert catheter and aspirate gastric contents and test the pH
- leave on free drainage.
5.3.5 Nutrition

- Small, frequent feeds of 15-60mL per kg per day (use colostrum or breast milk where available) may be commenced in stable newborns as this may reduce the duration of respiratory distress and length of hospital stay.
- If the respiratory rate exceeds 70 breaths per minute or the newborn exhibits sternal or subcostal recession, maintenance intravenous therapy is recommended.
- The newborn is graded to full oral feeds as his/her condition allows. Volumes in mL per kg per day to be used are the same as those for IV fluids (see Table 2 below).
- If the newborn is unable to tolerate a minimum of 60mL per kg per day oral feeds by Day 5, consultation with NETS NSW regarding transfer to a NICU is advised to meet nutritional requirements.

5.3.6 Breastfeeding

- While the newborn is unable to breastfeed, mothers are to be supported and encouraged to express breastmilk within 4 hours of birth and then regularly every 2 to 3 hours until breastfeeding is established.

5.3.7 Intravenous Therapy

Newborns who are unable to receive enteral nutrition owing to respiratory distress will require intravenous therapy to ensure adequate hydration and prevent hypoglycaemia.

- In general, newborns with a birthweight of less than 1500g or less than 32 completed weeks gestation and babies who have severe growth restriction at higher gestational ages should be commenced on maintenance intravenous therapy even without respiratory distress and are likely to require TPN.
- 10% Glucose on Day 1 and on Day 2, 0.225% Sodium Chloride plus 10% Glucose +/- potassium chloride 10mmol/500mL is used for maintenance.
- Commence at 60mL per kg per day, Day 1
- An example of a commonly used total fluid schedule used in newborns is shown in Table 2 below.
- The total volume is equal to that provided by the IV and any measurable enteral feeds.
- Inspect the cannula site hourly and document status.
- Signs of potential extravasation should be reported to medical staff.
- Fluid balance should be monitored and documented.

<table>
<thead>
<tr>
<th>Table 2. Total Fluid Requirements (mL per kg per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day</strong></td>
</tr>
<tr>
<td><strong>Volume</strong></td>
</tr>
</tbody>
</table>

5.3.8 Hypoglycaemia

Defined as blood glucose level (BGL) less than 2.6 mmol per Litre.

- Newborns with respiratory distress are at risk of hypoglycaemia.
• A blood glucose level should be checked within 2 hours and then at least every 6-8 hours while the newborn is unwell

• Newborns who are unable to be fed should start intravenous therapy as above.

6. HUMIDIFIED HIGH FLOW (greater than 2L per minute) NASAL CANNULAE (HHFNC)

Nasal prongs attached to a flow meter have long been used as a method to deliver variable flow rates of oxygen. With the advent of heating and humidification, flow rates greater than 1-2 litres per minute have become possible. When used at high flow rates (greater than 2 litres per minute) in the form of Humidified High Flow Nasal Cannulae (HHFNC) pressure is generated enabling a non-invasive way of providing ventilatory support. HHFNC has been shown to be beneficial in adults, in children with bronchiolitis and more recently in very preterm newborns post extubation.

HHFNC may be as good as nCPAP in reducing transfers in newborns with respiratory distress (but there is no evidence available) while also providing some advantages including reduced costs and improved feed establishment, weight gain, and parental satisfaction. There are a number of randomised controlled trials underway comparing HHFNC to nCPAP as the initial treatment for newborns with respiratory distress including one in the non-tertiary setting.

6.1 Situations where the use of HHFNC in SCNs may be appropriate:

• HHFNC may be used in SCNs in consultation with NETS NSW as “rescue treatment or stabilisation” for newborns while awaiting transfer. These newborns will have already been treated using Headbox, Crib or Humidified Low Flow oxygen

• HHFNC may be used in newborns back transferred from a NICU as ongoing support

6.2 Requirements for the use of HHFNC:

• be a Level 2 Nursery or above

• nurseries must have neonatal HHFNC equipment and appropriately trained medical and nursing staff in its use for this patient population

• there should be a trained and credentialed nurse available each shift (see Appendix A)

• nurseries must have unit-specific policies on the care of newborns on HHFNC, including guidelines that cover the circuit setup, interface used, troubleshooting of equipment and clearly defined failure criteria

7. NASAL CPAP (nCPAP)

This section does NOT refer to the use of face mask CPAP frequently used to provide positive end expiratory pressure during resuscitation and transfer between place of delivery and the Special Care Nursery.

The use of non-humidified inspired gas delivered in any form is not recommended beyond the acute resuscitation phase

Newborns who have established an adequate respiratory effort should only be given supplemental oxygen (via a headbox, crib or low flow humidified nasal cannulae) if need is identified by pulse oximetry

Where pressure support is required, commence on nCPAP.
Background

Nasal continuous positive airway pressure (nCPAP) is a method of delivering a humidified mixture of oxygen and air under pressure into the lungs. It recruits alveoli, increasing the mean airway pressure, oxygenation and functional residual capacity. Nasal CPAP reduces the work of breathing and may also conserve surfactant\(^3\).

7.1 CPAP Systems

A variety of techniques generate pressure and a number of different ways have been designed to interface with the newborn\(^3\).

In the setting of the SCN, the following methods may be appropriate depending upon the existing resources and capabilities:

**Pressure may be generated using:**

- a “flow driven” device such as the Infant FlowDriver
- a “pressure device” such as gas flow in a ventilator or a circuit with an expiratory pressure valve or an underwater seal such as Fisher Paykel™ bubble circuit
- a “combination device” such as a Neopuff™ with a ‘T piece’ that uses both flow and an expiratory valve.

**Nasal interfaces include:**

- Single prong, using an endotracheal tube, passed to the level of the nasopharynx
- binasal short prongs of a number of different types (Inca™, Argyle™, Hudson™)
- nasal masks.

In large SCNs, nCPAP, using the underwater bubble method with short binasal prongs, has been shown to reduce the need for transfer of newborns with respiratory distress to a NICU\(^3,36\).

The effective administration of nCPAP requires a combination of available skilled/credentialed medical and nursing clinicians and ongoing practical experience (see Appendix A Nurse Training). It is unlikely that an SCN can meet the substantial challenge of managing nCPAP with less than 24 patients\(^32\) needing the method each year.

7.2 nCPAP as rescue or stabilisation while awaiting transfer

- nCPAP may be used in SCNs in consultation with NETS NSW as “rescue treatment or stabilisation” for newborns while awaiting transfer. These newborns will have already been treated using Headbox, Crib or Humidified Low Flow oxygen
- The SCN should have an appropriately trained nurse experienced in the application and use of CPAP in newborns (see Appendix A) and a doctor able to diagnose and treat pneumothorax
- The SCN should have a unit-specific policy on the care of newborns on nCPAP, including guidelines that cover the circuit setup, interface and troubleshooting of equipment and interface used and agreed failure criteria

7.3 nCPAP as a definitive ongoing treatment

SCNs using continuous nCPAP are expected to meet the following:

- be a Level 4 Nursery
- have 24 hour pathology and radiology services available
- have on-site paediatric registrar or nurse practitioner and specialist paediatrician coverage capable of diagnosing and providing emergency management of a tension pneumothorax
have appropriately trained nursing staff experienced in the use of CPAP on newborns². Training should include theory provided from a recognised tertiary facility and core staff should have received practical experience at a recognised tertiary facility for a minimum of 2 days. There should be a trained and credentialed nurse available each shift (see Appendix A)

- have nursery-specific policies on the care of newborns on nCPAP, including guidelines that cover the circuit setup, interface and troubleshooting of equipment and interface used
- have at least one backup system available including humidifier base, circuits and gas supply

7.4 Indications for commencement of nCPAP

The timing of the commencement of CPAP must balance the desire to commence as early as possible to enable recruitment of the alveoli with the unnecessary use in a newborn who is in transition.

All newborns should have:
- signs of respiratory distress

or

- an oxygen requirement in order to maintain saturations at 91 – 95%.

In late preterm and early term newborns, when continual improvement through the first hour is not observed, consider commencing nCPAP.

7.5 Contraindications

Apnoea or any other condition requiring immediate intubation e.g: diaphragmatic hernia, evolving NEC, sepsis.

7.6 Complications

- nasal septal erosion – preventable when using correct size prongs, correctly positioned and constant observation
- nasal trauma such as ulceration
- nasal obstruction – from improper prong placement or inadequate airway care (suctioning)
- displaced cannulae
- blocked cannulae
- pneumothorax – usually occurs in the acute phase with an incidence of 5-10%. Pneumothoraces usually result from the underlying disease rather than pressure alone and is not a contraindication to CPAP
- abdominal distension (CPAP belly) is common and generally benign. This can be reduced with gastric drainage and aspiration using an 8F feeding tube. The possibility of NEC should always be considered and clinical examination and AXR performed when considered necessary.
7.7 **Commencing CPAP**
- Start with a pressure of 6 cm H₂O and a flow of 10L per minute. The flow should be adequate to produce continuous bubbling.
- Titrate oxygen to maintain saturations between 91 – 95%.
- Insert a Size 8 orogastric tube and leave on open drainage.

7.8 **Monitoring**
The following additional monitoring is required for newborns on nCPAP:
- continuous cardio-respiratory monitoring
- hourly blood pressure recordings until stable
- hourly observations of prong position and integrity of nares
- hourly check of circuit integrity FiO₂, flow rate, PEEP, humidity, base temperature and water level
- observe for bubbling of CPAP circuit in water chamber.

7.9 **Blood gas monitoring and chest x-rays when on nCPAP**
(see also section 4.3 Investigations and section 5.1 Oxygen Saturation Targets)
- Newborns on nCPAP need time to adjust. Procedures such as blood gases, x-rays and cannulation should be avoided, if possible, in the first hour
- the primary assessment of response to nCPAP is a reduction in the work of breathing
- blood gases form part of the assessment of response to nCPAP:
  - a blood gas should be done between 1 to 2 hours after commencing nCPAP
  - if on any blood gas assessment the pH is less than 7.25 or the CO₂ is greater than 60, a second measurement should occur between 1 and 4 hours after the first as clinically indicated
  - additional gases may be collected where clinically indicated such as for deterioration or continuing high oxygen requirement
- a chest x-ray should be done on all newborns who have a continuing need for oxygen. This will help to identify conditions that may require early escalation for example surfactant deficiency, meconium aspiration syndrome, congenital pneumonia and malformations.

7.10 **Suctioning**
Suctioning of the nares is critical in newborns on nCPAP to ensure no blockage develops.
Each SCN must have its own guidelines and ensure nurses undertake suctioning in a non-traumatic way.

7.11 **Nutrition**
Small feeds can be commenced when the newborn’s respiratory rate is less than 70-80 breaths per minute and there is no significant work of breathing.

7.12 **Agitation**
Newborns on CPAP, especially if larger, can become agitated. If the newborn is agitated, consider pneumothorax, hypoxaemia, and or pain. Persistent agitation should lead to early medical review.
Check that the interface is correctly in place and that the newborn does not need suctioning. Most agitation can be relieved by simple measures such as:

- swaddling, nesting, Kangaroo care, prone positioning (*parents should be advised that this is not to be done routinely, only when cardiorespiratory monitoring is in situ*)
- non-nutritive sucking

### 7.13 Success

A successful response to nCPAP is usually clear by 4 hours of life. Improvement in the condition is evident by:

- a reduction in respiratory rate
- a reduction in oxygen requirement to maintain saturation between 91 and 95%
- improvement in Standard Newborn Observation Chart\(^2\) measures
- resolution of grunting
- reduction in sternal and intercostal recession
- improving blood gases (if done).

### 7.14 Escalation criteria

Failure of nCPAP is usually indicated by increasing oxygen requirements or increasing signs of respiratory distress.

It is recommended that a neonatologist be contacted through NETS NSW to discuss management if:

- the CO\(_2\) is greater than 60 on two successive occasions more than an hour apart
- the pH is less than 7.25 on two successive occasions more than an hour apart
- oxygen requirement is greater than 40% to maintain saturation at or above 90%
- there are recurrent apnoeas or desaturations
- there is a pneumothorax.

**Sudden deterioration and increase in oxygen requirements**

If there is an increase in FiO\(_2\) of 10% or more:

- ensure nasal cannulae or the nares are not blocked
- ensure the circuit is intact
- consider the need for suctioning
- exclude a pneumothorax by transillumination and/or CXR.

### 7.15 When to cease nCPAP

- In the SCN setting nCPAP is **NOT** generally weaned before ceasing
- It should only be ceased once the newborn is in an FiO\(_2\) of 21% and has minimal work of breathing
- The longer a newborn has required supplemental oxygen with nCPAP the longer the newborn should be kept on nCPAP while in 21% before trialling off nCPAP
• Newborns who have required supplemental oxygen beyond 6 hours are likely to need to continue nCPAP while in 21% for a few hours
• nCPAP should be restarted should the newborn’s work of breathing increase or supplemental oxygen be required again.

7.16 Rescue CPAP while awaiting transfer

In SCNs without the resources and capabilities to use continuous nCPAP “rescue CPAP” may be appropriate.

This should only be undertaken after discussion with a neonatologist contacted through NETS NSW and would occur while awaiting transfer.

• nCPAP may be provided using a short nasopharyngeal tube inserted 3-4 cm and then connected to a Neopuff™, a ventilator or its equivalent
• Commence on PEEP of 6cms H₂O and a flow of 10L per minute
• Titrate oxygen to maintain saturation’s between 91 – 95%
• Insert an orogastric tube (FrG8) and leave on open drainage.
8. ENDOTRACHEAL INTUBATION

Table 3: Situations where intubation may be required post resuscitation

<table>
<thead>
<tr>
<th>Situation</th>
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<tbody>
<tr>
<td>T piece ventilation ineffective/failure of mask CPAP (try two handed technique to apply mask first)</td>
</tr>
<tr>
<td>Increasing oxygen requirements (&gt; 50%)</td>
</tr>
<tr>
<td>Persistent/recurrent/major apnoeas and bradycardias requiring intervention</td>
</tr>
<tr>
<td>Surfactant administration</td>
</tr>
<tr>
<td>Deterioration in clinical condition/blood gases</td>
</tr>
<tr>
<td>Congenital anomalies requiring airway securing</td>
</tr>
</tbody>
</table>

8.1 Contraindications

Unskilled staff: “more harm may be caused by multiple unsuccessful attempts at intubation than by resorting to less definitive methods of securing the airway”. Alternative methods include: nCPAP or mask ventilation combined with a Guedels airway; use of a Laryngeal Mask Airway.

8.2 Post intubation assessment

A CO₂ detector (e.g. PEDICAP™) should always be used. Failure to change colour from purple to gold after 6 breaths means the ETT is not in the trachea or there is no cardiac output.

If there is doubt on the confirmation of ETT placement, it should be replaced.

Confirm position of tube by:

- visualising ETT passing through the vocal cords
- observing symmetrical chest wall movement
- auscultating breath sounds in the axillae
- assessing improvements in heart rate, saturations, CO₂ detector change, and activity
- confirming absence of gastric inflation
- observing for misting in the ETT during expiration
- a CXR is used to identify the level of the ETT. The CXR is NOT to confirm placement in the trachea.

9. SURFACTANT

Background

Surfactant replacement in newborns with or at risk of RDS has been shown to reduce mortality and pneumothorax. Its use has been extensively studied in randomised controlled trials and in meta analyses which have focussed on the timing of administration (prophylaxis versus rescue), the dose and the type of surfactant (synthetic, Bovine or Porcine).
The use of surfactant has predominantly been in tertiary care centres or provided by NETS NSW during retrieval. Its use requires an experienced neonatal resuscitation/stabilisation team. While the use of surfactant is not routinely recommended in the non tertiary care setting there may be occasions where the benefits of providing it outweigh the risks of waiting for transfer.

9.1 **Surfactant should be available in Level 4 Neonatal Services that:**

- use nCPAP as an ongoing definitive treatment for newborns with respiratory distress
- have developed a specific policy for its use in their SCN. These policies should be developed in consultation with the appropriate Tiered Network
- have the following skills and resources:
  - ability to obtain and interpret a CXR
  - ability to take and analyse an arterial blood gas
  - ability to ventilate and actively wean ventilation post administration
  - personnel experienced in intubation, ventilation and use of surfactant
  - ability to recognise and treat a tension pneumothorax.

9.2 **Possible indications for surfactant in an SCN:**

- As prophylaxis (within 15 minutes) in a newborn born unexpectedly at less than 28 weeks while awaiting transfer
- Newborns with RDS who have required intubation for stabilisation awaiting transfer (likely to be gestational age < 32 weeks)
- In the above two situations it is recommended that discussion with a neonatologist through NETS NSW takes place so that the benefits and risks of using surfactant while awaiting transfer may be considered
- Newborns on nCPAP with RDS given surfactant via an endotracheal tube with the aim of returning to nCPAP and avoiding transfer OR via an intratracheal cannula minimising interruption to nCPAP and again aiming to avoid transfer.

The exact timing of the use of rescue surfactant in a newborn on nCPAP in a non-tertiary centre in order to prevent transfer is unknown. The post natal age of the newborn, the severity of the disease based on oxygen requirement and work of breathing while on nCPAP should guide decision making.

The earlier surfactant is used the greater its benefit and the greater the number of newborns who will have been treated who could have managed on nCPAP alone.

It is likely that the decision to treat would take place within 6 -12 hours of life. Anecdotal evidence suggests that the later surfactant is given the greater the chance for further deterioration leading to the need for transfer to a NICU.

**Consultation with a neonatologist through NETS is both advisable and recommended in this setting.**
10. REFERENCES

1. GL2016_081 NSW Maternity and Neonatal Service Capability Framework

2. NSW Health Guide to the Role Delineation of Health Services 2016 Statewide Services Development Branch and Rural Companion Guide 2004. *Statewide Services Development Branch NSW Health*

3. Lutz T, Buckmaster A, Bowen J, Kluckow M and Wright I. The need for intensive care for neonates born between 29 and 34 weeks inclusive gestation. JPCH 2013:49(2); 130


7. PD2011_025 NSW Maternity - Tocolytic Agents for Threatened Preterm Labour Before 34 Weeks Gestation


9. The Antenatal Magnesium Sulphate for Neuroprotection Guideline Development Panel. Australian Research Centre for the Health of Women and Babies (ARCH) University of Adelaide


35. Buckmaster A, G Arnolda, I Wright, J Foster, D Henderson-Smart. The use of CPAP to reduce up-transfer of infants with respiratory distress in non-tertiary care centres: A randomised, controlled trial. Pediatrics 2007: 120(3); 509-518


11. ADDITIONAL RESOURCES


APPENDIX A: NURSE TRAINING FOR nCPAP or HHFNC

There must be at least one registered nurse / midwife per shift with appropriate qualifications and experience present when caring for newborns on nCPAP or HHFNC.1

Appropriate qualifications for nurses caring for a newborn on nCPAP include a Neonatal Certificate or a Clinical Competency Assessment with the following elements.

- ability to identify the anatomical location of a nasopharyngeal tube and the mechanism by which it supports respiratory function
- clinical indications for nCPAP or HHFNC
- identify and correctly assemble the equipment required for nCPAP or HHFNC
- preparation of the newborn
- correct size and placement of a nasopharyngeal tube / CPAP prongs or HHFNC cannulae
- nursing care of a newborn receiving nCPAP or HHFNC including
  - respiratory assessment
  - maintaining effective ventilation
  - tube/prong/cannulae security and airway patency
  - suction and bag valve mask ventilation
  - trouble-shooting equipment
- emergency management of a blocked Nasopharyngeal CPAP tube
- recognition of complications associated with nCPAP or HHFNC, including pneumothorax and its management
- documentation of nCPAP or HHFNC
- family care when a newborn is receiving nCPAP

The Australian College of Nursing offers a Neonatal Special Care Course leading to a Graduate Certificate in Neonatal Care and is highly recommended.

In addition, a clinical placement in a nursery that provides higher level care is advisable to enable nursing staff to gain practical experience with the principles of CPAP or HHFNC management and the specific nursing care required.
# APPENDIX B: WORKING PARTY MEMBERS

<table>
<thead>
<tr>
<th>Name</th>
<th>Position and Affiliation</th>
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<tbody>
<tr>
<td>A/Prof Adam Buckmaster</td>
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</tr>
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<td>A/Prof Alison Kent</td>
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<tr>
<td>Dr Hazel Carlisle</td>
<td>Neonatologist, NICU The Canberra Hospital</td>
</tr>
<tr>
<td>Dr Paul Craven</td>
<td>Neonatologist JHH NICU, Clinical Lead in Education Training &amp; Research HNE, Neonatal Stream Coordinator for CMET</td>
</tr>
<tr>
<td>Dr Scott Finlay</td>
<td>GP Anaesthetist &amp; Obstetrician, Moree District Health Service</td>
</tr>
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<td>Ms Sylvia Lees</td>
<td>NUM Level 4 NTCC Wollongong Hospital</td>
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<td>Dr David McDonald</td>
<td>Paediatrician, Port Macquarie Base Hospital</td>
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<tr>
<td>Dr Lynn Sinclair</td>
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<td>Ms Vivienne Whitehead</td>
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<tr>
<td>Prof Ian Wright</td>
<td>Professor of Paediatrics &amp; Child Health Research, University of Wollongong and Senior Clinical Academic, The Wollongong Hospital Illawarra Shoalhaven Local Health District</td>
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