Management of neonatal respiratory distress incorporating the administration of continuous positive airway pressure (CPAP)
## Abbreviations

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<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ANZNN</td>
<td>Australia and New Zealand neonatal network</td>
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<tr>
<td>cm</td>
<td>Centimetres</td>
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<tr>
<td>CPAP</td>
<td>Continuous positive airway pressure</td>
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<tr>
<td>FiO₂</td>
<td>Fraction of inspired oxygen</td>
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<td>GBS</td>
<td>Group B streptococcal</td>
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<td>g</td>
<td>Gram</td>
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<td>HMD</td>
<td>Hyaline membrane disease</td>
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<td>ICC</td>
<td>Intercostal catheter</td>
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<td>IV</td>
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<td>kg</td>
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<td>NICU</td>
<td>Neonatal intensive care</td>
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<td>NRP</td>
<td>Neonatal resuscitation program</td>
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<tr>
<td>NNP</td>
<td>Neonatal nurse practitioner</td>
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<td>pCO₂</td>
<td>Partial pressure of carbon dioxide</td>
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<td>RDS</td>
<td>Respiratory distress syndrome</td>
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<tr>
<td>TPNEP</td>
<td>Transition to practise nurse education program</td>
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<td>TTN</td>
<td>Transient tachypnoea of the newborn</td>
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<td>UAC</td>
<td>Umbilical arterial catheter</td>
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<td>Umbilical venous catheter</td>
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<td>°C</td>
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1 Introduction

1.1 Background

Respiratory distress in a neonate presents as tachypnea after birth. Symptoms can last from hours to days. Correct diagnosis and management of respiratory distress in the neonate is extremely important. Respiratory distress is one of the most common problems seen in neonates.

Although resource intensive, continuous positive airway pressure (CPAP) is a relatively simple and effective therapy for respiratory distress and the complications and expected clinical course under a variety of circumstances are well understood. Despite this, CPAP is currently being provided in nurseries throughout Queensland without a standardised guideline and in facilities with varying infrastructure and clinical support mechanisms. This may lead to considerable variation in clinical practice.

CPAP is the application of positive pressure to the airways of spontaneously breathing patients throughout the respiratory cycle. The correct application of CPAP has been shown to decrease the work of breathing, reduce the requirement for oxygen, help establish and maintain functional residual capacity, prevent collapse and upper airway obstruction, reduce apnoea, bradycardia and cyanotic episodes and prevent the need for transfer to tertiary facilities in a target group of babies.

1.2 Objectives

- A Clinical Practice Guideline that encompasses definition, causes, management principles, method of administration, assessment of success/failure, weaning and discontinuation, complications, indications for up-transfer and monitoring requirements for respiratory distress and CPAP
- Identify medical resource requirements
- Identify neonatal nursing resource requirements
- Identify equipment resource requirements

1.3 Exclusions

This guideline does not encompass the complete care required of a neonate but aspects of care that are relevant to Respiratory Distress and CPAP.

1.4 Outcomes

- Improved clinical management of neonates of 32 weeks or more gestational age with respiratory distress
- Improved clinical management of neonates of 32 weeks or more gestational age on CPAP
- Increased staff confidence in the management of neonates
- Nurses (caring for neonates on CPAP) to complete a recognised Neonatal Certificate
- Nurseries to collect data for Australia and New Zealand Neonatal Network (ANZNN) and audit
- Each unit to have a policy on the use of CPAP
2 Management of respiratory distress

2.1 Definition
Respiratory distress may be characterised by the following:
- tachypnoea – more than 60 breaths /minute
- expiratory grunt
- sternal and intercostal recession
- nasal flaring
- cyanosis/oxygen need

2.2 Causes
- Hyaline membrane disease (HMD)
- Infection - follow the Prevention of neonatal early onset Group B streptococcal disease (EOGBSD) Queensland Maternity and Neonatal Clinical Guideline
- Retained fetal lung fluid (transient tachypnoea of the newborn (TTN))
- Aspiration (meconium, blood or liquor)
- Pneumothorax
- Congenital abnormalities including:
  - pulmonary hypoplasia
  - diaphragmatic hernia
  - airway obstruction
  - congenital cardiac disease

2.3 When to contact a higher level nursery
A level 6 nursery may be contacted by any level nursery for advice as required.

2.3.1 Level 2 and Level 3 Nursery
Contact a higher level service* to discuss:
- initiation of treatment for respiratory distress
- if oxygen requirements reach 30% to maintain saturation of 92-96%
- if oxygen rapidly increases eg 10% or more over 2 hours
- if neonate less than 35 weeks gestational age
- at least daily for on going advice and support

* Nursery Levels according to Queensland Clinical Services Capability Framework 2009.4

2.4 Management principles
Managing respiratory distress requires skilled supportive care. The following basic principles should be observed.

2.4.1 Oxygenation
- Give oxygen to maintain saturation 92-96%
- Monitor oxygen concentration in head box or incubator continuously
- Monitor oxygen saturations continuously, with the probe preferably on the right upper limb
- Monitor respirations and heart rate continuously if possible
2.4.2 Blood cultures

- Collect blood for blood culture and full blood count. Collect surface swabs if clinically indicated.
  - Blood culture result should be checked at 24 hours. If negative and the respiratory distress has resolved with no other sign of infection, give the 24 hour dose and then cease (giving coverage for 36 hours)
  - Blood culture result should be checked again at 48 hours to ensure results remain negative
  - If blood culture is positive contact higher level nursery to ensure the right antibiotics are prescribed

2.4.3 Fluids

- Insert intravenous (IV) cannula and commence fluids 60 mL/kg/day of 10% Glucose
- Consider an umbilical venous catheter (UVC) if peripheral cannulation is difficult

2.4.4 Antibiotics

- Aim to give antibiotics within 30 minutes of identification of respiratory distress
- Refer to local unit’s medication manual, if this is unavailable then give recommended antibiotics as follows:
  - Penicillin 60 mg/kg/dose 12 hourly or Ampicillin 50 mg/kg/dose 12 hourly and
  - Gentamicin 2.5 mg/kg ≥30 weeks - daily, <30 weeks every 36 hours:
    - check gentamicin level before third dose.

2.4.5 X-Ray

To exclude:

- pneumothorax
- congenital diaphragmatic hernia
- chest masses

(Level 3 Nurseries to arrange for the level 5 or 6 Nursery to view film).

2.4.6 Blood glucose level

- Refer to local unit’s hypoglycaemia guidelines; if this is unavailable then blood glucose management as follows:
  - measure blood glucose at 1, 2 and 4 hours of age (or hourly until normalised) and then 4 hourly for 24 hours until stable at more than 3 mmol/L
  - blood glucose of 2.6 mmol/L or more is acceptable, less than 2.6 mmol/L requires treatment

2.4.7 Supportive care

- Small trophic feeds eg. 2 mL/kg 3 hourly should be started in stable neonates with respiratory distress as this may reduce the duration of both respiratory distress and hospital admission
- Maintain temperature within the normal range:
  - axillary temperature should be between 36.5-37°C and skin temperature between 36-36.5°C.
- Disturb neonate only when absolutely necessary (“Minimal handling”)

**If Oxygen reaches 30% [go to Section 3 Management of CPAP]**
3 Management of CPAP

- CPAP must be managed in a nursery level 4 or above
- A neonate on CPAP must be cared for by a Specialist Paediatrician
- A trained neonatal nurse must be available while CPAP is being provided to the neonate
- The nurse: patient ratio should be 1:2. If the neonate is very unstable 1:1 may be required

3.1 Indications

- Oxygen requirement more than 30% to maintain saturation 92-96%
- If other significant signs of respiratory distress are present commence on CPAP at less than 30% oxygen requirement

3.2 When to contact a higher level nursery

A Level 6 nursery may be contacted by any Level Nursery* for advice as required.

3.2.1 Level 4 nursery

Contact higher level nursery if:
- birthweight less than 1500 g
- gestational age less than 32 weeks
- commencing CPAP and the neonate is greater than 24 hours old
- oxygen requirement greater than 50%
- partial pressure of carbon dioxide (pCO₂) greater than 60 mmHg
- insufficient medical or nursing resources

3.2.2 Level 5 nursery

Contact Level 6 nursery if:
- birthweight less than 1000 g
- gestational age less than 29 weeks
- commencing CPAP and the neonate is greater than 24 hours old
- oxygen requirement greater than 50%
- pCO₂ greater than 60 mmHg
- insufficient medical or nursing resources

3.3 Methods of administering CPAP

Experience is required for the successful application of short binasal prongs. Research supports the use of short binasal as a more successful method of providing CPAP, but correct positioning is essential. Single prong method may be beneficial for nurseries who have less experience with short binasal or when application of short binasal prongs is problematic.

3.3.1 CPAP components

All CPAP systems contain three basic components:
- CPAP generator (means of creating a positive pressure in the circuit)
- circuit for continuous flow of humidified inspired gases
- patient interface (device to connect the circuit to the neonate’s airway)

3.3.2 CPAP setup

- Obtain relevant CPAP equipment (Appendix A)
- Decide on the CPAP generator
- Set up circuit with humidifier corresponding to the patient interface required
- Test for leaks
3.3.3 Commencing CPAP
- Commence with a CPAP pressure of 8 cm water
- Give sufficient oxygen to maintain saturation 92-96% (i.e. turn oxygen up if saturation is continually less than 92%, turn oxygen down if saturation continually more than 96%)
- Pass an orogastric tube

3.3.4 Monitoring
- Monitor oxygen saturation continuously
- Monitor respiratory rate and heart rate continuously
- Blood gas - results must be available within 10 minutes (if measured)
- Check on circuit integrity and equipment hourly
- Visually check hourly that CPAP interface is positioned correctly

3.4 Expected clinical course
The need for support of acute neonatal lung disease normally lasts 1-3 days.

3.4.1 Improvement
- Reduction in respiratory rate
- Stabilization or reduction in oxygen requirement to maintain saturation 92-96%
- Resolution of grunting and decreased work of breathing
- Reduction in sternal and intercostal recession
- Improving blood gas (if measured)

3.4.2 Weaning
- Commence weaning when:
  - saturation more than 96 %
  - respiratory rate stabilized, grunting ceased and recession reduced
  - improving blood gas (if measured)
- Suggested weaning method:
  - wean oxygen until inspired oxygen 21-23%
  - then
  - wean pressure by 1 cm every 2-4 hours until 5 cm water is reached

3.4.3 Ceasing CPAP
- Consider ceasing CPAP when a neonate is stabilised in 21-23% oxygen and CPAP pressure 5 cm water

3.4.4 Recommencing
- CPAP may need to be recommenced if there is increased work of breathing or an increase in oxygen requirement
- When recommencing CPAP always undertake careful clinical assessment to preclude other complications requiring additional management (eg pneumothorax)
3.5 Failure of CPAP
Evidence of any of the following signs of failure requires:

- **immediate medical assessment and chest x-ray:**
  - transillumination may be used, but is not meaningful if negative in this target group
  - consultation with a level 6 Nursery is advised as the neonate may require retrieval

3.5.1 Signs of failure

- Oxygen requirement > 50% to maintain saturation >92%
- A rapid rise in oxygen requirement (an absolute 10% rise in oxygen over 2 hours eg an increase from 30% to 40%)
- A respiratory acidosis eg pH < 7.25 with a normal base excess, or pCO₂ > 60 mmHg
- Recurrent apnoeic episodes requiring stimulation
- Increased work of breathing (sternal and intercostal recession/grunt/tachypnoea)
- Agitation that cannot be relieved:
  - narcotic analgesics should not be administered to unventilated neonates as it causes respiratory depression
  - containment, nesting, dummy, or sucrose are more acceptable techniques for settling the neonate

3.6 Complications of CPAP

- Pneumothorax – needs urgent medical attention (Appendix B)
- Nasal trauma – may require a different patient interface
- Abdominal distension – may require a reduced CPAP pressure or orogastric tube venting of stomach
- Agitation – try settling techniques

3.7 Staffing requirements

Nurseries must have Medical staff or a Neonatal Nurse Practitioner (NNP) capable of emergency management of acute deterioration, recognizing pneumothorax and resuscitation (including intubation) available in less than 10 minutes. The Medical Officer and NNP must be Neonatal Resuscitation Program (NRP) qualified or equivalent.

3.7.1 Medical Staff

Consultants caring for the neonate on CPAP should be:

- no more than 30 minutes away and contactable by phone immediately
- NRP trained or equivalent
- experienced in the management of CPAP
- knowledgeable of the indications for and contraindications of commencing a neonate on CPAP
- knowledgeable of the expected course of neonates on CPAP
- technically experienced in the management of a pneumothorax, intubation and the delivery of mechanical ventilation

3.7.2 Nursing staff

Appropriately trained nursing staff is essential (Appendix C). Nursing staff caring for the neonate on CPAP should be:

- NRP trained or equivalent
- experienced in the management of CPAP
- knowledgeable of the indications for and contraindications of commencing a neonate on CPAP
- knowledgeable of the expected course of neonates on CPAP
Appendix A: CPAP equipment

1.1. CPAP generating system
- Emergency power available
- Air and oxygen gas supply
- Air/oxygen blender
- CPAP delivery system either:
  - bubbles or
  - infant flow driver/Infant flow nasal CPAP system or
  - continuous flow mechanical ventilator set in the CPAP mode with high and low
    pressure, loss of power and gas alarms
- Appropriate breathing circuit for delivery device
- Humidifier/sterile water (bottle or bag)
- Set temperature:
  - circuit 40°
  - humidifier 37°C

1.2. Patient Interface
Short binasal prongs are the preferred interface. Use single prong if unfamiliar with binasal or binasal unavailable.

1.2.1. Short Binasal
Examples of short binasal prongs include:
- Hudson Prongs
- Fisher and Paykel Midline Interface
- Drager Midline Interface
- Infant flow driver prongs
Knit hats are available with the binasal packs. Alternative wrap hats are also available - refer to CPAP clinical resource package.7

1.2.2. Single Prong
Single prong is an alternative to short binasal. [Sizes as per Table 1].

Table 1: Single prong size for weight

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<thead>
<tr>
<th>Weight (g)</th>
<th>Size</th>
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<tr>
<td>&lt;1400</td>
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<tr>
<td>1400 - 3000</td>
<td>3.0 mm</td>
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<tr>
<td>&gt;3000</td>
<td>3.5 mm</td>
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1.3. Resuscitation equipment
- Suction equipment
- Suction catheters (sizes 5, 6 and 8)
- Intubation equipment
- Resuscitation bag (Neopuff TM or equivalent resuscitation device, anaesthetic or Laerdal
  bag) and various sizes of masks
- Umbilical venous (UV) line equipment
- Transilluminator
- Thoracentesis equipment:
  - 23-25 gauge butterfly needle or 24 gauge intravenous cannula
  - 3 way stopcock
  - 10 mL syringe
  - skin preparation - chlorhexidine 2% in alcohol 70% or local infection control
    recommendations for skin preparation
  - sterile dressing pack
- Intercostal catheter
- Equipment for the inserting an intercostal catheter
1.4. Monitoring Equipment

- Cardio-respiratory monitor
- Pulse oximeter
- Non-invasive blood pressure monitoring
- Equipment for blood gases
- Arterial monitoring if available
- Blood glucose monitor

1.5. Thermal maintenance

- Open bed warmer with servo controlled heater or
- Incubator

1.6. Equipment for gastric decompression

- Oral-gastric tube size 8 and 6 FG
- Tape for securing
- 10 mL syringe

1.7. Documentation

- Observation chart with provision for hourly recording of:
  - vital signs
  - fractional of inspired oxygen (FiO₂)
  - CPAP pressure
  - gas flow
  - humidifier and circuit temperature
  - water level in humidifier
- Observe prong position and check septal integrity hourly
- If suctioning required, observe nasal septum and nares for blanching, pressure areas and breakdown

1.8. Parents

- Inform parents of condition, management and likely outcomes
Appendix B: Emergency management of pneumothorax

1. INTERCOSTAL CATHETER (ICC)

1.1. Procedure
- Identify insertion site:
  - the best insertion site is in the mid to anterior axillary line, 5th -6th intercostal space
  - stay well away from the nipple
- This is a sterile procedure
- Use local anaesthetic if there is time
- Make a hole through the parietal pleura using a No. 11 scalpel blade and then artery forceps
- Insert size 10 catheter perpendicular to the skin and guide tip of the catheter in front of the lung
- Never use any force to insert the catheter through the chest wall
- The procedure may be performed with or without a trocar
- Ensure a chest X-ray is taken after insertion
- A flutter valve should be adequate -it is usually not necessary to apply suction

1.1.1. Without Trocar
- Incise down to and through the parietal pleura with a number 11 scalpel blade
- Then blunt dissect to enlarge the hole created, and use curved artery forceps to insert the intercostal catheter
- Direct the tip antero-infero-medially (towards the xiphisternum)

1.1.2. With Trocar
- This is only safe if the catheter with trocar is held in both hands with the forefingers on either side of the catheter 1-1.5 cm back from the tip and all movement is from the elbows [Figure 1]. NEVER use the palm of the hand over the back end of the trochar
- Incise down to and through the parietal pleura with a number 11 scalpel blade, insert the catheter with trocar
- When in the pleural space, advance the catheter off the trocar, directing it antero-infero-medially (towards the xiphisternum)
- Positioning the catheter anterior to the lung is critically important, and this may be assisted by having an assistant roll the baby away from you after you have the catheter in the pleural space
- Some operators bend the trocar (1-1.5 cm from the tip) at 20-30° to aid in directing the ICC tip anteriorly

Figure 1. Insertion with trochar
1.2. Notes

- If drainage is ineffective contact higher level nursery
- If choosing to suture the ICC, do not use a purse string suture, as this will produce a puckered scar
- Tape with transparent, bio-occlusive dressing, sandwich the catheter between two pieces [Figure 4]
- Place the external part of ICC under the arm running up past the head
- Refer to local guideline on the management of ICC for ongoing care

Figure 4. ICC bio-occlusive dressing
2. NEEDLE THORACOCENTESIS

Needle thoracocentesis is an emergency procedure, when the neonate is rapidly deteriorating. The procedure can be both diagnostic and therapeutic.

2.1. Site

- Avoid the heart, internal mammary artery and the intercostal arteries
- Use either:
  - 2nd intercostal space, mid-clavicular line
  - 4th intercostal space, anterior axillary line
- Insert the needle as near as possible to the upper edge of the lower rib

2.2. Equipment

Attach a 23 G or 25 G butterfly needle to a 3 way tap and then attach this to a 10 mL syringe.

2.3. Procedure

- Prepare the skin with an alcohol wipe and let dry
- Insert the needle perpendicular to the chest wall 1-2 cm in this target group
- Open the tap to the syringe and needle
- Aspirate, if the syringe fills with gas then there is a pneumothorax
- Close the three way tap to the needle and open to atmosphere and empty the syringe
- Repeat until there is no more air to aspirate. Record the amount of air aspirated
- Remove the needle, no dressing is required

2.4. Notes

- Do not empty syringe back into the neonate
- There can be an ongoing air leak, which may necessitate leaving the needle in situ until an ICC can be inserted
- After the procedure an ICC will usually need to be inserted

Figure 5. Needling a pneumothorax
Appendix C: Neonatal Nurse Training

As a minimum requirement nurses working in a nursery caring for a neonate on CPAP in regional centres are recommended to undergo a clinical competency assessment of a neonate requiring CPAP.

For Nurses without a neonatal certificate the Neonatal Nursing Education Outreach Program is available. Three subjects of study that should be a minimum requirement are:

- respiratory distress
- respiratory problems
- CPAP

A clinical placement would be beneficial for nursing staff to gain exposure to CPAP with education including:

- Neonatal Resuscitation Program
- principles of CPAP management
- specific nursing care – identify change of condition and complications
- prevention, diagnosis and management of delivery device
- problem solving with the equipment associated with the delivery

There is a CPAP clinical learning resource package available from Statewide Maternity and Neonatal Clinical Network website via CPIC.7
References


Bibliography


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