

NURSING MANAGEMENT OF CPAP

INTRODUCTION

Continuous Positive Airway Pressure (CPAP) is used to deliver low pressure distension to the lungs whilst the baby is spontaneously breathing. It is an effective treatment for respiratory distress in premature infants^{1,2}. The physiological effects of nasal CPAP (nCPAP), its clinical applications and indications for use, technical issues, contraindications and adverse effects are also reviewed in the *RPA Newborn Care CPAP protocol* - <http://www.sswahs.nsw.gov.au/rpa/neonatal/>. In our unit nCPAP is delivered using short nasal prongs or mask using the Fisher & Paykel Bubbly® nCPAP circuit, the Infant Flow Driver (EME, UK), Dräger Babylog or Stephanie ventilators.

General guidelines and care specific to each method will be discussed. Skilled nursing intervention is required to deliver appropriate nCPAP and prevent complications.

PATIENT SAFETY

1. Infants needing nCPAP are nursed with a minimum 1:2 nurse / patient ratio by registered nurses with additional preparation in the use of nCPAP.
2. Continuous cardio respiratory and oxygen saturation monitoring must be used, with hourly observations documented. All alarms must be set appropriately for gestation and postnatal age.
3. All infants receiving assisted ventilation are to have a t-piece resuscitation device (Neopuff®, Fisher & Paykel) or a continuous flow resuscitation bag (anaesthetic bag) attached to a blended gas supply with the appropriate size mask and checked by the registered nurse each shift.
4. The Fisher & Paykel Bubbly® nCPAP circuit must be connected to the air flow meter (not blender) when the infant does not require additional oxygen.
5. Infection control – all circuits to be changed weekly, and date next change is due clearly marked.

Threshold for Intubation

Preterm infants with respiratory distress should be considered for intubation and surfactant treatment if:

Early chest x-ray is consistent with RDS and,

Despite adequate CPAP require $FiO_2 > 0.35$ in 1st 24 hours, or

$FiO_2 > 0.4$ to 0.6 after 1st 24 hours

A lower threshold may be used for intubation and surfactant for infants < 30 weeks' gestation at high risk of RDS and increasing oxygen requirements, particularly if the x-ray is consistent with RDS.

<http://www.sswahs.nsw.gov.au/rpa/neonatal/>

PRONGS or MASK

Prongs Short binasal prongs are more effective than mask, single nasal or nasopharyngeal prongs² and should always be used where possible. The short binasal prongs used in this nursery include the Fisher & Paykel short binasal prongs used in conjunction with F&P Bubbly® nCPAP circuit, the Infant Flow Driver prongs (EME,UK), the Dräger short binasal prongs used with either the F&P Bubbly® nCPAP circuit or Dräger ventilator and the Argyle prongs (Tyco Healthcare) used with the Stephanie ventilator.

Masks For infants where there is risk of damage to the nasal septum or nares, masks may be used to rest the affected area. The Dräger masks may be used with either the F&P Bubbly® nCPAP circuit or Dräger ventilator using the Dräger Babyflow® interface. Masks may also be used for infants using the Infant Flow Driver (EME, UK) when prongs do not provide an adequate seal or the septum / nares are in need of a "rest". CPAP via mask has not been demonstrated to be as effective as nCPAP ([reference here](#))

Nasopharyngeal tubes This mode of nCPAP is not routinely used in our nursery but can be considered for use in infants where facial anomalies such as bilateral cleft lip / palate make use of short prongs impractical. A short endotracheal tube is positioned in the nasopharynx and usually attached to a Dräger ventilator.

Type of CPAP device

Research has not demonstrated the best device for the delivery of nCPAP^{1,2}. At RPA Newborn Care the following are used:

1. The F&P Bubbly® CPAP circuit is the preferred device for infants at all gestations and for all causes of respiratory distress.
2. The Dräger Babylog 8000 ventilator may be used for the near term and term infants or with a birth weight greater than >1250g.
3. The Stephanie ventilator is used with Argyle prongs (Tyco Healthcare) and may be used when the near term / term infant has been extubated and continues to need respiratory support.
4. The EME Flow Driver (EME, UK) is used for infants less than <1250g if the F&P Bubbly® CPAP circuit is not available. The Infant Flow Driver does not appear suitable for infants needing more than 6cms H₂O pressure.

General Guidelines when commencing nCPAP

Photo guides for each method of nCPAP used in RPA Newborn Care - *see the NICU Useful folder. In general*

Ensure adequate humidification will be achieved – check with 2nd registered nurse and connect the 2L sterile water bag to the humidifier cassette, confirm water level & temperature setting. Commence gas flow through the device and turn on humidifier – *see settings below.*

Confirm the nCPAP device is correctly set up and is functional on the desired pressure / gas flow and oxygen settings. Ensure gas is warmed and humidified.

All nCPAP devices must have either an inline oxygen analyser (Dräger Babylog 8000 ventilator, the Stephanie ventilator or the EME Flow Driver) or a Teledyne oxygen analyser is used with the F&P Bubbly® CPAP circuit – *see below*.

Measure head circumference & choose an appropriate type / size hat that provides a snug fit. It should sit just above the brow line, and extend to the base of the neck, covering both ears.. It is important to fit the hat correctly or the prongs will be positioned incorrectly.

Poorly positioned prongs are the primary reason for injury to the nasal septum and / or nares. Broken skin due to pressure causes discomfort to the infant, increased anxiety for parents and reflects poorly on the nursing management of these infants.

Select the appropriate size prongs / mask using the sizing template for the Fisher & Paykel short binasal prongs, the Dräger short binasal prongs / mask or the Infant Flow Driver prongs / mask and attach to compatible nCPAP device.

The size of the prongs / mask should be documented on the *intensive care chart* I/D 630727.

With the assistance of a 2nd registered nurse position the hat and attach the nCPAP Do **not** use lubricants to aid prong insertion, use a few drops of normal saline if required.

Ensure the prong size is correct, with no blanching or distending of the nares. Position the infant to optimise comfort and secure prongs correctly. The aim is to prevent excessive movement of the prongs and so minimise risk of pressure / friction injuries.

Confirm that the prescribed level of nCPAP is being delivered.

Minimise pressure leaks by positioning the infant so the mouth is closed. The use of a dummy may assist. The use of a chin strap may be considered to maintain higher levels of nCPAP. Ensure this is not too tight so the infant may still yawn, cough and secretions can get away. *Chin straps should only be used if other methods to maintain pressure are not effective. Do not leave insitu long term – review periodically.*

If the baby requires oxygen, continue crib or ambient oxygen at the same concentration (\pm 5%).

Commence the *intensive care chart* I/D 630727 and record observations including nCPAP settings and integrity of the skin.

Observe the effect of nCPAP on heart rate, oxygen saturation, respiratory rate and work of breathing. Often oxygen concentration can be reduced.

A capillary ABG may be requested to assess the baby's response to nCPAP.

Inform medical staff / transitional nurse practitioner if the infant has increasing oxygen requirements despite effective nCPAP.

The Fisher & Paykel Bubbly® nCPAP device

Confirm the circuit is correctly set up and open the 2L bag of sterile water to fill the water chamber. Connect circuit to the blender and turn on gas flow (commence at 8L/minute). Set the required level of nCPAP by inserting the rod under the water to desired pressure, occlude end and ensure system is bubbling

This system uses the F&P MR850 humidifier to warm and humidify gases. Ensure the invasive or ventilator mode is used, the temperature display should read $37^{\circ}\text{C} \pm 0.2^{\circ}\text{C}$ and measures the temperature delivered at the patient wye.

The Fisher & Paykel Bubbly® nCPAP device should be connected to the blended gas supply and oxygen concentration titrated with the infant's $\text{SpO}_2\%$. If oxygen is not needed, the Fisher & Paykel Bubbly® nCPAP circuit must be connected to an air flow meter to prevent accidental administration of oxygen.

The Teledyne oxygen analyser is used with the F&P Bubbly® CPAP circuit – *see Teledyne oxygen analyser – calibration instructions on intranet site <http://intranet.sswahs.nsw.gov.au/RPA/neonatal/policy/>*. Alarms should be set $\pm 5\%$ from target oxygen level. The instrument should be calibrated every shift or at the initiation of nCPAP. The procedure should be documented on the *intensive care chart* I/D 630727.

Hat

Choose the appropriate hat size (22-25cm, 25-29cm, 29-36cms, >37cms) to provide a snug fit and minimise movement of prongs.

Connect the correct size F&P nasal extension tubing – 50mm for premature infants, 70mm for larger infants.

Prongs

Measure width of the infant's nares and septum using the F&P reference guide and select an appropriate set of prongs. Connect prongs to the circuit.

Position the prongs gently in the nares and secure with the lateral tapes to the hat. The prongs should rest approx 2-3 mm from the nares and should NOT be in contact with the columella (end of septum)

Very premature infants may need to alternate between prongs and mask to reduce pressure to the nares / septum.

Use the Dräger Babyflow® interface to apply the Dräger mask to the Fisher & Paykel Bubbly® nCPAP circuit.

Loss of bubbling

Target pressures are reached when the water bubbles, if there is intermittent / regular loss of pressure you may need to re position the infant, insert a dummy or use a chin strap to achieve an optimal seal. Some infants are more challenging to nurse on nCPAP than others.

Consideration should also be given to trialling a larger size prong especially if the infant has been on nCPAP for a few days and bubbling is intermittent. If the bigger size prong is too large, retain the smaller size and use Comfeel® on nares and septum to minimize leak.

The Dräger Babylog 8000 ventilator

This appears to be a less effective method of delivering nCPAP and is usually restricted to use in the larger near term and term infant. Pressures of 8-10cms H₂O water are generally ordered.

Set the ventilator to *CPAP* mode and adjust the *PEEP* dial to deliver the pressures required.

This system uses the F&P MR850 humidifier to warm and humidify gases. Ensure the invasive or ventilator mode is used, the temperature display should read $37^{\circ}\text{C} \pm 0.2^{\circ}\text{C}$ and measures the temperature delivered at the patient wye.

Connect the Dräger Babyflow® interface to use the Dräger nasal prongs with the F&P ventilator circuit.

Use the Dräger nCPAP reference guide to select an appropriate size hat and nasal prongs.

The prongs should rest gently inside the nares, with the tapes securing them flat to the skin, avoid excessive pressure on cheeks and septum.

Near term and term infants can be very difficult to settle on nCPAP – additional nesting and containment may be required. A dummy will be essential to calm them and maintain effective CPAP.

The Stephanie ventilator

This ventilator is rarely used to deliver nCPAP in RPA Newborn Care but can be utilised for the near term or term infant, who after extubation still requires some assisted ventilation for several hours.

Set the ventilator to *CPAP* mode and adjust the *PEEP* dial to deliver the pressures required. Set alarms – *Nursing guide to the management of ventilated infants* (Daco 2009) <http://intranet.sswahs.nsw.gov.au/RPA/neonatal/policy/>.

This unit uses the Stephanie humidification system to warm and humidify gases and may be left at the same setting following extubation - $37^{\circ}\text{C}^{0-+2}$. The temperature display should read $37^{\circ}\text{C} \pm 0.2^{\circ}\text{C}$ and it measures the temperature delivered at the patient wye.

Connect the Argyle prongs (Tyco Healthcare) to the ventilator circuit and secure using a knitted cap and linen tapes. The prongs should rest gently inside the nares, with the tapes securing the prongs flat to the philtrum - avoid excessive pressure on cheeks and septum.

The Stephanie circuit is heavy so additional support is often necessary to prevent excessive pressure / pull on the nares.

Near term and term infants can be very difficult to settle on nCPAP – additional nesting and containment may be required. A dummy will be essential to calm them and maintain effective CPAP.

The Infant Flow Driver (EME, UK)

Usually used for very small infants weighing less than 1250grammes following extubation.

No longer commonly used in the nursery but this system does provide a *back up* should the number of babies requiring nCPAP exceed 14.

The system derives its distending pressure from the gas flow – therefore the higher gas flow the higher the pressure generated. Up to 10L/minute will achieve 5-6cms H₂O with a good seal.

The device uses a blended gas supply and in line oxygen analyser. Use the oxygen dial to set required level - the digital display will show what is delivered.

The EME system uses the F&P MR 750 humidifier – set temperature at 39⁰C⁻². The temperature display should read 39⁰C ± 0.5⁰C and measures the temperature of the gas as it leaves the humidifier.

Using the EME reference guide select an appropriate size prongs / mask and connect to the circuit.

Using the coloured tape and reference guide select an appropriate size hat to provide a snug (not tight) fit.

Use all three openings on each side of the hat to connect the nCPAP prongs / mask correctly. This will distribute the pressure from the prongs / mask pressure evenly and minimise injury to the bridge, septum and nares. Starting from under the hat behind the ear, weave the tape up and through the remaining openings – *see diagram below*. Pull tight to achieve firm support with the prongs resting gently below the nares. If a mask is in use, ensure that it is not too tight and occluding the nares.



Gradually increase flow (max 10L/minute) to achieve target nCPAP pressures.

Once the baby is settled, set the alarms (automatic ranges) by holding the alarm button for 3 seconds.

Nursing management

Observations / Documentation

On the *intensive care chart* I/D 630727, the registered nurse will record the heart rate, respiratory rate, SpO₂% range, nCPAP settings (water level, temperature, pressures, size of nasal prongs / mask in use), ambient and circuit oxygen levels and isolette temperature. Calibration of the Teledyne oxygen analyser, equipment safety checks such as suction, resuscitation devices and the ventilator, intravenous syringe drivers / pump and monitor alarms should also be documented on the *intensive care chart* I/D 630727.

The axilla temperature should be checked at least 4 hourly or prn. Application of skin probe to continuously monitor temperature may be indicated.

The registered nurse should sample arterial or capillary blood gases as indicated by the infant's condition.

Document any changes in the infant's condition including response to handling, changes to skin integrity, administration of medications, fluid balance, procedures and investigations and parental interaction.

Airway management

Humidification of inspired gases

Continue to maintain optimal humidity for the inspired gases. Misting should be observed at the patient wye but there should not be excessive rainout in the circuit. Ensure gases are delivered at core temperature 37⁰C and there is adequate water in the humidification chamber. This will facilitate muco ciliary action, clear secretions, optimise gas exchange and minimise the risk of infection³. Empty the circuit of excess water every hour and as necessary.

Suction

Airway suction is not routine and is performed on a needs basis. Indications for suction may include: increasing frequency and severity of apnoea, slowing of response to tactile stimulation and increasing oro pharyngeal secretions. The need for suction is assessed by the registered nurse caring for the infant. The nurse should always optimise work of breathing (confirm patency of nasal prongs), humidification, infant position, the thermal environment and enteral feeding techniques. If suction is required the colour, consistency and quantity of secretions should be documented on the *intensive care chart* I/D 630727.

Positioning and handling

The infant should be positioned to facilitate comfort and optimise respiratory effort. The prone position has been demonstrated (McEvoy et al 1998).

Use of the prone, supine and lateral body positions should all be considered and used intermittently to promote upper airway stability, reduce work of breathing, facilitate physiological flexion of the trunk and limbs, prevent posture and movement problems and encourage midline orientation of the hands to face. Document preferred and best tolerated position. See *developmental care protocols* for optimal positioning methods – (Limberg, Hinwood & Bredemeyer) <http://intranet.sswahs.nsw.gov.au/RPA/neonatal/policy/>.

To minimise pressure / friction injury to the nasal septum and nares the nurse must limit excessive movement of the nasal prongs through good positioning and alignment of prongs. In addition nursing care should be cue based, generally 4-6th hourly and should include oral hygiene, umbilical cord care and promotion of skin integrity.

Once stable on nCPAP most infants will tolerate a 2nd daily weigh and a *top & tail*. Skin to skin contact and / or nurse by the parents are at the discretion of the registered nurse caring for the infant and should be facilitated.

Parental involvement

The parents should be kept informed and involved in all aspects of their infant's management. Encourage questions and opportunities to interact with their infant.

Once the infant can tolerate some handling the parents should be encouraged to participate in their routine care. Methods commonly used to comfort and contain infants in the NICU should be demonstrated and discussed with parents.

Frequent skin to skin contact should be encouraged especially when the infant is having time off nCPAP so the parents can *see* more baby and less ICU equipment. See *developmental care protocols* for benefits and potential challenges of skin to skin contact – (Dixon & Cutrupi 2006) <http://intranet.sswahs.nsw.gov.au/RPA/neonatal/policy/>.

Prevention of complications

Pneumothorax is a known complication of nCPAP, especially in the first 72 hours after birth in infants with of Respiratory Distress Syndrome^{2,4}. Signs of air leak include: respiratory distress, increased work of breathing, increasing severity and frequency of apnoea, oxygen desaturation, decreased air entry and asymmetrical chest movement. If suspected support infant and inform medical staff.

Retinopathy of Prematurity (ROP)

The risk of retinopathy of prematurity can be minimised by judicious use of oxygen therapy and vigilant compliance with oxygen protocols. Ensure oxygen saturation and trans cutaneous monitor alarms are all set at correct limits – *see protocol Administration and monitoring of oxygen therapy in the newborn* (Martin & James 2004) <http://intranet.sswahs.nsw.gov.au/RPA/neonatal/policy/>.

Gastric Distension

Infants receiving nCPAP commonly develop abdominal distension. This can cause discomfort, splinting of the diaphragm and compromise respiration⁵.

All infants with respiratory distress requiring nCPAP must have a 6Fg intra gastric tube inserted to prevent over distension of the stomach. This will be reviewed when the new enteral feeding system is introduced.

Always review x-ray for position of intra gastric tube. Routinely most infants will remain on hourly feeds to limit chances of aspiration.

Between feeds the intra gastric tube is attached to an open, elevated syringe to promote gastric venting of air.

It may be necessary to close the intra gastric tube immediately after feeding for approximately 10-15minutes to promote absorption of feeds. Do not tolerate a gastric tube with regurgitated milk insitu.

Prevention of pressure injuries to septum and / or nares

Damage to the nares or septum occurs when poorly fitted or mobile prongs cause friction / pressure. Excessive moisture from lubricants / humidification and secretions will also increase friction and undermine skin integrity^{6,7}

Do NOT use any lubricants except for a few drops of saline if necessary for initial prong placement^{3,7},

Stop excessive rainout in the nCPAP circuit by frequently checking the tubing and removing excess water. Dry the nares and prongs / mask as needed.

Use correct size prongs / mask.

Ensure the hat remains fitted over the glabella to anchor prongs / mask effectively. Do not tolerate hats that slide back over the forehead.

Avoid poorly fitting prongs / masks that pinch, blanch or distend the nares, tight security straps causing excessive pressure on cheeks or orbital oedema. Prevent twisting or tension on the nCPAP circuit, this will cause incorrect positioning of the prongs or mask.

Routine Prong (Pressure) Release

This procedure must be performed every two hours.

The prongs / mask should be removed and the nares gently massaged and skin integrity assessed. Masks can cause pressure across the bridge of the nose and under the columella.

If the infant does not tolerate time off nCPAP then the registered nurse must provide CPAP and / or oxygen using the Neopuff® device for up to 5 minutes to allow for adequate pressure release.

If a chin strap is in use, this must be released. Poorly fitting and / or prolonged use of chin straps chin straps can increase pressure on the columella and cause excessive moulding of the soft head.

Reposition the prongs / mask - if the nares are slightly reddened - try hourly prong release for 1-4 hours. Evaluate and if there is minimal to no improvement, review prong size (document on the *intensive care chart* I/D 630727) and assess possible application of Comfeel®. Application of Comfeel® is not routine, as skin integrity cannot be easily observed. Comfeel® will prevent injury from friction, but will not relieve pressure, so prong release and examination of the skin for abrasion, oedema or inflammation remains vital.

Comfeel®. should be changed at least 12th hourly⁷ or earlier if lifting, moist or soiled - document time and condition of the skin on the *intensive care chart* I/D 630727.

If skin deteriorates with resultant break in skin integrity Comfeel® should be removed. The nares should be reviewed by senior nursing / medical staff. Alternating between prongs and mask may be advisable. Take pictures of the injury 2nd daily, insert in notes, commence an *Individualised Baby Care Plan* and discuss management with parents. The Staff specialist on service should be informed as soon as practical.

Weaning nCPAP

The best strategy for weaning nCPAP has not yet been demonstrated. Research is currently underway to assess the most beneficial method⁸. At present the following are used as guidelines only – individualise to each baby. Length of time off nCPAP is generally decided at the discretion of the registered nurse caring for the infant.

35 – 40+ weeks gestation

The more mature infant needing nCPAP for respiratory distress or support post extubation often settles quickly.

Less than 35 weeks gestation

Once stable in air or low FiO and requires ≤ 6 cms H₂O, time off nCPAP may begin.

Increased work of breathing, tachypnoea, increased oxygen requirements or recurrent apnoea / bradycardia will indicate need for the reapplication of nCPAP. The length of time off nCPAP including rationale for recommencing support should be documented on the *intensive care chart* I/D 630727.

Usually the very preterm (< 30 weeks) and / or extremely low birth weight infants (< 1000 grammes) require long term nCPAP. A management plan for these infants may provide a more consistent and sensible approach. Consideration should be given to documenting this on the *Individualised Baby Care Plan*.

Plan time off nCPAP to coincide with parental visiting will facilitate attachment and maximise involvement in their infant's care.

Preterm infant < 37 weeks		Target Oxygen	Alarm limits
Infant in air	SpO ₂ %	90-95%	88-100%
Infant in oxygen	SpO ₂ %	90 -95%	88-96%
Transcutaneous	TC O ₂ mmHg	50-60 mmHg	45-70 mmHg
Transcutaneous	TC CO ₂ mmHg	45-55 mmHg	40-60 mmHg
Term infant		Target Oxygen	Alarm limits
Infant in air	SpO ₂ %	91-100%	88-100%
Infant in oxygen	SpO ₂ %	92-98%	91-99%
Transcutaneous	TC O ₂ mmHg	60 – 80 mmHg	50- 90 mmHg
For the <u>term</u> infant with Persistent Pulmonary Hypertension of the Newborn (PPHN) then discuss target oxygen and alarm limits with staff specialist & document on NICU chart. Modify target oxygen <u>only</u> after discussion with staff specialist / Fellow.			
Transcutaneous	TC CO ₂ mmHg	45-55 mmHg	40-60 mmHg

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