CONTINUOUS POSITIVE AIRWAY PRESSURE THERAPY DEVICES

This LOP is developed to guide clinical practice at the Royal Hospital for Women. Individual patient circumstances may mean that practice diverges from this LOP.

AIM
To provide safe and appropriate continuous positive airway pressure (CPAP) to neonates in the NICU.

BACKGROUND
Nasal CPAP has become the pillar of treatment for respiratory distress in newborns. It can be delivered in a number of ways. Therefore, it is vital for both medical and nursing staff to have a thorough understanding of these devices available in their NICU. The purpose of this document is to provide the basic concept and differences in various CPAP devices available in our NICU.

INDICATIONS IN THE NICU
1. Initial therapy for respiratory distress
2. Ongoing therapy for respiratory distress
3. Weaning therapy for respiratory distress
4. Post-extubation
5. Treatment of apnoeas
6. Obstructive airways

CPAP SYSTEM

How does CPAP work?
CPAP maintains positive pressure in the airway and thereby increases functional residual capacity. CPAP does this by stabilizing airspaces so that they don’t collapse during expiration.

Various proposed mechanisms:
Increase transpulmonary pressure
Increase functional residual capacity
Prevent alveolar collapse
Decrease intrapulmonary shunting
Increase lung compliance
Conserve surfactant
Increase airway diameter
Splint the airway
Splint the diaphragm
Stimulate lung growth

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There are 4 important components to consider before commencing an infant on CPAP: (1) Pressure, (2) Gas Flow, (3) Gas Humidity and (4) CPAP device

**CPAP Pressure**
Normal physiologic PEEP is 2-3 cmH$_2$O. CPAP of 5-8 cmH$_2$O, which is higher than physiologic pressure recruits more alveoli for gas exchange and increases functional residual capacity.

CPAP pressure needs to be individualised for each baby and it may vary for each clinical scenario.

In most cases, CPAP of 6-8 cmH$_2$O as the starting CPAP for any preterm infant with acute RDS is a good starting point. But as the lung compliance improves, particularly after surfactant administration, infant may not need high CPAP and may be able to wean it down to 5 cmH$_2$O.

**In our NICU default starting CPAP pressure in acute RDS is 6 cmH$_2$O.**

Remember adjusting CPAP is an art and needs to be individualised. One blanket rule doesn’t work for every infant.

**CPAP Gas Flow**
A flow of 5 to 10 litres/minute will provide adequate pressure and prevent carbon dioxide re-breathing. Required CPAP gas flow can vary depending on the device. Please refer to Flow-Pressure tables below for F&P Bubble CPAP and Infant Flow Driver.

**CPAP Humidity**
During normal inspiration the human airway conditions inspired gases with heat and humidity to body temperature (100% Relative Humidity with 44 mg/L of Absolute Humidity). The lungs rely on these conditions to maintain the physiological balance of heat and moisture necessary for optimized airway defense and gas exchange while maintaining infant comfort.

When delivering respiratory support to infants, aim is to deliver gas (air/oxygen) at the nose at or near body temperature with optimal humidity (100% relative humidity at 37°C). Optimal humidity prevents (1) airway cooling, which is a primary cause of pain and discomfort, (2) airway drying and water loss, which will lead to thickened secretions, and (3) airway inflammation and constriction.

**In our NICU, we use F&P MR850 humidifiers for all respiratory devices with preset temperature.**

An adequate water level is required to maintain inspired gas humidity. All our humidifiers have auto-feed system for the water chambers. Pressure bag is used only for Infant Flow

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Driver. Condensation will cause water to accumulate in tubing. This needs to be removed in order to prevent water from reaching the infant.

### CPAP DELIVERY SYSTEMS

In principle, all CPAP delivery systems have 4 components:

(1) Circuit to run the gas, (2) patient interface that connects the circuit to the infant, (3) CPAP generator and (4) hats and straps to secure interface

CPAP devices can be divided into constant flow and variable flow devices:

**Constant Flow devices:** (1) Bubble CPAP and (2) conventional ventilator CPAP.

**Variable Flow CPAP:** Infant Flow Driver

In our NICU, we routinely use F&P Bubble CPAP and Infant Flow Driver and rarely Drager VN 500 for delivering nasal CPAP

### BUBBLE CPAP

Bubble CPAP is a constant flow CPAP. CPAP is generated by placing the expiratory limb of the breathing circuit under water which generates pressure and provide oscillations. Patient Interface can be Hudson prongs (not used in our NICU), bi-nasal prongs or nasal masks.

**How does Bubble CPAP work?**

Simply, the expiratory limb of the breathing circuit is placed under water. This generates pressure and provides oscillations (almost similar to High frequency at 15-30 Hz). The "bubbles" are generated as the gas flows into the water. There was a perception that vigorous bubbling is necessary to create oscillations and the pressure amplitude necessary for these oscillations to provide the maximum benefit. However, gentle bubbling is as good as vigorous bubbling. The amplitude created by the oscillations by vigorous bubbling is only 10% of the amplitude we notice on high frequency. In a short term cross-over trial, vigorous high amplitude bubbling compared with slow bubbling was not associated with any significant differences in respiratory rate, oxygen saturation or transcutaneous carbon dioxide levels.

**Do we need bubbling all the time?**

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The bubbling indicates that the desired CPAP pressure is being generated. Vigorous bubbling is not necessary. Consistent, gentle bubbling is adequate. Some infants with mild respiratory distress may tolerate intermittent bubbling.

So, make sure there is bubbling happening but doesn’t have to be vigorous, like “spa”. If no bubbling, search for leak in the system. Once that is ruled out, generally increasing the gas flow will increase the bubbling, but most often it is leak somewhere such as an open mouth. Bubble CPAP rarely need more than 8 L/m flow.

**Bubble CPAP in our NICU**

We use F&P Bubble CPAP System.

It is all-in-one system with F-P MR850 Humdifier, MR 290V auto-fill water chamber and BC-161 F-P midline interface.

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The following table shows the average CPAP values generated at set gas flow and Probe level using F-P interface.

For example, if the gas flow is set at 6 L/min and the CPAP probe is set at 6 cmH₂O, mean CPAP generated at the interface with a good seal will be 6.4 cmH₂O.

Mean CPAP values generated by F-P Bubble CPAP at the set gas flow and Probe level using F-P interface with a tight seal (source: F&P CPAP Manual)

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INFANT FLOW DRIVER (VIASYS SIPAP DRIVER)

This is a variable Flow CPAP system. It provides more effective CPAP with less work of breathing compared to ventilator-derived CPAP. However, variable flow CPAP and bubble CPAP showed similar comparable clinical results.

How is the CPAP generated in infant flow driver?
Variable Flow CPAP is created by the fluidic flip technology and the Coanda effect at the patient interface (see below):
Expiratory Channel

Intranasal pressure monitoring

Fresh Gas Inlet

Patient Nasal Connection

Twin jet injector nozzles

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How much gas flow is needed to generate CPAP on Infant-Flow Driver?
The nomogram below (source: Operating manual) shows the relationship between airway pressure and flow settings on infant flow driver.

For example, 8 L/min provides 5 cmH₂O and 9 L/min provides 6 cm H₂O.

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What are the available modes on Infant-Flow Driver?

**NCPAP**

- NCPAP mode – Abdominal Respiratory Sensor not required
- NCPAP-Apnea mode - Abdominal Respiratory Sensor required
- NCPAP-LBR mode - Abdominal Respiratory Sensor required
BiPhasic

**Time** triggered pressure assists (i.e. PIP), delivered based on clinician set inspiratory time (T-High), rate and pressure settings.

![Image of BiPhasic settings]

**BiPhasic tr** – Abdominal Respiratory Sensor required

**Patient** triggered pressure assists, delivered based on clinician set inspiratory time (T-High) and pressure settings.

![Image of BiPhasic tr settings]

In biphasic modes, it is always good to connect abdominal respiratory sensor (between umbilicus and xiphisternum) to enable patient triggering, apnea and respiratory monitoring.

**Gas flow meters on the Infant-Flow Driver**

NCAP/Pres Low Flow meter (1-15 L/m) determines the nCPAP pressure. As shown in the nomogram, a flow of 9 L/m generates about 6 cm H$_2$O.

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Pres High Flow meter (1-5 L/m) determines PIP or Pressure Assist. Maximum PIP achieved is 5 cm above the set CPAP pressure or maximum of 11 cm H₂O.

(Example: If we decide to go on biphasic mode with a PIP/CPAP of 11/6, you may require CPAP flow meter at 9 L/m and Pres High meter at 5 L/m)
What do the symbols on the LCD Touch Screen indicate?
Some symbols used on Infant Flow Driver:
Rb: Back-up rate. Manufacturer’s default setting is 10 bpm.
T-High: Inspiratory Time in seconds. Manufacturer’s default setting is 0.3 sec.
T-apnea: Apnea time out alarm. Manufacturer’s default setting is 20 sec.
T-LBR: Low Breath Rate Time out Alarm.
Rspn: Spontaneous Respiratory Rate.

Where do we place the respiratory sensor?
In CPAP mode alone, there is no need to use the sensor. However, we encourage the staff to use the sensor to have better monitoring of apneas and the infant’s respiratory rate. Sensor should be placed between umbilicus and xiphisternum.

KEY POINTS
1. There is no firm evidence to suggest one CPAP device is better over the other in terms of major clinical outcomes including mortality and chronic lung disease.
2. Bubble CPAP has the same benefits as the variable flow CPAP in infants with RDS (Yagui et al).
3. Bubble CPAP is as effective as variable flow CPAP in the post-extubation management of preterm infants with RDS (Gupta S, J Ped 2009).
4. Short binasal prong devices are more effective than single prongs in reducing the rate of re-intubation (De Paoli AG, 2008).
5. NIPPV is a useful method of augmenting the beneficial effects of NCPAP in preterm infants. Its use reduces the incidence of symptoms of extubation failure more effectively than NCPAP (Davis PG, Cochrane 2008).

Education Resources


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