LOCAL OPERATING PROCEDURE

NEONATAL SERVICES DIVISION

Approved by Quality & Patient Care Committee
19 April 2018

CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) THERAPY

This LOP is developed to guide safe clinical practice in Newborn Care Centre (NCC) at The Royal Hospital for Women. Individual patient circumstances may mean that practice diverges from this Local Operations Procedure (LOP). Using this document outside the Royal Hospital for Women or its reproduction in whole or part, is subject to acknowledgement that it is the property of NCC and is valid and applicable for use at the time of publication. NCC is not responsible for consequences that may develop from the use of this document outside NCC.

INTRODUCTION

Nasal Continuous Positive Airway Pressure (nCPAP) has become the pillar of treatment for respiratory distress in newborns.[1] 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 the devices available in their NICU. The purpose of this document is to outline the basic concept of the CPAP device available in our NICU.

1. AIM

- To provide safe and appropriate CPAP to neonates in the NICU

2. PATIENT

- Newborns

3. STAFF

- Medical and nursing staff

4. CLINICAL PRACTICE

Indications in the NICU[2-5]

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 stabilising 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

CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) THERAPY cont'd

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 cm H_2O. CPAP of 5-8 cm H_2O, 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 cm H_2O 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, infants may not need high CPAP and may be able to wean it down to 5 cm H_2O.

NOTE: In our NICU default starting CPAP pressure in acute RDS is

- CPAP therapy needs to be individualised. One blanket rule does not work for every infant.

CPAP Gas Flow

- A flow of 5 to 8 L/min 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.

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 optimised airway defence 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.

NOTE: In our NICU, we use F&P MR850 humidifiers for all respiratory devices with pre-set

- An adequate water level is required to maintain inspired gas humidity. All our humidifiers have auto-feed system for the water chambers. 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[6-8]

- 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 and in our NICU the following devices are used:
  (1) Bubble CPAP (2) Drager ventilator CPAP (3) Maquet Servo-n CPAP

CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) THERAPY cont'd

Bubble CPAP

Bubble CPAP is a constant flow CPAP, 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.[9]

Do we need bubbling all the time?

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, ensure there is bubbling happening but does not 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/min flow.

Bubble CPAP in our NICU

- It is all-in-one system with F&P MR850 Humidifier, MR 290V auto-fill water chamber and BC-161 F&P midline interface.
- 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 cm H_2O, mean CPAP generated at the interface with a good seal will be 6.4 cm H_2O.

CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) THERAPY cont'd

Table: 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)

Flow (L/min)	Probe setting (cm H2O)							
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**
4	3.1	4.1	5.1	6.1	7.1	8.1	9.1	10
5	3.2	4.2	5.3	6.3	7.3	8.3	9.2	10.1
6	3.4	4.4	5.4	6.4	7.4	8.4	9.3	10.2
7	3.6	4.6	5.6	6.6	7.6	8.5	9.5	10.4
8	3.8	4.8	5.8	6.8	7.8	8.7	9.6	10.5
9	4	5	6	7	7.9	8.9	9.8	10.6
10	4.3	5.3	6.2	7.2	8.1	9	9.9	10.8
11	4.6	5.6	6.5	7.4	8.4	9.2	10.1	10.9
12	4.9	5.8	6.8	7.7	8.5	9.4	10.2	11.1
13	5.2	6.1	7	7.9	8.8	9.6	10.4	11.3
14	5.5	6.4	7.3	8.2	9	9.8	10.6	11.4
15	5.8	6.7	7.5	8.4	9.2	10	10.8	11.6

5. RELATED POLICIES/PROCEDURES/CLINICAL PRACTICE LOP

- NAVA (Neurally Adjusted Ventilatory Assist) Clinical Guidelines

6. RISK RATING

- Low

7. NATIONAL STANDARD

- Standard 1 Governance for Safety and quality in Health Service Organisation
- Standard 12 Provision of Care

8. ABBREVIATIONS AND DEFINITIONS OF TERMS

CPAP	Continuous Positive Airway Pressure	NICU	Neonatal Intensive Care Unit
NCC	Newborn Care Centre	PEEP	Positive End Expiratory Pressure
LOP	Local Operations Procedure	NAVA	Neurally Adjusted Ventilatory Assist
nCPAP	Nasal Continuous Positive Airway Pressure		

9. REFERENCES

1. De Paoli AG, Davis PG, Faber B, Morley CJ. Devices and pressure sources for administration of nasal continuous positive airway pressure (NCPAP) in preterm neonates. Cochrane Database of Systematic Reviews 2008, Issue 1. Art. No.: CD002977. DOI: 10.1002/14651858.CD002977.pub2
2. Subramaniam P, Ho JJ, Davis PG. Prophylactic nasal continuous positive airway pressure for preventing morbidity and mortality in very preterm infants. Cochrane Database of Systematic Reviews 2016, Issue 6. Art. No.: CD001243. DOI: 10.1002/14651858.CD001243.pub3
3. Davis PG, Henderson-Smart DJ. Nasal continuous positive airway pressure immediately after extubation for preventing morbidity in preterm infants. Cochrane Database of Systematic Reviews 2003, Issue 2. Art. No.: CD000143. DOI: 10.1002/14651858.CD000143

CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) THERAPY cont'd

4. Stevens TP., Blennow M, Myers EH, Soll R. Early surfactant administration with brief ventilation vs. selective surfactant and continued mechanical ventilation for preterm infants with or at risk for respiratory distress syndrome. Cochrane Database of Systematic Reviews 2007, Issue 4. Art. No.: CD003063. DOI: 10.1002/14651858.CD003063.pub3

5. Rojas-Reyes MX, Morley CJ, Soll R. Prophylactic versus selective use of surfactant in preventing morbidity and mortality in preterm infants. Cochrane Database of Systematic Reviews 2012, Issue 3. Art. No.: CD000510. DOI: 10.1002/14651858.CD000510.pub2

6. Pillow J. Which continuous positive airway pressure system is best for the preterm infant with respiratory distress syndrome? Clinics in Perinatology 2012;39:483-96.

7. Bober K, Swietlinski J, Zejda J, Kornacka K, Pawlik D, Behrendt J, et al. A multicenter randomized controlled trial comparing effectiveness of two nasal continuous positive airway pressure devices in very-low-birth-weight infants. Pediatric Critical Care Medicine 2012;13:191-6.

8. Courtney SE. Kahn DJ. Singh R. Habib RH. Bubble and ventilator-derived nasal continuous positive airway pressure in premature infants: work of breathing and gas exchange. Journal of Perinatology 2011;31:44-50.

9. Morley CJ, Lau R, De Paoli A, Davis PG. Nasal continuous positive airway pressure: does bubbling improve gas exchange? Arch Dis Child Fetal Neonatal Ed 2005;90:F343–F344.

10. AUTHORS

Primary	24/9/2013	Srinivas Bolisetty (Lead Clinician), Joanne Sheils (CNE), Eszter Jozsa (CNE)
Revised	17/4/2018	RHW NCC LOPS Committee

REVISION & APPROVAL HISTORY
Reviewed and approved Neonatal Services LOPs group April 2018
Approved Newborn Care Centre Quality Committee 24/9/2013