

VENTILATION: CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP)

See **Ventilation: high-flow nasal cannulae (HFNC)** guideline

DEFINITION

- Non-invasive respiratory support utilising continuous distending pressure during inspiration and expiration in spontaneously breathing babies

Benefits

- Improves oxygenation
- Reduces work of breathing
- Maintains lung volume
- Lowers upper airway resistance
- Conserves surfactant

INDICATIONS

- Early onset respiratory distress in preterm babies
- Respiratory support following extubation
- Respiratory support in preterm babies with evolving chronic lung disease
- Recurrent apnoea (in preterm babies)
- Atelectasis
- Tracheomalacia

CPAP following extubation

- Consider in babies <32 weeks' gestation

CONTRAINDICATIONS

- Any baby fulfilling the criteria for ventilation
- Irregular respirations
- Pneumothorax without chest drain
- Nasal trauma/deformity that might be exacerbated by use of nasal prongs
- Larger, more mature babies often do not tolerate application of CPAP devices well
- Congenital anomalies:
 - diaphragmatic hernia
 - choanal atresia
 - tracheo-oesophageal fistula
 - gastroschisis

TYPES OF CPAP (exact CPAP device will vary from unit to unit)

1. **Standard CPAP**
2. **Two-level CPAP**

1. STANDARD CPAP

Equipment

- Short binasal prongs and/or nasal mask
- Circuit
- Humidification
- CPAP generating device with gas mixing and pressure monitoring
- All require high gas flow (usual starting rate 8 L/min)

Fixing nasal CPAP device: short binasal prongs (preferred)

- To avoid loss of pressure, use largest prongs that fit nostrils comfortably

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- Ensure device is straight and not pressed hard against nasal septum or lateral walls of nostrils. Excessive pressure can cause tissue damage

Nasal mask

- Fit securely over nose
- consider alternating mask with prongs, particularly if baby developing excoriation or erosion of nasal septum. Masks can also result in trauma, usually at the junction between the nasal septum and philtrum
- Masks can give a poor seal and can obstruct

Procedure

Position baby

- Prone position is preferable
- Avoid excessive flexion, extension or rotation of the head

Set up equipment (see specific manufacturer instructions)

- Connect humidification to CPAP
- Connect CPAP circuit with prongs to CPAP device
- Place CPAP hat on baby
- Turn on CPAP flow and set pressure
- Attach CPAP circuit to CPAP hat and apply prongs/mask

Pressure range

- Start at 5–6 cm H₂O initially and increase by 1 cm H₂O increments
- Optimum pressure depends on illness type and severity – watch baby and use lowest pressure required to improve work of breathing

High pressures (≥ 10 cm H₂O) may restrict pulmonary blood flow, increase air leak risk and cause over-distension

CPAP 'failure'

- 'Failure of CPAP' implies a need for ventilation. Consider intubation and surfactant for preterm babies on CPAP as initial therapy if early chest X-ray demonstrates RDS and if any of the following apply:
 - FiO₂ >0.3 with CPAP pressure 6 cm H₂O
 - marked respiratory distress
 - persistent respiratory acidosis
 - recurrent significant apnoea
 - irregular breathing

Checks

- Before accepting apparent CPAP 'failure' exclude:
 - pneumothorax
 - insufficient pressure
 - insufficient circuit flow
 - inappropriate prong size or placement
 - airway obstruction from secretions
 - open mouth

Complications

- Erosion of nasal septum: reduce risk by careful prong placement and regular reassessment
- Gastric distension: benign, reduce by maintaining open nasogastric tube

Weaning CPAP

When

- Start when baby consistently requiring FiO₂ <0.3, pressure 5 cm H₂O and stable clinical condition

- If nasal tissue damage significant, consider earlier weaning

How: 'Pressure reduction' or 'Time off'

- **Pressure reduction**
 - more physiological approach although can increase the work of breathing if pressure is too low. Has been shown to be quicker than 'time off' mode
 - wean pressures in steps of 1 cm H₂O every 12–24 hr. If no deterioration discontinue CPAP after 24 hr of 4–5 cm H₂O and minimal oxygen requirement
- **Time off CPAP**
 - plan using 2 × 12 or 3 × 8 hr time periods
 - The following regimen of cycling CPAP can be adapted to individual situations

Day 1	1 hr off twice a day (1 off, 11 on)
Day 2	2 hr off twice a day (2 off, 10 on)
Day 3	3 hr off twice a day (3 off, 9 on)
Day 4	4 hr off twice a day (4 off, 8 on)
Day 5	6 hr off twice a day (6 off, 6 on)
Day 6	Off CPAP

Note: High-flow humidified oxygen therapy

- Increasingly used as non-invasive respiratory support
- Offers theoretical advantages over CPAP in ventilating upper airway spaces and producing less nasal tissue damage
- When weaning CPAP, consider using 5–6 L/min of high-flow humidified oxygen (e.g. VapoTherm® or Optiflow™) rather than low-flow nasal cannulae oxygen or lower pressure CPAP

Failure of weaning

- Increased oxygen requirement, increasing frequency of apnoeas associated with bradycardias and cyanosis, increasing respiratory distress and/or worsening respiratory acidosis during weaning should necessitate a review and consider escalation of support

2. BiPAP (TWO-LEVEL CPAP)

- Two-level CPAP at a rate set by clinician (biphasic) or triggered by baby using an abdominal sensor (biphasic trigger or Infant Flow® SiPAP)
- Inspiratory time, pressures and apnoea alarm limit set by clinician
- Indications/contraindications as CPAP and can be used when baby's clinical condition is not improving despite CPAP

Theoretical advantages over CPAP

- Improved thoraco-abdominal synchrony
- Better chest wall stabilisation
- Reduced upper airway resistance
- Reduced work of breathing

Specific modes of two-level CPAP (specific names vary with manufacturer)

CPAP and apnoea

- CPAP with added advantage of apnoea monitoring via sensor attached to abdomen
- Apnoea alarm triggered when no breaths detected within set time-out period

Biphasic

- Bi-level pressure respiratory support with/without apnoea monitoring
- Higher level pressure above baseline CPAP delivered intermittently at pressure, rate and inspiratory time set by clinician
- Not synchronised with respiratory effort

Biphasic trigger (tr)

- Bi-level pressure respiratory support with inbuilt apnoea monitoring

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- Higher level pressure above baseline CPAP at rate determined by, and in synchrony with, baby's respiratory effort sensed through abdominal sensor
- Pressure, inspiratory time and back-up rate set by clinician

Clinical use

Biphasic

- Begin with CPAP pressure of 5–6 cm H₂O
- Set peak inspiratory pressure (PIP) at 3–4 cm H₂O above CPAP and rate 30 breaths/min
- Keep T_{insp} and apnoea alarm delay at default setting
- If CO₂ retention occurs, review baby and consider increase in rate and/or PIP
- Avoid over-distension and keep PIP to minimum for optimum chest expansion

Weaning

- By rate and pressure
- If rate >30 breaths/min, wean to 30 breaths/min
- Reduce MAP, by reducing PIP by 1 cm H₂O every 12–24 hr
- When baby breathing above 30 breaths/min change to biphasic tr mode
- When MAP 5–6 cm H₂O, change to CPAP

Biphasic tr

- Begin with CPAP pressure of 5–6 cm H₂O with PIP at 3–4 cm H₂O above CPAP
- Keep T_{insp} and apnoea alarm delay at default setting
- Set back-up rate at 30 bpm

Weaning

- Reduce MAP by reducing PIP by 1 cm H₂O every 12–24 hr
- Once MAP 5–6 cm H₂O, change to standard CPAP
- If deterioration occurs during weaning process, assess baby and consider returning to biphasic mode