Neonatal respiratory distress and CPAP

Workshop Presentation

45 minutes

Towards CPD Hours

References:

Queensland Clinical Guideline: Respiratory distress and CPAP is the primary reference for this package.

Recommended citation:

Queensland Clinical Guidelines. Respiratory distress and CPAP workshop presentation O20.3-4-V1-R25. Queensland Health. 2020.

Disclaimer:

This presentation is an implementation tool and should be used in conjunction with the published guideline. This information does not supersede or replace the guideline. Consult the guideline for further information and references.

Feedback and contact details:

M: GPO Box 48 Brisbane QLD 4001 | **E:** guidelines@health.qld.gov.au | **URL:** www.health.qld.gov.au/qcg

Funding:

Queensland Clinical Guidelines is supported by the Queensland Health, Healthcare Improvement Unit.

Copyright:

Learning Objectives

- Identify babies at risk for respiratory distress
- Identify babies with respiratory distress at birth
  - Diagnosis and management
- Consider the management and care of a baby requiring continuous positive airway pressure (CPAP)
- Identify complications of CPAP

Abbreviations

>	Greater than	**NEC**	Necrotising enterocolitis
<	Less than	**NPT**	Nasopharyngeal tube
≤	Less than or equal to	**OGT**	Orogastric tube
CPAP	Continuous positive airways pressure	**ORS**	Operating room suite
ETT	Endotracheal tube	**pCO_2**	Partial pressure of carbon dioxide
F_iO_2	Fractional inspired oxygen	**PEEP**	Positive end expiratory pressure
IV	Intravenous	**PPHN**	Persistent pulmonary hypertension of the newborn
MAP	Mean airway pressure	**RDS**	Respiratory distress syndrome
ORS	Operating room suite	**TTN**	Transient tachypnoea of the newborn

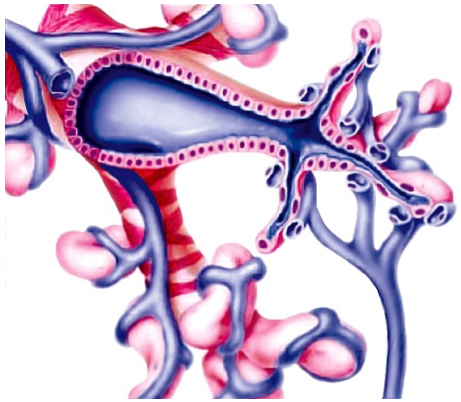
Lung development and physiology

- Bronchioles and alveolar ducts develop from 16–25 weeks gestation—potentially viable lungs
- Surfactant is produced after 20 weeks gestation
- Chest wall compliance and decreased lung function increase risk of respiratory distress with decreased gestation

Pulmonary surfactant

- Reduces alveolar surface tension
- Facilitates alveolar expansion
- Reduces risk of atelectasis from alveolar collapse

Surfactant present during normal expiration



Surfactant absent resulting in abnormal respiration

Surfactant deficiency

- Excessive negative intrathoracic pressure and poorly compliant lungs

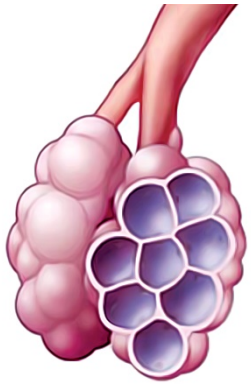
  → *Chest recession*
- High surface tension

  → *Lungs–low volume and decreased compliance*
- Lung inflammation and epithelial injury

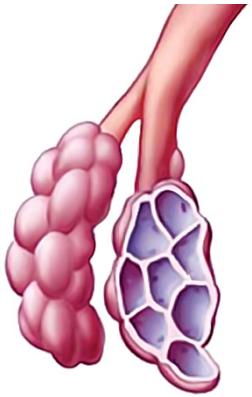
  → *Pulmonary oedema and increased airway resistance*

Surfactant deficiency

- Primary cause of respiratory distress syndrome (RDS)
- Requires increased pressure to open the alveoli
- Alveolar instability at low lung volumes leads to collapse and diffuse atelectasis



Normal alveoli



Underinflated alveoli

Hypoxaemia

Caused by:

- Ventilation-perfusion mismatch
- Extra-pulmonary shunting

Poor ventilation identified from:

- Elevated pCO_2 (respiratory acidosis)
- Lactic acid production from hypoxaemia and poor perfusion (metabolic acidosis)

Ventilation-perfusion mismatch

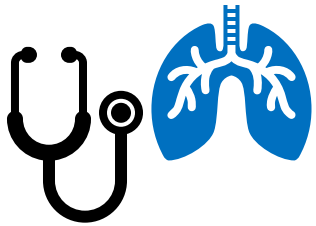
- Atelectasis–portions of lung collapse
- Intra- and extrapulmonary shunts
- Abnormal fluid absorption from inefficient clearing in damaged lung– pulmonary oedema impedes gas exchange

Causes of respiratory distress

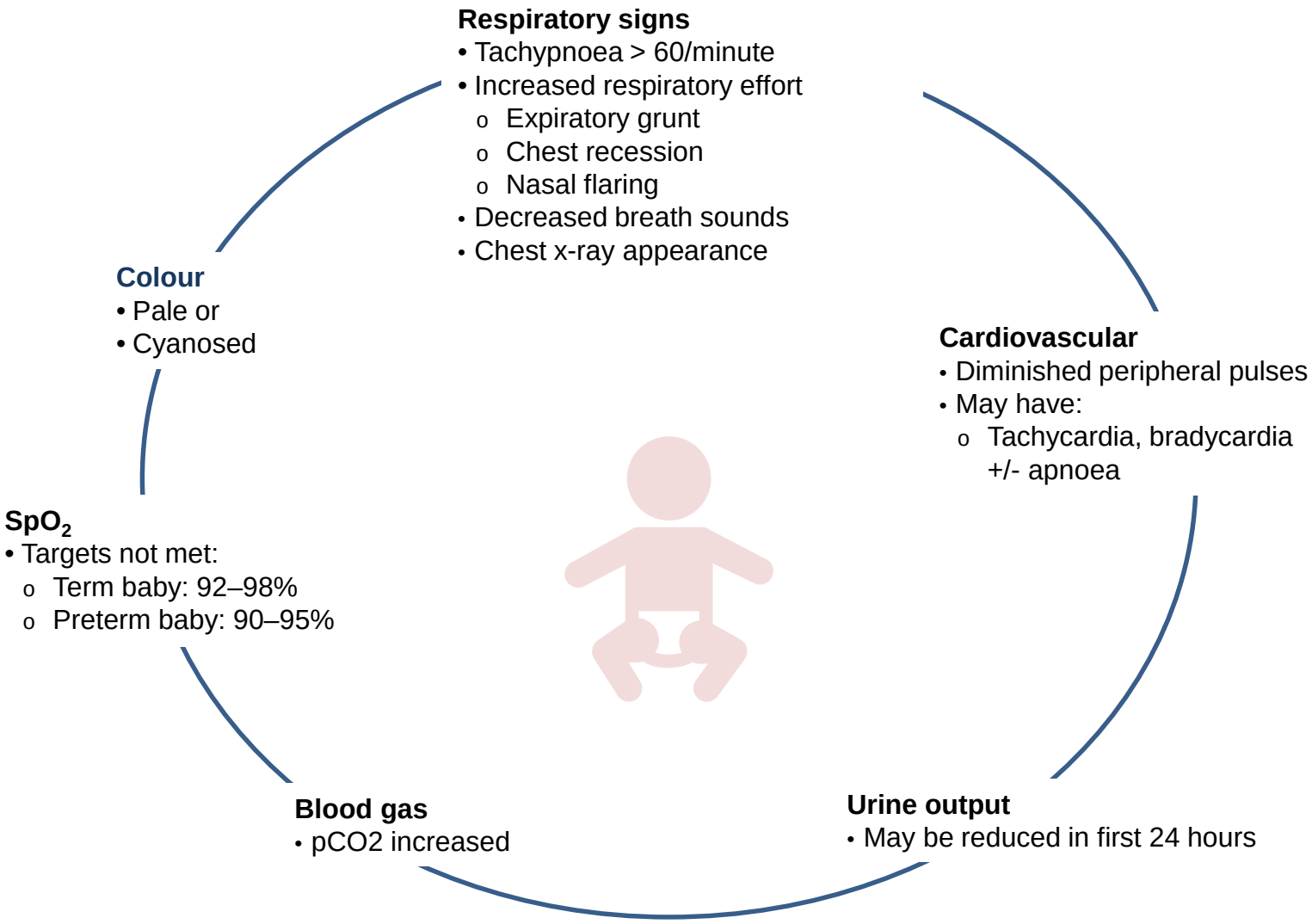
- RDS
- Transient tachypnoea of the newborn (TTN)
- Infection
- Persistent pulmonary hypertension of the newborn (PPHN)
- Pulmonary air leak
- Aspiration
  - Meconium, liquor, water, milk
- Congenital anomalies
- Interstitial lung disease

Signs of respiratory distress

- Tachypnoea > 60 breaths per minute
- Increased work of breathing
  - Expiratory grunt
  - Recession–sternal, lower costal, intercostal
  - Nasal flaring
- Cyanosis



Respiratory distress syndrome

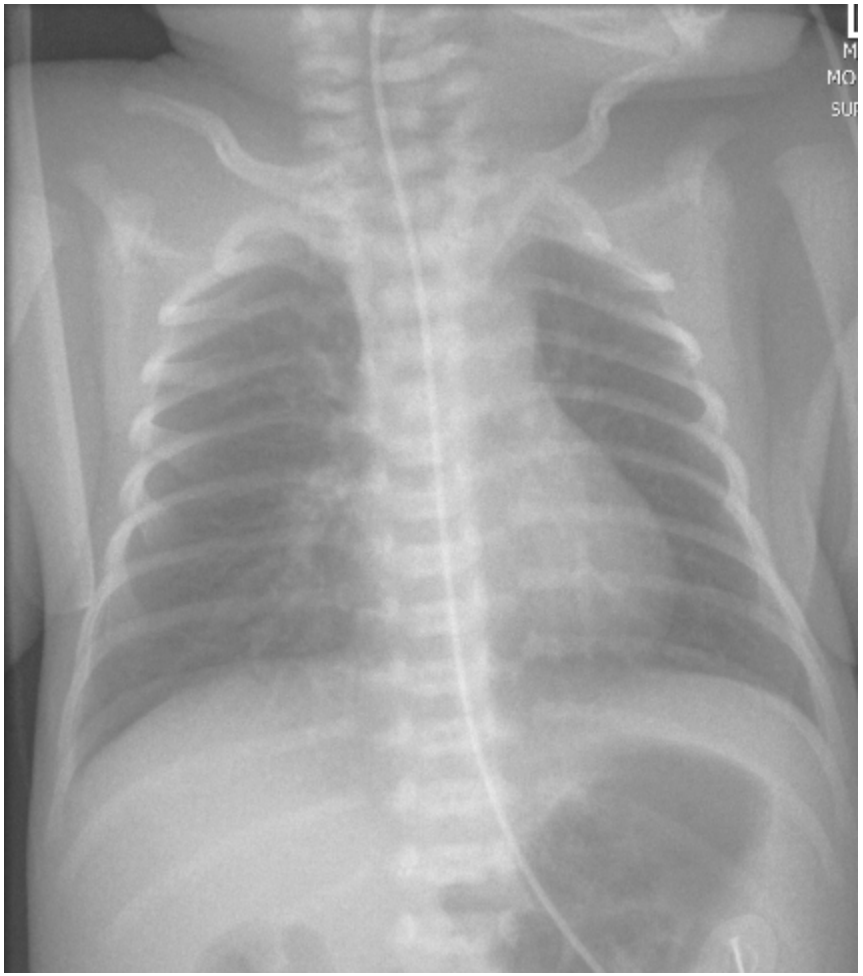


Babies at risk of RDS

- Preterm birth
- Maternal diabetes in pregnancy (poorly controlled)
- Elective caesarean section

Normal chest x-ray

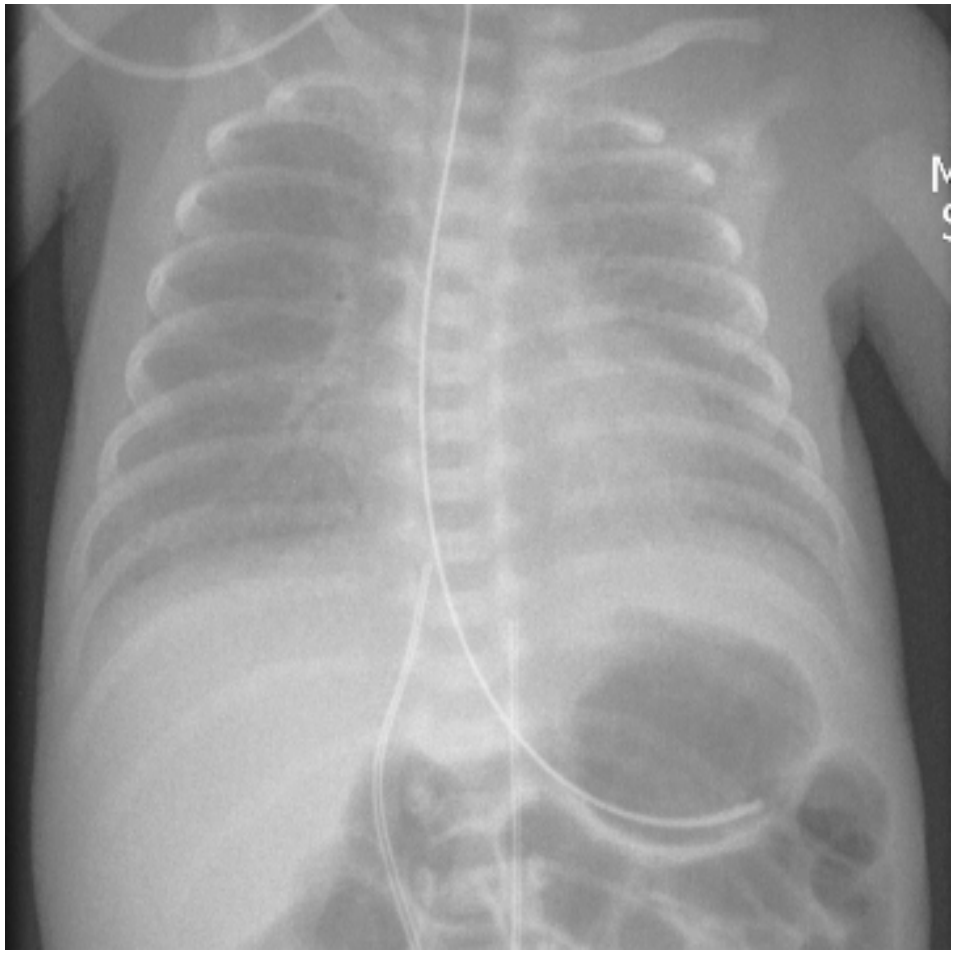
- Symmetrically aerated lung fields
- Diaphragm at 6th ribs anteriorly and 8th rib posteriorly



Abnormal chest x-ray

RDS

- Low lung volume
- Diffuse reticulogranular ‘ground glass’
- Air bronchograms
- Confluent alveolar shadowing



Abnormal chest x-ray

TTN

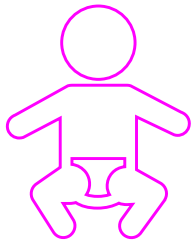
- Normal or slightly over-inflated lung fields
- Increased streaky shadowing and perihilar densities
- Fluid in horizontal fissure

Meconium aspiration syndrome

- Asymmetrical opacification
- Streaky linear densities
- Hyperinflation of lungs
- Flattening of diaphragm

Management and supportive care

- Oxygenation
- Fluids–IV glucose
- Thermoregulation
- Developmental care
- Infection screening
- Antibiotics
- Monitoring
- Blood glucose



CPAP

- Maintains expansion of alveoli by providing a constant pressure to the lungs
- Prevents atelectasis
- Allows gas exchange

Benefits of CPAP

- Improves lung compliance
- Stabilises the compliant chest wall
- Improves thoraco-abdominal synchrony
- Reduces work of breathing
- Reduces apnoea:
  - Obstructive–by upper airway splinting
  - Central–due to regular breathing pattern
- Reduces oxygen requirements
- Reduces risk of bronchopulmonary dysplasia (BPD)

Indications for CPAP

- To correct respiratory failure
  - Signs of respiratory distress
  - Oxygen requirement ≥ 30% *or*
  - < 30% and other significant signs of respiratory distress
- To treat airway obstruction
- To prevent respiratory failure
  - Apnoea of prematurity

Contraindications to CPAP

- Bi-lateral choanal atresia
- Tracheo-oesophageal atresia
- Congenital diaphragmatic hernia
- Gastroschisis or omphalocele
- Necrotising enterocolitis
- Cleft palate

Commencing CPAP

- Pressure: start at 7–8 cmH_2O

- Flow: 6–8 L per minute
- FiO_2: to maintain oxygen saturations
- Humidification temperature:
  - 37 ºC at baby interface and
  - 40 ºC at humidifier

Nursing management

- Know all the equipment
  - How it works, advantages, disadvantages, complications
- Know how to troubleshoot problems
  - CPAP generator, interface and the baby
- Know how to measure baby for correct size interface, prongs and/or mask

CPAP components

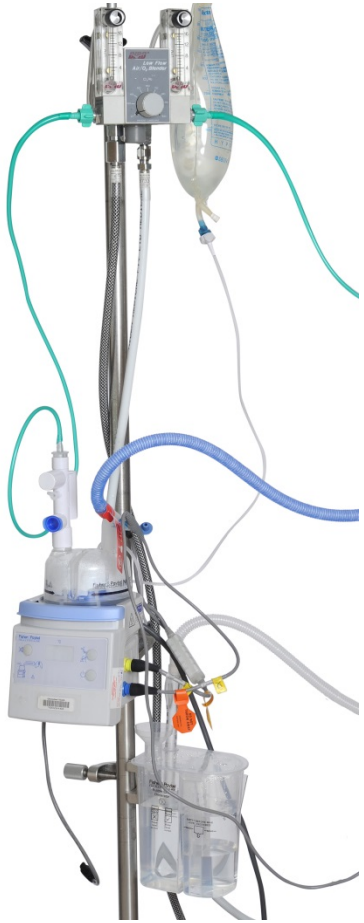
Component	Comment
Gas source	Oxygen and air
CPAP generator	Creates pressure in the circuit • Bubble • T-piece resuscitator e.g. NeoPuff™ • Ventilator
Patient interface	
Binasal prongs	Midline, e.g. • Fisher and Paykel Healthcare FlexiTrunk® (snorkel) • TeleFlex Hudson prongs®
Face mask	Select populations
Long NPT	Single prong–flexible, ivory (e.g. Portex™)
ETT	Not recommended due to poor outcomes

CPAP delivery systems

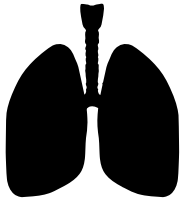
T-piece device

Ventilator

Infant flow driver



Bubble CPAP



Ventilator

- Ventilator PEEP valve controls CPAP delivery
- CPAP pressure is flow dependent (6–8 L/minute)
- CPAP (PEEP) is manually set
- Audible alarm if pressure falls too low below the set CPAP pressure
- Gas flow is via a humidification system

T-Piece device

- Used for short-term delivery of CPAP:
  - Often used for transfer from birth suite/ORS to nursery
  - Waiting for retrieval
- Provides a constant pressure provided seal is maintained
- If gases are **not humidified** not for long term use
  - May have humidification system added

Infant flow driver

- Variable flow
- Pressure is affected by flow
- Gas is delivered in response to the baby's respiratory effort

Infant flow driver

Bubble CPAP

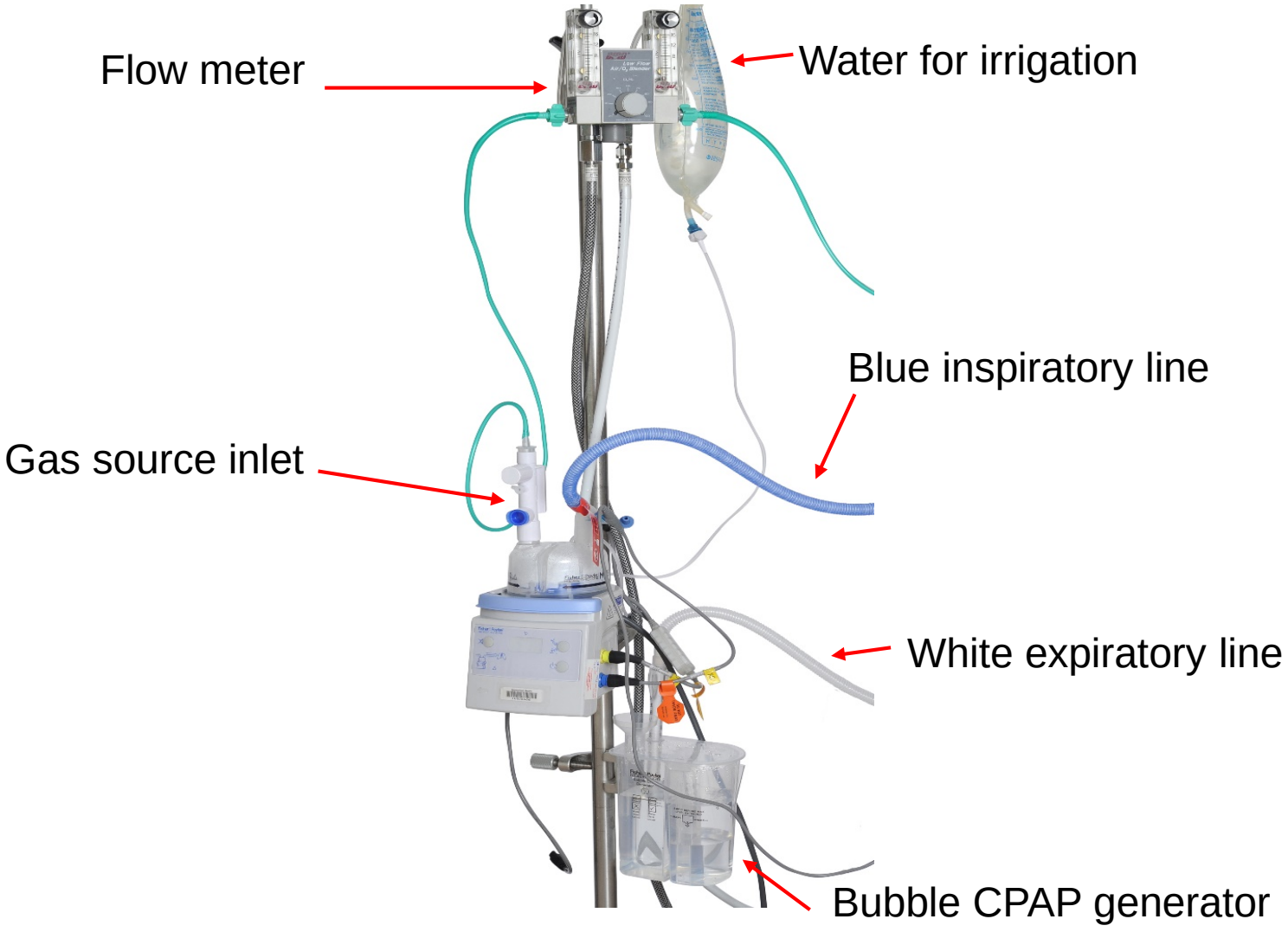
- Pressure generated in the circuit by placing the distal limb of circuit under water
- When water is bubbling CPAP is being delivered
- Pressure set by depth of expiratory tubing–

  6 cm depth = 6 cm water pressure
- Need oxygen/air blender, flow meters and a humidifier
- Fill chamber with water to measured level
- Less cumbersome and cheaper than ventilator CPAP

Bubble CPAP

- Requires vigilant nursing observation
- Continuous bubbling needed to provide CPAP
- No audible alarms to indicate loss of pressure
  - **No bubble means no CPAP**
  - If the water is swinging, CPAP not at desired level
  - May still bubble even if the prongs are out of the nares, (e.g. prongs are on forehead)

Bubble CPAP setup

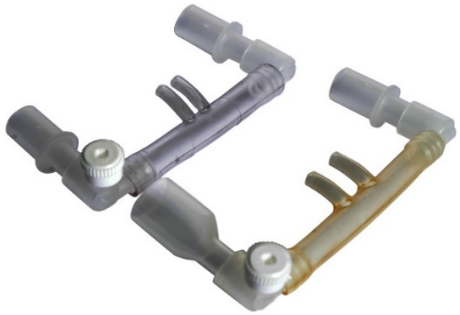


Patent interfaces

Midline interface

Binasal prongs

Nasal masks



Hudson® prongs

Patient interfaces (cont'd)

Regardless of the interface used, if bi-nasal CPAP:

- Ensure correctly sized prongs–
  - Fit snugly filling the entire nare
  - No blanching, redness or pressure areas
  - More likely to achieve prescribed CPAP pressure
  - If history of pressure injury, nasal mask may be alternated
  - Pressure commonly observed to nasal bridge–vigilant monitoring required

Patient interfaces (cont'd)

- **If too small**:
  - Will not create the seal necessary to generate the prescribed CPAP
  - Movement from ill-fitting prongs may cause skin/mucosal injury and an increase in airway resistance
- **If too large:**
  - Damage to the surrounding tissue can lead to blanching, erosion and necrosis
  - Can lead to nasal dilatation

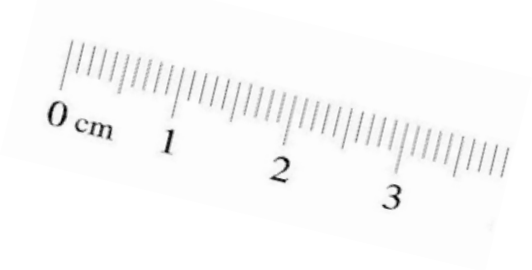
Measurements–prongs

Fisher and Paykel Healthcare FlexiTrunk ®

- Head circumference determines hat size
- Weight determines size/set of midline tubing
- Size of the nare and nasal septal width determine the prong size (use supplied ruler to measure)

TeleFlex Hudson® prongs

- Weight determines size/set of prongs
- Other hats may be used
- Velcro is used to attach the prongs to the ventilator circuit



Measurements–nasal mask

- Head circumference determines hat size
- Weight determines size/set of midline FlexiTrunk® tubing
- Size of the nose determines the mask size–small, medium or large (use supplied ruler to measure)

Vigilant monitoring required as pressure commonly observed to nasal bridge

Hats or wraps

Canberra hat

Fisher and Paykel® hat

Hudson® cap

Nasopharyngeal tube (NPT)

- Use if congenital malformations where bi-nasal devices cannot create a seal, e.g. cleft lip or palate, choanal atresia
- May achieve better airway patency in babies with Pierre-Robin sequence or Treacher Collins syndrome
- May be considered post-operatively following VP shunt insertion

Ivory Portex® tube

Humidification

- Humidity is:
  - Water vapour in a gas
  - Expressed in terms of:
    - Absolute humidity
    - Relative humidity
    - Dewpoint
  - Fundamental for preventing complications
    - Airway obstruction
    - Pneumothorax
    - Trauma to respiratory epithelium

Humidification (cont'd)

- What should the chamber temperature be?
- What should the temperature be at the patient interface?
- Why is there a difference?
- What is the ideal temperature and saturation of the respiratory gases by the time they reach the lungs?

Condensation

Remember to empty rain-out before re-positioning baby

- Condensation or rain-out occurs as gases cool
- Largely a problem when circuitry is exposed to cooler cot temperatures or open cots
- Can build up at the patient interface and risk baby's airway

CPAP complications

- Pulmonary air leaks
- Pain and discomfort
- Abdominal insufflation/distension
- Hyperinflation of the lungs
- Pressure injury
- CPAP failure

Pain and discomfort

- May be caused by the firm fitting nature of the prongs or hat
- May be related to other CPAP complications
- Assess infant cues with a validated pain too
- Consider non-pharmacological pain relief
  - Non-nutritive sucking
  - Sucrose (follow local protocols)
  - Reduce environmental stimuli
  - Positioning and containment

Abdominal insufflation

- Monitor degree of gastric distention
- Vent orogastric tube between feeds
- May need to use a size 8 FG OGT
- May need to aspirate OGT for air regularly
- Consider decreasing the flow
- “CPAP belly” usually benign, however important to exclude other causes (e.g. NEC)

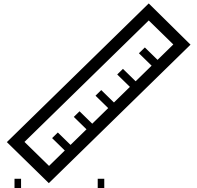
Pressure area care

- Requires vigilant nursing care
- Regular skin assessment and skin resting time–erythema first sign of pressure injury
- Risk factors
  - Nasal CPAP
  - Length of therapy
  - Age and size of baby
  - Environmental temperature and humidity

Pressure injury prevention– prongs

- Correctly fit prongs to avoid pressure on high risk areas, and prevent excess rubbing and movement
- Position binasal prongs ≤ 2 mm from nares
- Avoid septal columella contact
- Minimise propping of the cot
- Position circuit in opposite direction to the way the baby is facing
- Position baby for comfort and containment

Pressure injury prevention– masks



- Measure and size the interface for each baby
- Cover entire nose
- Do not fit mask tightly
- Avoid indentations and pressure on nasal bridge
- Avoid tight fitting hat

Good positioning of prongs and midline interface

Positioning for Hudson® prongs

What is good about this baby's positioning?

What could be improved with this baby's positioning?

Positioning for the midline interface

What is good about this baby's positioning?

What could be improved with this baby's positioning?

Positioning

Position:
- **Prone or quarter prone**
- **Avoid propping bed > 30°**

Use chin strap/pacifier to keep baby's mouth closed

Avoid:
- **Tension to interface**
- **Accumulation of condensate at nares**

Canberra wrap™

Hat too high

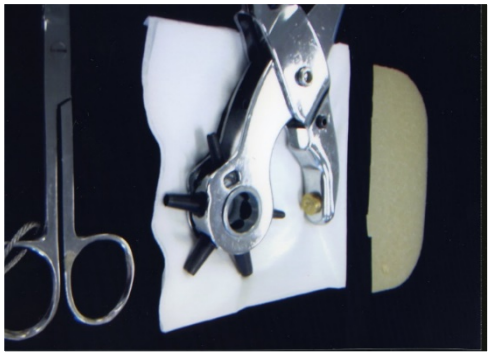
Hat well positioned

Positioning aids

If using Hudson® prongs, positioning aids such as a pillow reduce pressure resting on the circuit

Nasal seals

- Can help to reduce loss of mean airway pressure if other troubleshooting methods have been unsuccessful
- If using remember to change when moist
- Always remove for trials off CPAP



- Consider first if prongs need to be upsized
- If pressure is not achieved when mouth is closed use a chin strap

Maintaining airway pressure

- Check MAP achieved/constant bubbling
- Maintain prongs in the nares
- Use the correct size prongs–snug fit
- Minimise oral air leak–positioning, dummy, chin strap
- Use a nasal seal to improve pressure delivery
- Re-measure baby for prongs, hat and interface weekly (upsize if necessary)

Troubleshooting pressure loss

- If bubbling stops or MAP decreases, check:
  - Integrity of the circuit
  - Prongs are in the nares and a snug fit
  - Hat is positioned correctly and the midline devise is correctly aligned
  - Correct size manifold between nares and tubing (too small and it will drag)
  - If the mouth is closed, apply a chin strap

Care of baby on CPAP

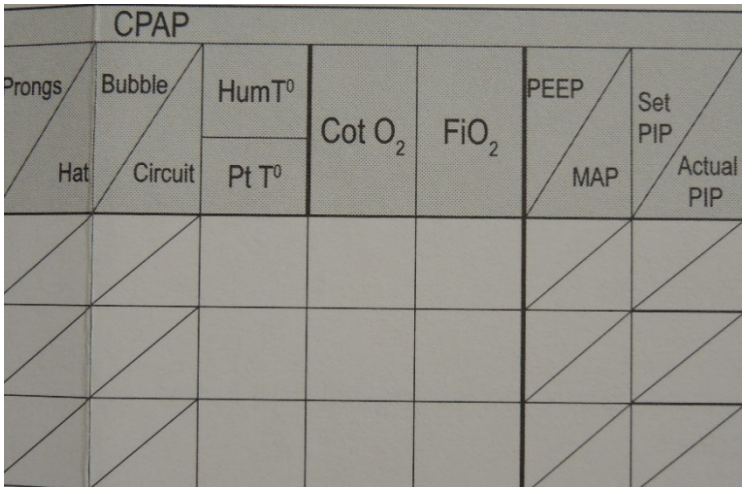
- Observe baby in incubator (nappy only)
- Supportive care
- Oxygen to incubator during cares
  - If fragile baby, two people to perform cares
  - Cares and re-position 4–6 hourly
  - Only disturb baby when necessary
- Thermoregulation
- Pain management
- Encourage family involvement

Care of baby on CPAP

- Assessment and monitoring
  - Work of breathing
  - Vital signs
  - Oxygen saturations (preductal)
  - Blood glucose levels
  - Blood gas as clinically indicated
  - Visual checks of the CPAP system–baby, hat, prongs, nares, circuit
  - Monitor the baby's general condition–colour, tone, response to handling, signs of complications

Care of baby on CPAP

- Suctioning
  - Keep airways clear
  - Avoid deep suctioning
  - Typically oral secretions increased rather than nasal
- Circuit
  - Avoid traction
  - Remove condensation
- Record CPAP settings
  - Pressure, gas flow, FiO_2 and humidifier temperature



Skin care

- Assess for:
  - Nasal–redness, skin breakdown, bruising, indentation, bleeding, altered shape
  - Ears–creases, folds, pressure areas
  - Forehead–pressure areas (if midline device)
  - Nasal bridge–midfacial indentation
  - Head–pressure areas

Feeding

- Commence when respiratory status stable as per unit protocol
- Small trophic feeds may reduce the duration of both respiratory distress and hospital admission
- OGT on free drainage; aspirate if vomiting or gastric distension
- IV fluids or parenteral nutrition as prescribed
- Non-nutritive sucking

Developmental care

- Aim to avoid skin breakdown and plagiocephaly
- Release bonnet for few minutes with cares
- Developmental positioning
- Cycled lighting
- Reduce environmental stimuli
- Family bonding time

Kangaroo Care

Communication and family

- Meet before birth
- Take on nursery tour
- Demonstrate and explain CPAP on Manikin
- Discuss:
  - Photo albums
  - How to help settle their baby
  - How to do cares for their baby
  - When they can hold their baby

Weaning CPAP

- Reduce FiO_2 before pressure
- Commence when:
  - $FiO_2 < 0.25$
  - Respiratory rate < 60 breaths/minute
  - Chest recession absent
  - Apnoeas < 20 seconds and self-reverting
  - Bradycardias not < 100 beats/minute
  - Average SpO_2 > 95% for previous 6 hours
- Cease if stable in air and CPAP 5 cmH_2O

Key Points

- Know the equipment
- Ensure a good fit of interface
- Monitor vigilantly to avoid complications
- Troubleshoot loss of pressure before turning up flow
- Utilise good developmental care practices
- Support the family