

Navigating Clinical Challenges when Managing Infants with Bubble CPAP

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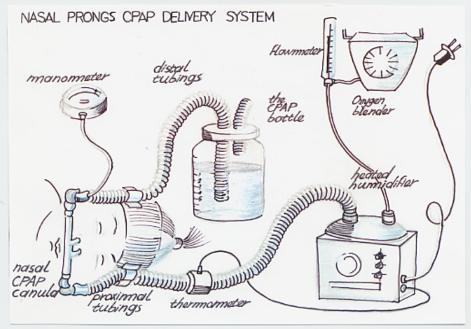


Disclosures

Off-Label Usage: None

Interests: None

- Healthy for the driver→ Less BPD ...
- More affordable
 - → Reduced cost of care
- Better for the environment
 - → Non-invasive culture





- Difficult in the beginning
- Needs a lot of training
- Careful attention to the details at all times

Learning Objectives

Choice of your respiratory intervention:

- When you should and should not use bCPAP?
- If bCPAP is not helping?
 - How to "maximize" bCPAP?
 - When to consider other modes of noninvasive ventilation and what to use?
 - How to incorporate iNO with bCPAP
 - When to intubate your baby

Managing infants on bCPAP:

- How to monitor success with bCPAP?
- Feeding while on bCPAP
- Managing significant PDA with bCPAP
- How to "wean" off bCPAP?



Case (1): Common Encounter

You are called to assess this preterm male infant with signs of respiratory distress and frequent desaturations at one hour of life



Assessment

Baby boy is a 36 1/7 wk, 2310g, non-significant perinatal history, presented at birth with respiratory distress and was given X2 rounds of face mask CPAP in DR, improved and was transferred to nursery for observation

Baby now is in moderate distress with RR in the 80s and SaO₂ fluctuating 84-91%



The late preterm infant with respiratory distress

Common encounter

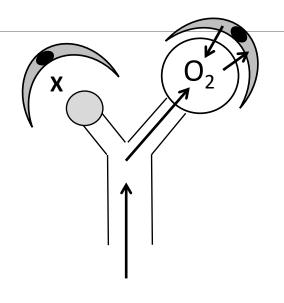
o difficult transition (TTN) vs. presumed sepsis

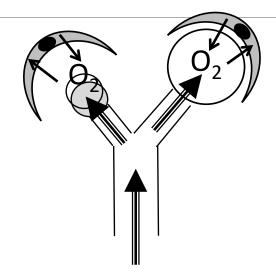
Potential for underestimating condition

- commonly managed with NC or Oxy-hood
- usually, babies treat themselves with spontaneous grunting...

Nasal Cannula

CPAP

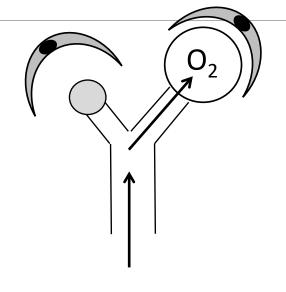




SaO_2	improved
V/Q	mismatch

SaO ₂	improved
V/Q	well-match

Nasal Cannula



SaO₂ improved
V/Q mismatch

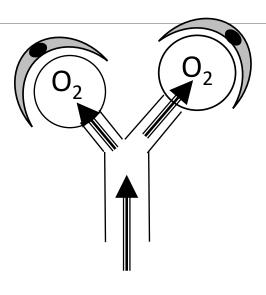
If no spontaneous recruitment of collapsed alveoli

- → continued hypoxemia
- → reactive pulmonary vascular constriction
- \rightarrow PPHN
- \rightarrow ECMO

Early use of bCPAP:

- → proper recruitment of collapsed alveoli
- → improved V/Q mismatch
- → improved oxygenation
- → early wean off bCPAP
- → shorter length of stay
- → avoid PPHN/ECMO

CPAP



SaO ₂	improved
V/Q	match

If the infant does not improve!

Monitor for signs of PPHN:

- 1) excessive increase in FiO₂ requirement with no significant parenchymal lung disease on chest x-ray.
- 2) history suggestive for inefficient management with O₂ flow and prolonged borderline oxygen saturation



Can bCPAP help in these cases?

- Inhaled Nitric Oxide (iNO) could be incorporated into the bCPAP circuits.
- Without the need for intubation or mechanical ventilation especially if PCO₂ is within normal.





Case (2): Good Candidate

28 week (GA) > 750 gm

You are in the DR resuscitating a 28 3/7 week female infant 823g with face mask CPAP

- she has moderate respiratory effort,
- HR is 140
- good color and (+1) tone...

What is your next step?...

Keys for success: bCPAP Initiation

CPAP is applied from the very beginning:

- in DR via face mask continuous flow (NeoPuff or Carden valve free flow)
- bCPAP set-up shall be always ready in NICU
- infants are to be transferred to NICU on face mask CPAP and immediately get started on bCPAP

Keys for success: bCPAP Maintenance

"bCPAP is a respiratory support system that maintains steady low positive pressure in the newborn's airway during spontaneous breathing"

→ meticulous attention to the patency and continuity of this system is essential!

Keys for success: bCPAP Maintenance

- Nurse should examine bCPAP and review bedside check list every care
- Prongs size need to be upgraded with gradual dilation of the nasal apertures and infant's growth
- Nasal septum needs to be frequently examined to avoid erosions
- Proper suctioning every 2-3h especially in 1st 3 days

Keys for success: <u>Feeding</u> on bCPAP

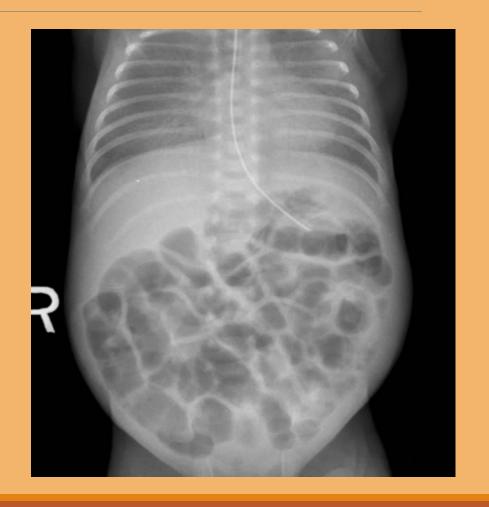
- Feeding should start as early as possible
- Feeding is advanced gradually but steadily (10-20 ml/kg/day)
 - →After successful trophic feeding phase
- Bolus gastric feeding is the preferred method

Keys for success: <u>Feeding</u> on bCPAP

- <u>Continuous transpyloric</u> feeding may be indicated in ELBW infants or severe GERD
 - → after assuring infant's tolerance to bolus feeding
- Raise head side of the bed may help moving diaphragm against full stomach

Abdominal Distention

Bowel distention in infants on bCPAP is usually benign



Keys for success: weaning off bCPAP

"Infants should continue on bCPAP as long as they need respiratory support"

- Weaning should be considered when
 - they have been on +5/21% for 2-3 days
 - weight is => 1200g and age is => 32 weeks
- Weaning starts by once-a-day trial
 - Infant should be put back on bCPAP if apneas, bradycardias, desaturations or severe tachypnea develop.
- Off bCPAP time should increase daily until infant is completely off

Keys for success: weaning off bCPAP

"Do not trade Pressure for Oxygen"

- → CPAP is an active therapy, it enhances lung growth
- → Oxygen induces inflammation, it hurts the lung
- If there is any doubt of respiratory compromise during weaning, do not wean, put back on bCPAP
- It is better to anticipate and prevent lung collapse rather than manage a collapsed lungs.



Case (3): Relative Challenge



You are called to attend the delivery of a 25 2/7 week pregnant mother who:

- presents with premature contractions (intact membrane) since yesterday morning
- she is GBS negative and was started on antibiotics
- she completed her 2nd dose of betamethasone 6h ago

Resuscitation sequence:

- Membranes ruptured at time of delivery
- A female infant (BW 628g) was delivered vaginally
- She was apneic, limp, with HR <80
- Bag and mask ventilation was initiated for 2 min.
- Heart rate improved to ~120, color improved, and baby started to have weak crying.



This is the one that you may try bCPAP ...success factors:

- GA & BW
- prenatal steroids
- smooth DR course
- low risk for infection

Your 25 2/7 wk was stable on bCPAP +5/ 27% for a whole day, but at 17h of life her FiO₂ requirement started to gradually increase.

Assessment:

FiO2 is up to 38%
Moderate retractions
ABG: pH of 7.25,
PCO2 52, PO2 58 &
BD of -5

You decided to continue and check blood gas in 4h...

25 week on bCPAP > 50%O₂ → parameters of bCPAP failure

Assessment:

...Four hours later:

FiO2 47%

ABG: pH is 7.22, PCO2 64, PO2 40 & BD -7

What to do now?

Premature infants on bCPAP will need higher level of respiratory support (NIPPV/MV) if:

- $\underline{\text{FiO}_2 > 50\%}$ (relative to your experience)
- $\underline{PaCO_2} > 65 \text{ mm Hg}$
- Metabolic acidosis **BD < -10**
- marked retractions, frequent apneas, or bradycardias

25 wk on bCPAP > 50% O₂ → Is your 'circuit' working

Before considering bCPAP failure check nasal interface and respiratory circuits for leaks

- be sure nasal prongs are snugly fitting in nasal apertures
 - → consider larger prongs
- suction newborns nose to remove excessive secretions
- be sure newborn is positioned properly with head of bed higher than lower body (may try prone position)
- be sure respiratory tubes are properly attached to prongs properly
- if infant looks in no distress, check blood gas again
- Consider increasing PEEP to (+6 cm H2O)

25 wk on bCPAP > 50% O_2

→ do you have enough pressure

Assessment:

Now, at 36 h of life, baby is on:

FiO2 52%

pH is 7.20, PCO2 68, PO2 35 & BD -11 Bubble CPAP may fail as infants may not be able to generate enough tidal volume or minute ventilation to wash their $CO_2 \rightarrow Try NIPPV$:

- \rightarrow PIP 18/ PEEP 5 /IMV 40 /Ti =0.4 /FiO₂ (as needed to keep saturation (90-95%)
- → monitor blood gases closely (hypo or hyperventilation)
- → monitor abdominal girth and decompress stomach
- → switch back to bCPAP in few days

25 week on bCPAP for 2 weeks now is requiring more FiO₂

Your baby now is 14 d old, 728g

- She has been on bCPAP PEEP +6 /FiO₂ 23-28%.
- yesterday, she started to have more <u>apneia</u> and <u>desaturations</u> episodes than her baseline
- her CBG reflects mixed respiratory and metabolic acidosis and high CO₂
- -How should you proceed?

25 week on bCPAP for 2 weeks now is requiring more FiO₂

This clinical picture of does not resemble the initial bCPAP failure associated with severely premature lung presenting early in life.

you need to examine for other causes

- airway obstruction (blood in the nose)
- GERD: higher volumes of enteral feeding (>1 week)
- severe anemia reaching critical threshold (Hct <35%)
- sepsis/pneumonitis/NEC

25 week on bCPAP for 2 weeks now is requiring more FiO₂

Another form of decompensation

Over the last few days she started to have increasing FiO₂ requirements and now she is on +6/38%. However, she has been tolerating her feeds with no observed increase in her bradycardia or desaturation events

Assessment:

Tachycardia ~160 bpm III/VI ejection systolic murmur with pounding pericardial pulses. B/P 48/24 (32)

pH is 7.28, PCO2 61, PO2 35 & BD -3

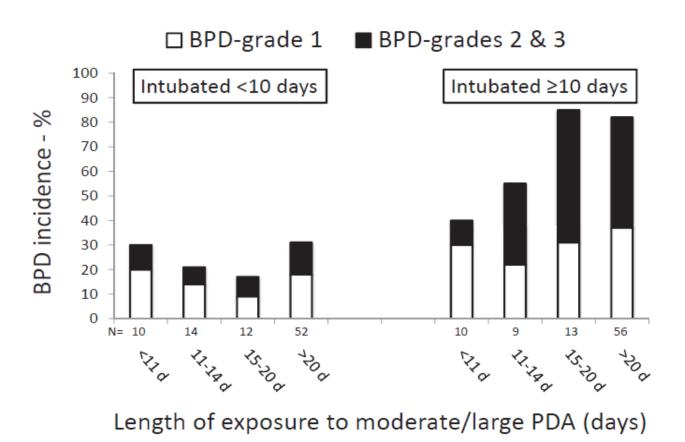


Figure 2. Relationship between PDA exposure and the outcomes BPD of any grade and BPD grades 2 and 3 among infants intubated for <10 days or ≥10 days. The height of the bars represents the incidence of BPD of any grade. The clear portion of the bar represents the incidence of BPD grade 1. The solid portion of the bar represents the incidence of BPD grade 2-3. Infants exposed to a moderate to large PDA for ≥11 days were arbitrarily divided into 3 exposure subgroups (11-14 days, 15-20 days, and >20 days) to illustrate how incremental increases in exposure (beyond 10 days) affects the association between BPD and the presence of a persistent PDA.



Case (4): Mastery is required

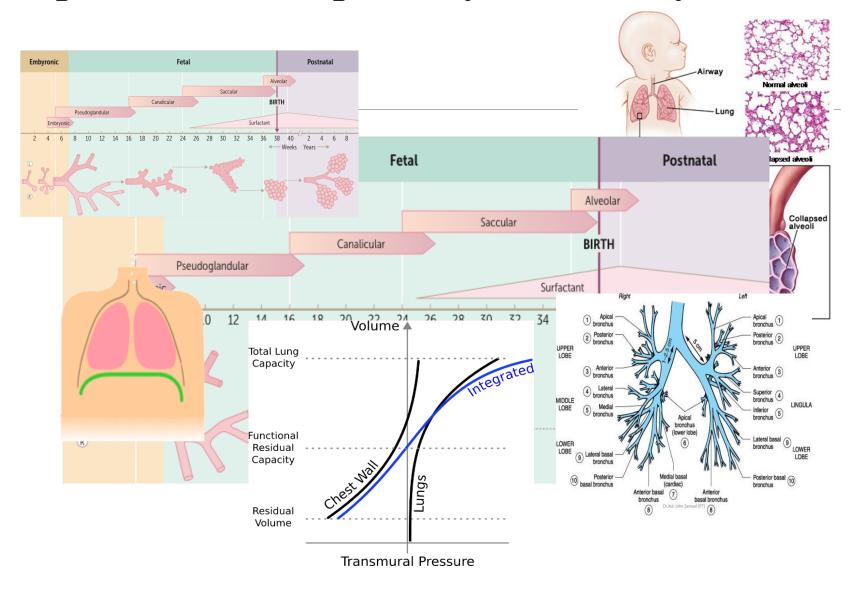
23 weeks < 500g

You are counseling a 23 4/7 week pregnant women who was admitted this morning with PROM

- oduring fetal U/S this morning the EFW was about 470g
- mom has strong contraction every 3-5 minutes.

How would you plan to manage this newborn infant if delivered today?

Spectrum of Respiratory Distress Syndrome



What to do then

If it is not surfactant deficiency
If it is complex interaction of elements all relate
to less developed lung

-Let it grow

 Use least possible invasive intervention to support bare minimum of the oxygenating and ventilatory need to reduce inflammatory insult on the developing lung while optimizing lung and overall growth

Initial trial of CPAP in 23 wk <500g

If you are a bCPAP starter: "<u>Do Not</u>" consider CPAP in the "*Initial*" management of *this infant*

- severe lung immaturity
 - respiratory bronchioles phase of lung developmental
 - paucity of alveoli
 - narrow collapsible airways
- reduced muscle mass
- excessively compliant chest wall
- severe apnea of prematurity

Guidelines on how to start bCPAP program in your unit

Gestational age or birth weight	Duration	
=> 32 weeks/=>1500g	4-6 months	
=>28 weeks / > 1000g	4-6 months	
=> 26 weeks / => 750g	4-6 months	
=> 24 weeks / => 500g	6 months	
Any GA or BW	thereafter	

Surfactant Therapy

Infants who are likely to need mechanical ventilation should be intubated and given surfactant as early as possible

Infants who are not likely to need ventilation should not be exposed to the risk of intubation

Non-invasive surfactant instillation

INSURE technique, although invasive, is currently the common method of surfactant instillation in bCPAP oriented centers

LISA: (Less Invasive Surfactant Administration)

MIST: (Minimally Invasive Surfactant Therapy)

LMA: (Laryngeal Mask Airway)

Nebulized surfactant

23 week < 500g → Delivery Room Management

Your 23 4/7 wk infant was delivered few hours later

- in the DR, the male infant didn't breath and was limp and cyanotic
- after initial bag & mask ventilation, HR was 60 but continued to be apneic and cyanotic
- Baby was then intubated and bag ventilated
- -HR, tone and color improved

23 week < 500g

→ Chances for intubation in Delivery Room

	All infants <1500g n= 643	Group (1) 1000-1499g n= 333	Group (2) 750-999g n= 135	Group (3) 500-749g n= 136	Group (4) <500g n= 39
Gestational Age (mean <u>+</u> sd)	27.8 (+3.1)	29.8 (+2.3)	26.8 (+1.8)	24.7 (+1.8)	24.9 (+2.5)
Birth Weight (mean <u>+</u> sd)	997 (+321)	1267 (+146)	869 (+78)	622 (+73)	442 (+52)
Intubated at least once	41.4	18.4	48.1	81.2	80.6
Surfactant therapy	21.6	8.7	23.3	42.4	51.3

23 week < 500g → Initial NICU Management

The extremely immature newborn infant was transferred to NICU:

- was placed on mechanical ventilation with PIP 20/ PEEP 5/ IMV 40/ FiO₂ 60%
- central lines were placed, and surfactant was instilled

Infant gradually stabilized and vent settings were gradually weaned...

23 week <500g DOL#3: on low vent. settings)

Currently infants is on

- PIP 17 /PEEP 5 /IMV 25/FiO₂ 27% (NIV-NAVA)
- baby started to feed with BM @1ml q3 via TP tube

Is there a chance to consider bCPAP?

This infant is relatively ready for extubation

- you may extubate directly to bCPAP and if apnea develops you switch to NIPPV
- or you may extubate to NIPPV and if stable in 24-48h you wean to bCPAP

23 week <500g (DOL#12: bloody gastric aspirate)

Before starting your 'NEC' work up, check nasal septum



Nasal septum irritation or erosion with bleeding may be induced by the pressure or friction from the nasal prongs, consider other non-invasive intervention for 24-48 hours and prophylaxis is the key.

23 week <500g (DOL#12: bloody gastric aspirate)

Prevention is a key strategy:

- use the correct size prongs
- secure prongs with fitted hat and correctly position the corrugated tubes
- do not allow the bridge of prongs to touch the nasal septum
- avoid twisting prongs. This can cause lateral pressure against the septum



Case (5): Unexplained Failure

This is a 31 wk female, BW 1280g SGA who has been on bCPAP +5/21% for 14h.

→Now she is distressed with intercostal and subcostal retractions and her FiO₂ is up to 38%

What is going on?...

Think "Mechanical Failure"

If CPAP water bottle is not bubbling, then there is an air leak somewhere

Remove prongs from nose and occlude them by hand to check for leak in the circuit

- inspiratory or expiratory limbs are disconnected or have excessive water condensation
- leak in the humidifier or in the gas supply
- inappropriate gas flow

Check nasal interface

- prongs may have been out side the nose
- prongs are too small or malpositioned
- Is the hat fitting snugly?
- are the respiratory tubes fixed correctly to the hat on both sides of the head (not on eye) and at the correct angle to prongs?
- does the Velcro moustache need replacement?
- Infant's mouth may be wide open leaking air out and needs a "chin strip"

If every thing is $Ok \rightarrow do chest x-ray$

- → Pneumothorax may occur with bCPAP
 - Commonly within 12-24 hours
 - managed conservatively or with single needle aspiration or chest tube placement while on bCPAP

bCPAP: GW - 14 years of experience

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Intubated at least once	41.4	18.4	48.1	81.2	80.6
Surfactant therapy	21.6	8.7	23.3	42.4	51.3

Aly and Mohamed, Peds Research, 2020

- 1- Early introduction in the delivery room
 - → Allow time for establishing lung volume before proceeding with intubation

bCPAP: GW - 14 years of experience

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Birth Weight (mean <u>+</u> sd)	997 (+321)	1267 (+146)	869 (+78)	622 (+73)	442 (+52)
Days of intubation	1.7 (+5.0)	1.0 (+1.9)	1.9 (+4.8)	7.0 (+10.3)	7.3 (6.2)
*(mean <u>+</u> sd)					

Aly and Mohamed, Peds Research, 2020

2 - Early extubation to bCPAP (or NIPPV) with consistent drive to reach stability on bubble CPAP

bCPAP: GW - 14 years of experience

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Birth Weight (mean <u>+</u> sd)	997 (+321)	1267 (+146)	869 (+78)	622 (+73)	442 (+52)
Days on bCPAP/NIPPV	28.6 (+25.1)	16.6 (+17.3)	44.5 (+19.4)	55.5 (+22.2)	76.8 (+31.3)
*(mean <u>+</u> sd)					
Days on Oxygen (> 21%)	12.3 (+23.8)	4.5 (+12.4)	17.7 (+23.6)	37.7 (+38.5)	51.4 (+37.1)
*(mean <u>+</u> sd)			Aly and Mo	hamed, Peds R	Research, 2020

3- Continued use of **b**CPAP as long as infant requires respiratory support (to allow for continued lung growth), then gradual wean off CPAP to room air

(No free flow O2 via nasal cannula at anytime)

In Conclusion:

Elements of success of bCPAP

- 1- Early introduction at birth
- 2- If intubated, swift extubation
- 3- Continued use of bCPAP to RA
- 4- Meticulous attention to details, continued monitoring and proper training

