Non-Invasive Respiratory Support – Pearls & Pitfalls of CPAP and NIPPV

NeoQIC Respiratory Care Collaborative
July 22, 2020

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Agenda

2:00 – 2:05	Welcome & Reminders
2:05 – 12:15	Review of Collaborative NIV Data
12:15 – 12:45	Topic Presentation
12:45 – 12:55	Discussion
12:55 – 1:00	Wrap Up

Upcoming Events & Reminders

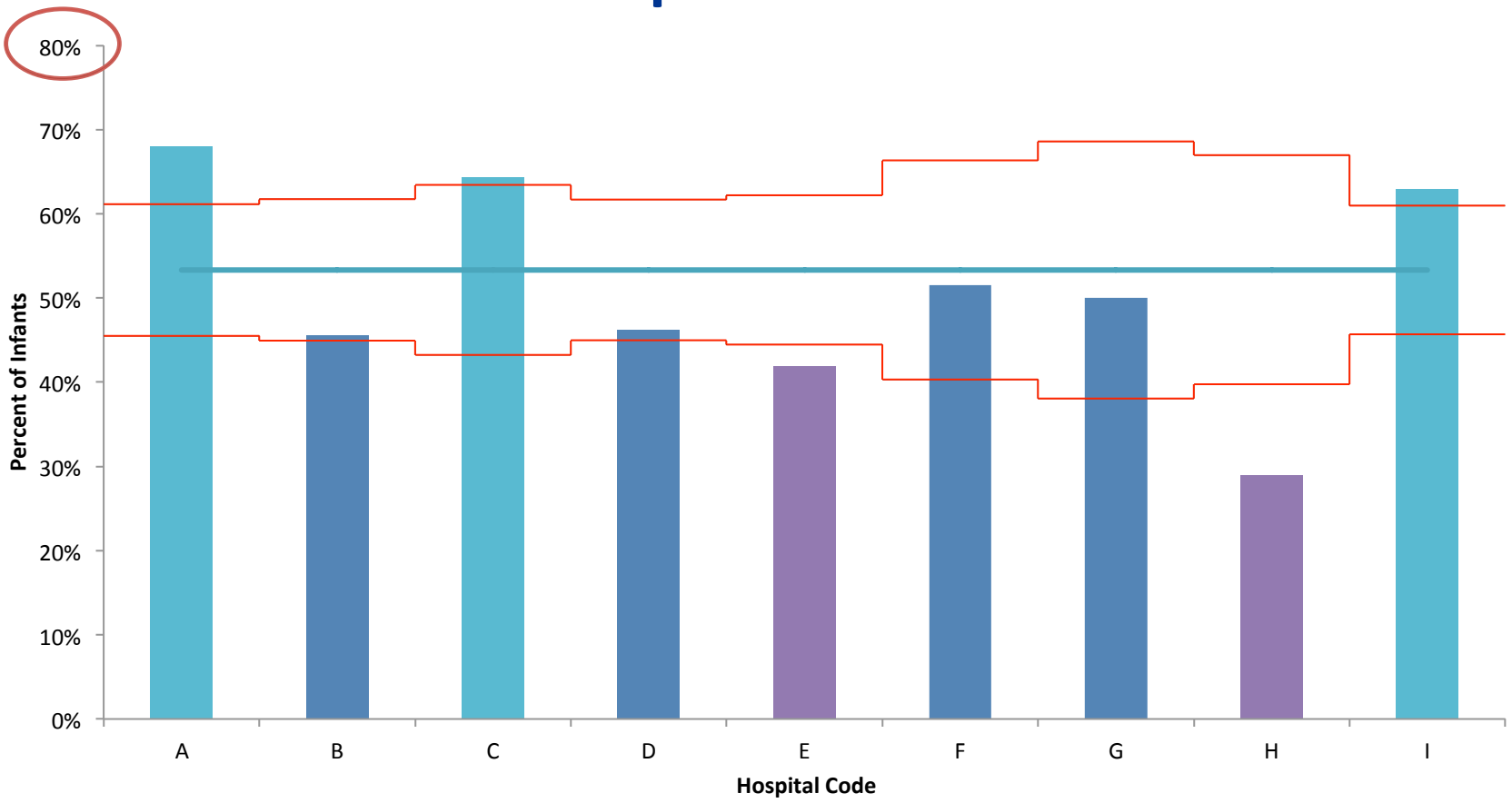
September 1st 2020 @ 11 – 3pm:
Respiratory Care Collaborative Semi-Annual

- Virtual Meeting – invites to follow
- We are seeking 5 programs to present their QI work at the next meeting

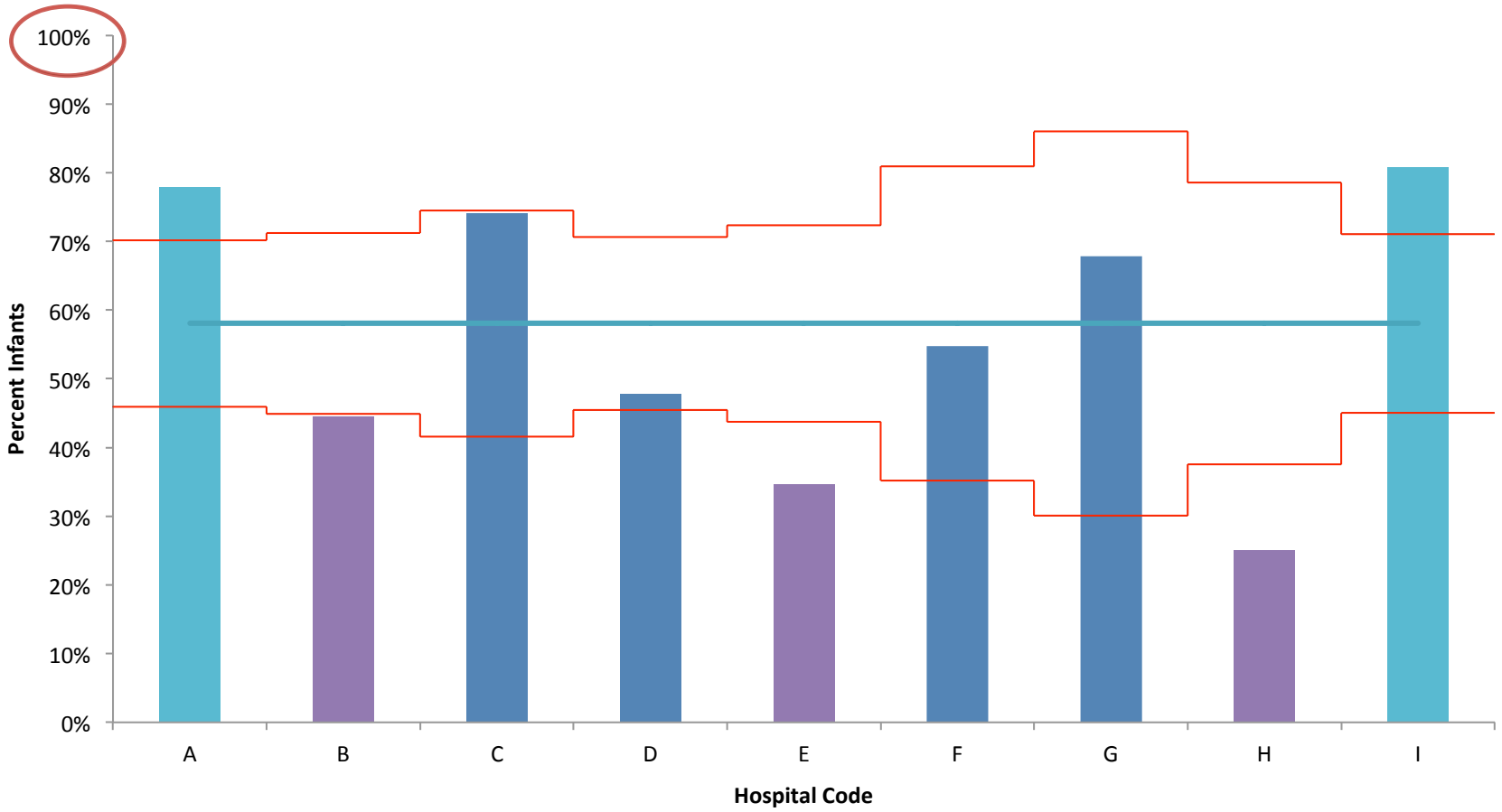
Reminder: We are still collecting hospital guidelines and your articles

Your Data

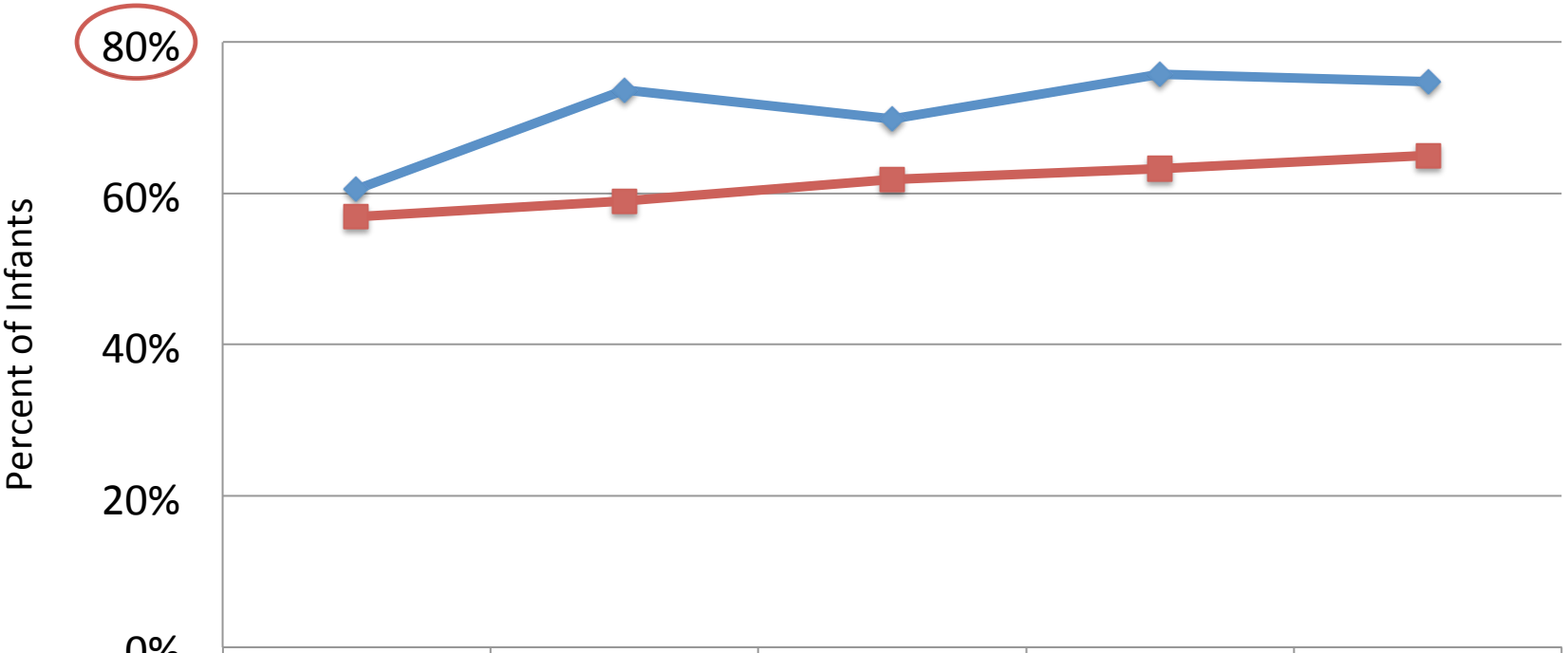
Any Ventilation, all VLBW, 2016 – 2018
p Chart



Any Ventilation, 27- 29 wks GA, 2016 - 2018
p Chart

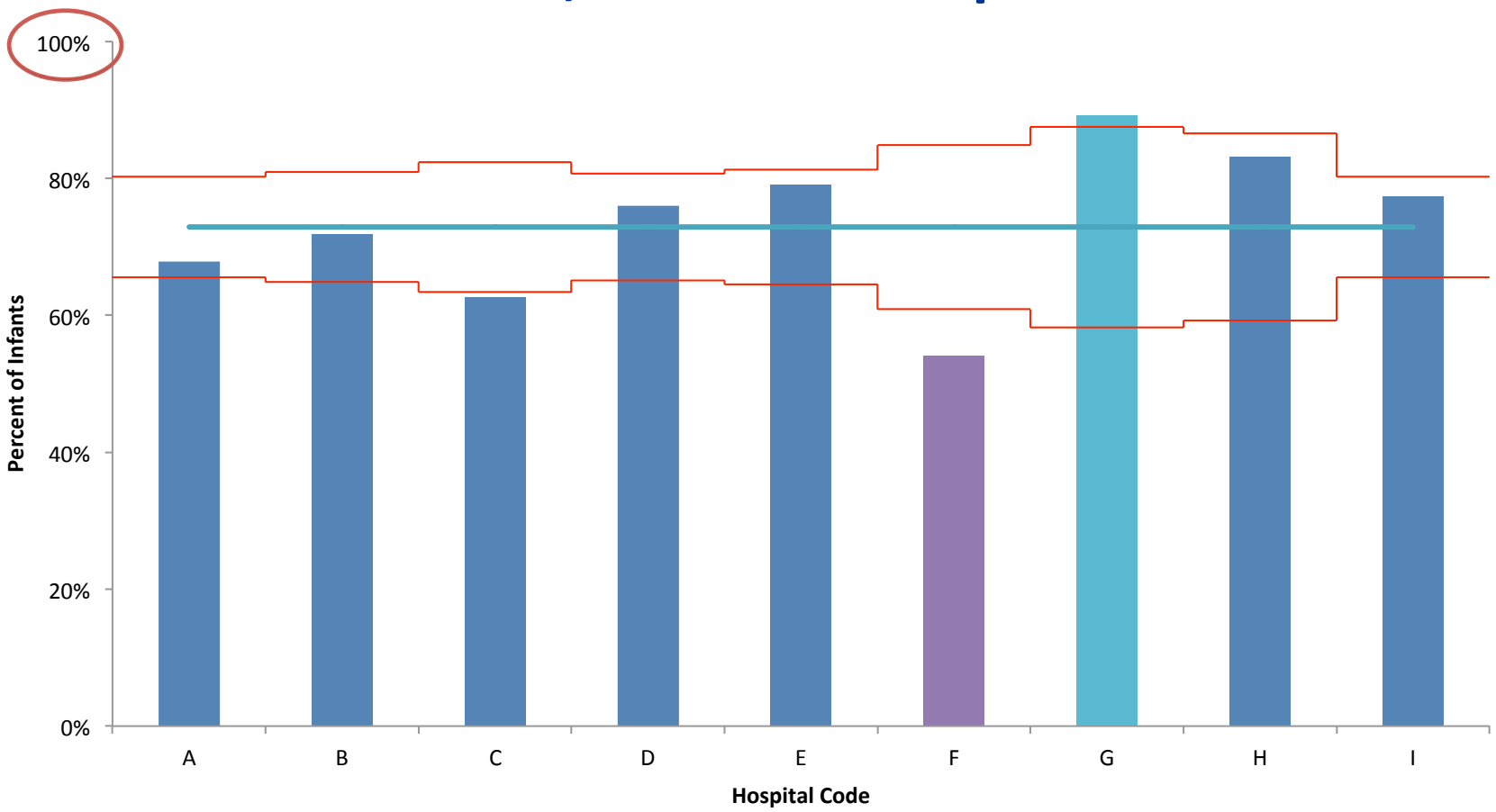


CPAP or NIV Trial before or without ETT all VLBW, 2014 - 2018



	2014	2015	2016	2017	2018
NeoQIC	61%	74%	70%	76%	75%
VON	57%	59%	62%	63%	65%

CPAP or NIV Trial before or without ETT
All VLBW, 2016 - 2018 - p Chart



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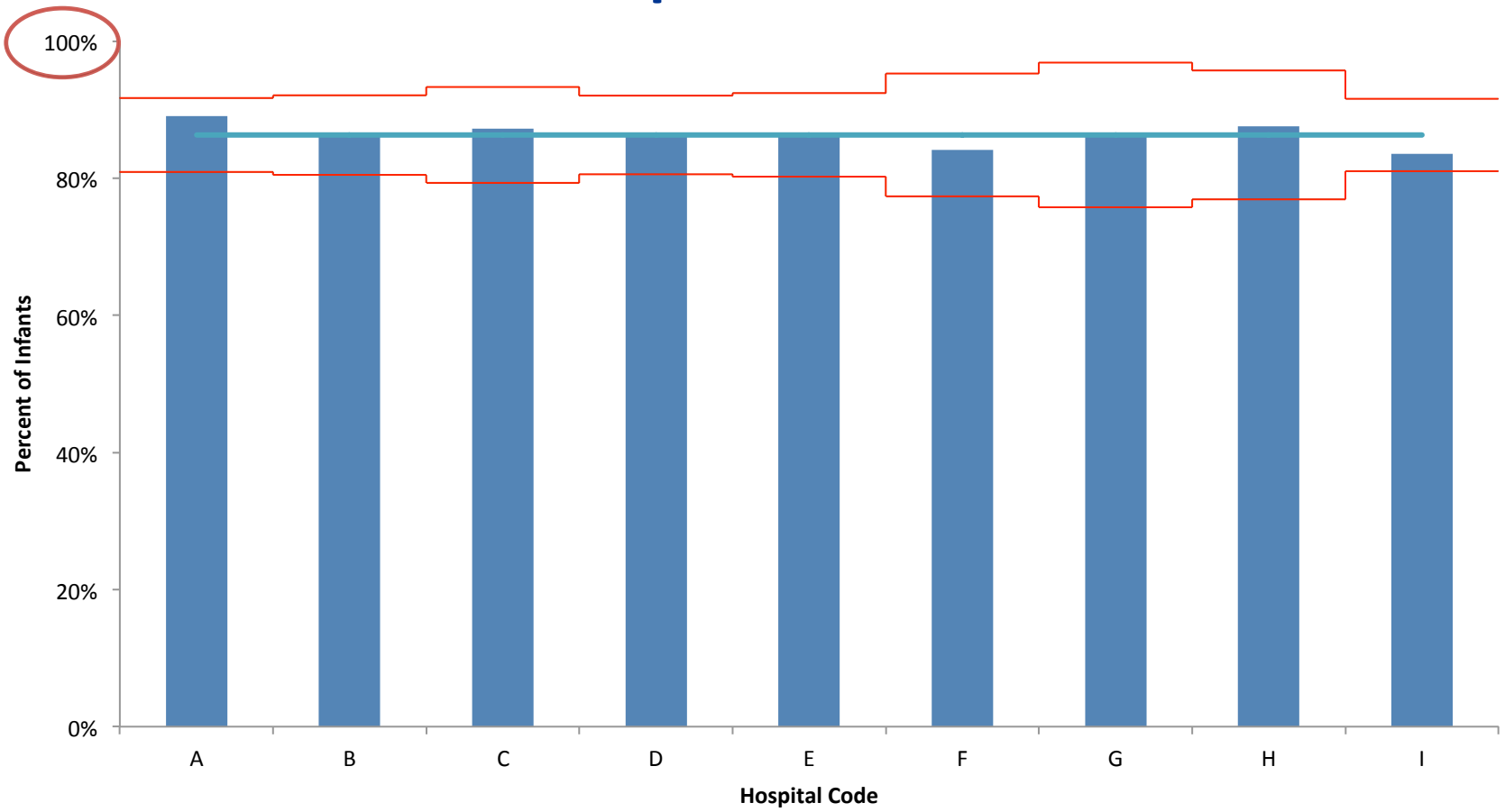
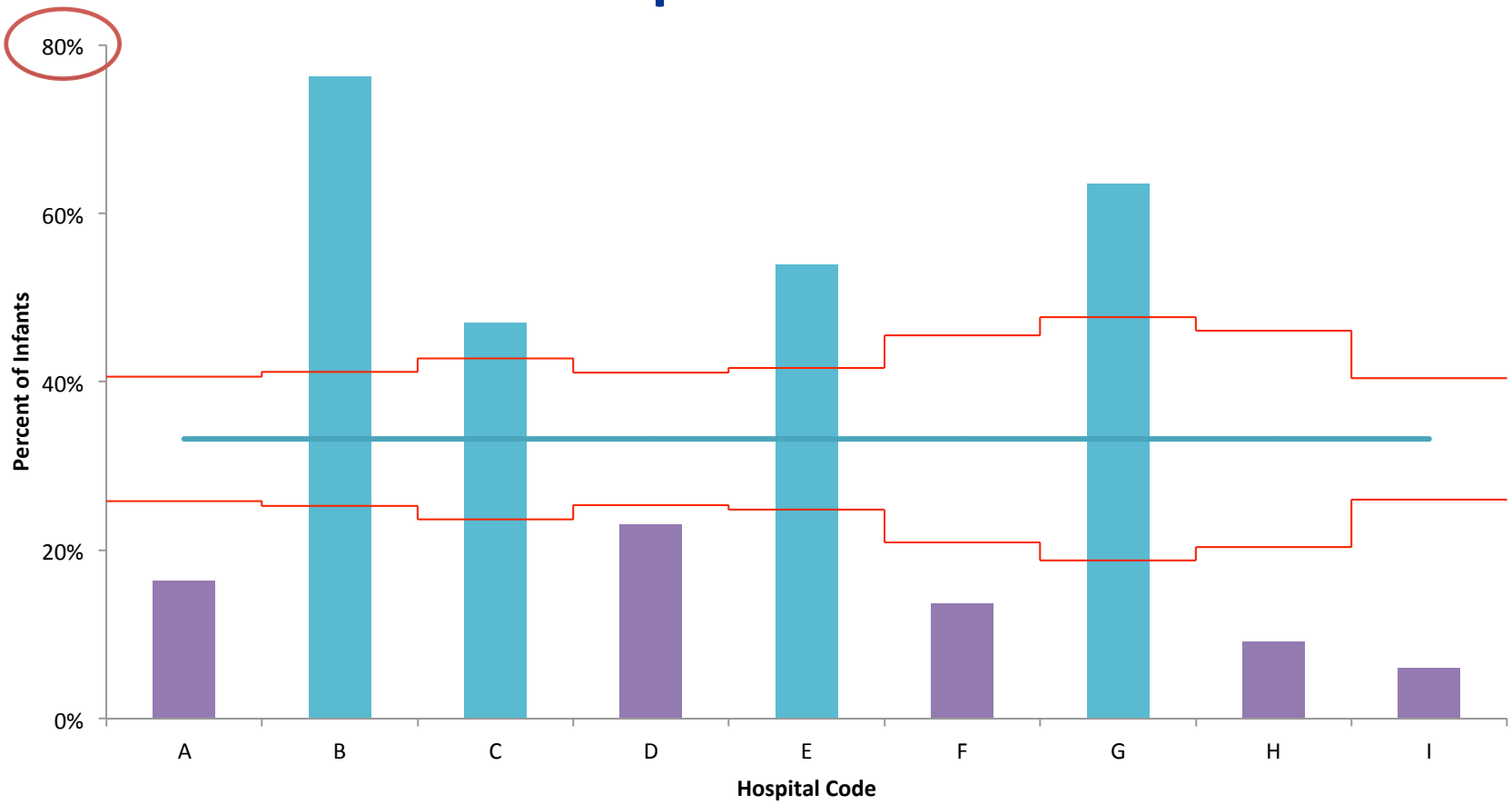
Nasal CPAP Use, All VLBW, 2016 – 2018
p Chart



Nasal Ventilation, All VLBW, 2016 – 2018
p Chart



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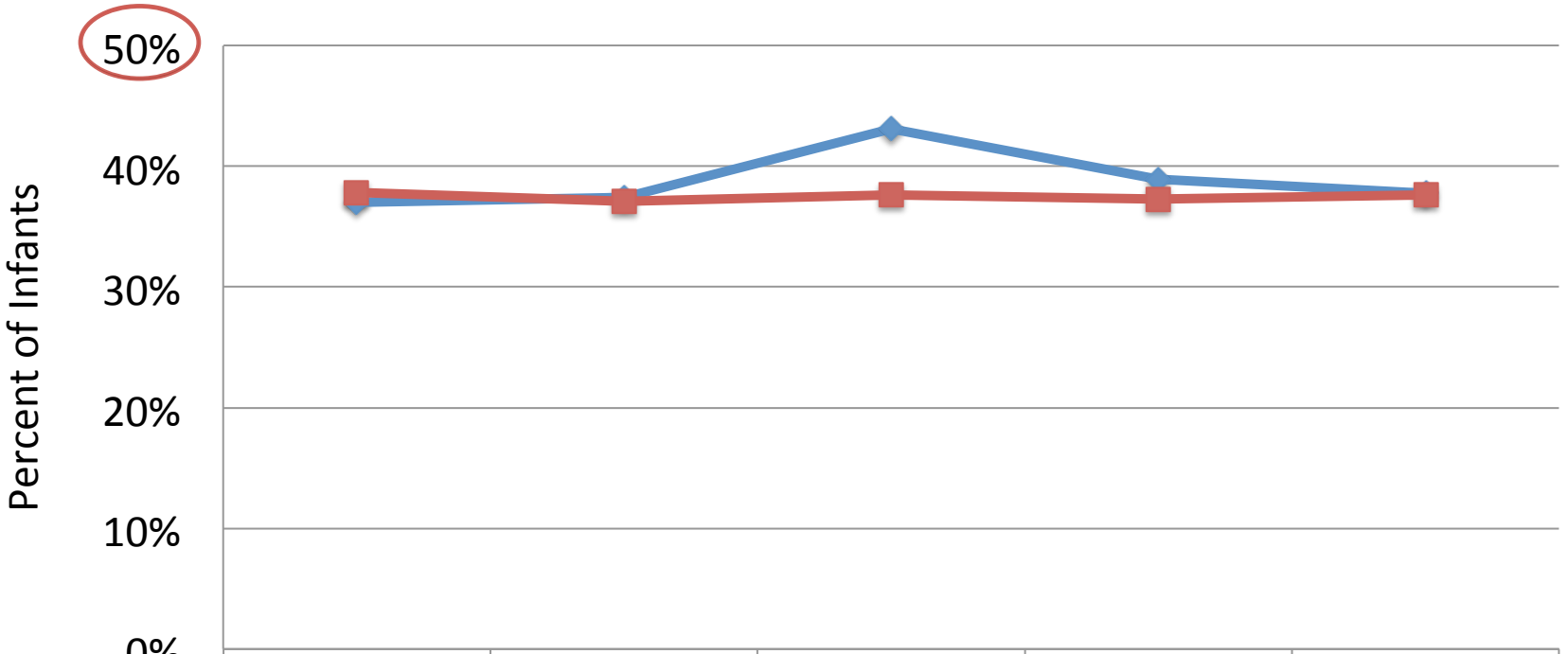
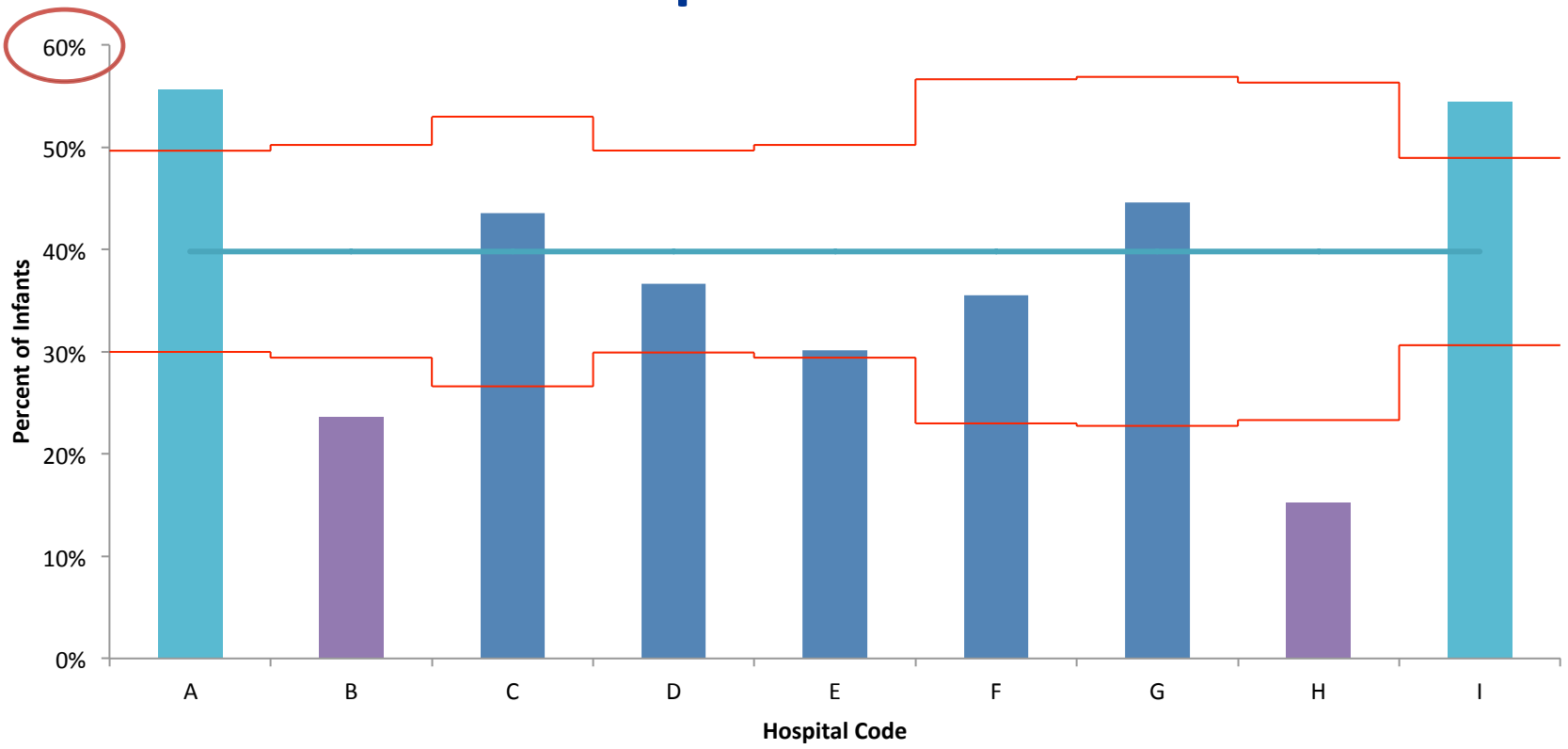
Intubation and Ventilation After Trial of CPAP or NIV, 2014 - 2018



	2014	2015	2016	2017	2018
NeoQIC	37%	37%	43%	39%	38%
VON	38%	37%	38%	37%	38%

Intubation and Ventilation After Trial of CPAP or NIV, 2016 – 2018
p Chart



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Non-Invasive Respiratory Support – Pearls & Pitfalls of CPAP and NIPPV

NeoQIC Respiratory Care Collaborative
July 22, 2020

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South Shore Health

APPLYING NIPPV VENTILATION TO DECREASE CLD RATES IN VLBW INFANTS SSH NICU EXPERIENCE

ZUZANNA KUBICKA MD
BOSTON CHILDREN'S HOSPITAL, BOSTON, MA AND
SOUTH SHORE HOSPITAL, WEYMOUTH, MA
CAROLYN O'ROURKE LEAD NICU RT
SOUTH SHORE HOSPITAL NICU

I have no financial relationships to disclose or conflicts of interest (COI) to resolve

Learner objectives

- To be able to describe how to apply NIPPV in VLBW infants to clinical practice, in order to decrease the occurrence of chronic lung disease in this population.
- After completing this activity the learner should be able to answer the following questions:

1. What are the elements of respiratory care bundle in the delivery room, on admission to the NICU, during NICU stay and how to apply them in clinical practice?
2. Practical pearls of NIPPV use
3. What is the existing evidence behind NIPPV ventilation in VLBW infants?

Respiratory guideline

- Prospective quality improvement study of infants < 32 weeks gestation in a small NICU.
- Interdisciplinary development of respiratory care bundle, followed by training by peers for RTs, RNs, MDs, NNPs
- A respiratory care bundle (“Respiratory Distress Syndrome Management Guideline for Infants < 32 weeks ”) to eliminate inter-provider variability and minimize use of conventional ventilation implemented.
- Guideline included: standardizing delivery room management with use of continuous positive airway pressure/nasal intermittent positive pressure ventilation, uniform intubation/extubation criteria, and standardizing ventilation/post-extubation support.

- 1:1 refresher course for all staff members yearly
- CLD review yearly
- Providers aware of the group compliance rate
- Yearly outcomes shared with entire team and posted on the board
- Learning module for nursing staff
- Small changes adopted

Act

Plan

- Assemble multidisciplinary task force
- Review our respiratory management practices
- Task force visit to the site with a very low incidence of CLD
- Review of relevant literature
- Develop evidence-based respiratory guideline with emphasis on non-invasive ventilation:
  - defining DR management with use of CPAP/NIPPV as the primary mode
  - uniform intubation/extubation criteria
  - HFOV mode as a "rescue mode"
  - standardizing post-extubation support

Study

Do

- Collection of data on Guideline compliance and outcomes in real time: "Compliance data sheets"
- Primary outcome: CLD or CLD/death rates
- Secondary outcomes: supplemental O2 home, LOS, need for pressors, need for surgical/ medical therapy for PDA
- Balancing measures : rates of nosocomial infections, pneumothorax, severe IVH/ROP, NEC

- Intense training of all staff members between January-March 2014.
- Implementation of all the changes (Guideline) as a bundle in March 2014-March 2016

Setting: SSH NICU

- ~3600 deliveries and 450 NICU admissions per year.
- 30 beds, ~30 -50 VLBW infant's admissions per year.
- The only level 3 NICU in the state not located in an academic medical center (Division of Newborn Medicine at Children's Boston Hospital).
- 7 neonatologists, 2→5 neonatal nurse practitioners, 8 pediatric/neonatal certified respiratory therapists and 70 nurses.
- No physicians or NNPs in training participating in patient care.
- High-risk deliveries always attended by a pediatric/neonatal respiratory therapist, a nurse and an NNP or neonatologist.

Equipment used

- DR: NeoPuff and an appropriate size mask or a RAM cannula(Neotech).
- NICU: RAM cannula(Neotech) with size based on birth weight; Babylog VN500 or an Evita Infinity V500 ventilator (Draeger Medical).

Important DR considerations

- Initial stabilization and resuscitation (if needed) per NRP guidelines with the use of blended oxygen initially set at 21-30% and titrated according to pulse oximetry saturations.
- Saturation probe placed on right wrist as soon as possible after delivery
- CPAP (RAM cannula prongs)/Neopuff system set-up prior to any delivery of <32 weeks gestational age infant

- CPAP administered via CPAP prongs /Neopuff system placed immediately after delivery on any qualifying infant; Initial PEEP 5-7, adjusted according to clinical status, initial FIO2 30%, with adjustment as needed based on oxygen saturation

- If possible-avoid PPV prior to placing on CPAP

Important considerations on admission

- **Caffeine administration:** All infants <32 weeks with respiratory distress will be loaded with Caffeine 20 mg/kg/dose and started on maintaince dose 8 mg/kg/ dose
- **Minimizing air leak:** Strongly consider using chin straps for all non-intubated infants requiring CPAP/NIPPV therapy
- **CPAP apparatus should be kept on** at all times and not disconnected even for short periods of time(for example weight check even on admission)
- **Significant secretions can obstruct the airway**: Suction mouth and pharynx q 4h or as necessary
- **Nasal obstruction "bugger rounds"**
- **Position of RAM cannula prongs**
- **Significant amount of gas trapping in the stomach** :good continuous stomach decompression with minimum gavage tube 6.5Fr.

Initial respiratory mode for non-intubated infants on admission

<28 weeks GA

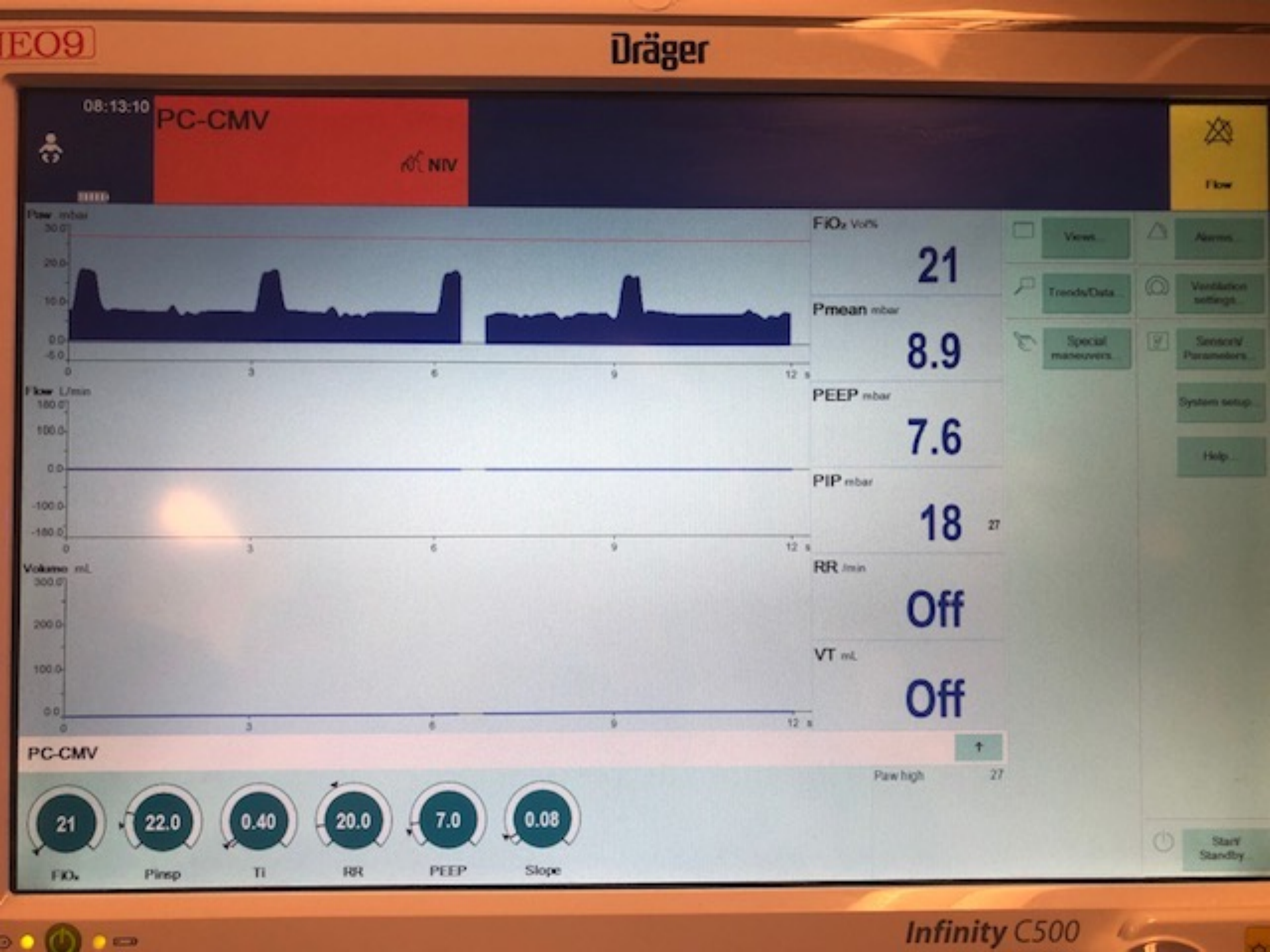
- Consider **NIPPV** as initial mode
- Suggested initial settings : rate≈40, PIP 4 cmH20>PIP required during manual ventilation PEEP 4-7 cm H2O
- Max NIPPV support for infants <1kg MAP 14, for infants>1kg MAP 16

>28 weeks GA

- **CPAP or NIPPV** acceptable

NIPPV settings

- Very common to start VLBW infant on high setting and wean to stable level
- 25/7 rate 40 common initially
- 20/7 rate 15-20 “maintenance” setting till apneas significantly decreased
- No need for blood gases once on ” maintenance” settings
- Difference between settings chosen and delivered
- Using MAP delivered to the infant as reference-at least 10-11 MAP needed initially


Dräger
08:13:10
PC-CMV
NIV
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Paw mbar
30.0
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0.0
-5.0
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3
6
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12 s
Flow L/min
180.0
100.0
0.0
-100.0
-180.0
Volume mL
300.0
200.0
100.0
0.0
FiO2 Vol%
21
Pmean mbar
8.9
PEEP mbar
7.6
PIP mbar
18
27
RR /min
Off
VT mL
Off
Views...
Alarms...
Trends/Data...
Ventilation settings...
Special maneuvers...
Sensors/ Parameters...
System setup...
Help...
PC-CMV
Paw high
27
21
FiO2
22.0
Pinsp
0.40
Ti
20.0
RR
7.0
PEEP
0.08
Slope
Start/ Standby
Infinity C500

Intubation/surfactant administration criteria

- **Arterial blood gases** necessary
- Consider first ABG within **2h** after birth
- Any of the following:

-FiO_2 ~ 0.40 or PaO_2 of 50 mmHg or $PaCO_2$ of 65

-Recurrent significant apnea and bradycardia spells despite Caffeine and NIPPV therapy

-Marked retractions not improving on CPAP/NIPPV **after at least 2h**

-Other (CV collapse, neuromuscular disorder, CDH, for transport, etc.)

Use of sedation may interfere with weaning from mechanical ventilation and extubation therefore the goal is to avoid oversadation for intubation, maintance on SIMV and while on HFOV

Mechanical Ventilation(if needed)

- AC/VG suggested initial mode
- Consider **rescue** HFOV if MAP >10-11 or in the presence of air leaks
- HFOV use as a primary ventilation mode **discouraged**
- Aggressive weaning while intubated/ “weanable” ABG parameters:
  - -$PaCO_2$ 50-60 mmHg
  - -pH 7.25-7.33
  - -PaO_2 55-65 mmHg
  - -Saturation goal-use current parameters

Extubation criteria (all must be met)

- FiO_2 </= 0.40 with PaO_2 > 50 mmHg
- $PaCO_2$ < 60 mmHg
- MAP </=8
- Evidence of consistent spontaneous breathing above the ventilator
- For re-intubated infants – prior to another extubation attempt: extubation criteria must be met and 48h stability on the mechanical ventilation achieved
- Extubation within **2h** of reaching parameters

Post-extubation modes and timing

Infants<28 weeks GA

- **Extubate to NIPPV** as soon as possible, preferably **within 2 hours** of reaching extubation criteria.
- Use pressure settings **higher** than would be ordered for SIMV
- Suggested settings : PIP on SIMV +2-4; PEEP on SIMV +1-2; rate ≈15-25; FIO2 to maintain goal saturations
- Max settings: infants<1kg: MAP 14; infants >1kg: MAP16

Infants>28 weeks GA

- **Extubate to CPAP or NIPPV** as soon as possible, preferably **within 2 hours** of reaching extubation criteria

Weaning from NIPPV

- Wean as tolerated as mechanical ventilation settings; consider weaning to CPAP once stable on low settings
- No significant apnea, tachypnea, or increased work of breathing

Weaning from CPAP to HFNC/LFNC

Infants<28 weeks GA

- CPAP until at least **32 weeks** PMA **AND** all criteria for trial off met
- CPAP can be trialed off before 32 weeks PCA **only if** infant doesn't require any respiratory support after trial off (HFNC/ LFNC) and meets the criteria for trial off
- **If failed trial off -**restart CPAP and trial off again in 5-7 days, if still meets criteria

Infants>28 weeks GA

- CPAP until meets criteria for trial off
- **If failed trial off-**restart CPAP **or** place on HFNC/LFNC

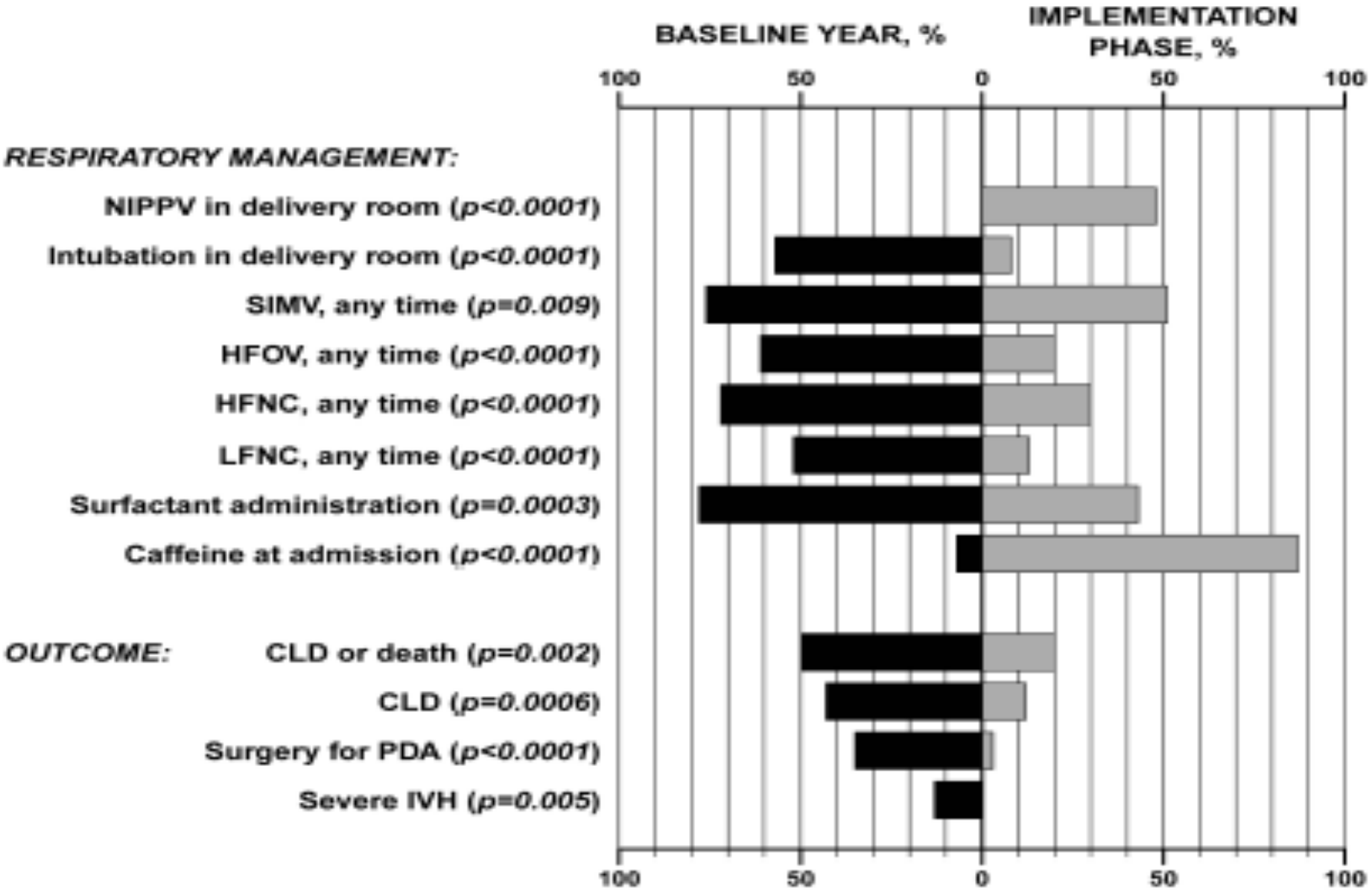
Results

- 110 infants with a birth weight of <1500 g born at South Shore Hospital between January 2013- March 2016.
- 3 infants excluded from analysis
- Out of the 107 infants analyzed, 46 born during baseline year 2013 and 61 during the implementation phase.

Main findings

- **Compliance with the respiratory care bundle > 90%**.
- CLD rates at 36 weeks postmenstrual age fell from 43% to 12% (P = 0.0006).
- Rates of combined CLD/death decreased from 50% to 20% (P = 0.002, OR = 0.25, 95% CI 0.1 - 0.6).
- Rates of severe IVH decreased from 13% to 0% (P = 0.005).
- Surgical ligation of PDA decreased from 35% to 3% (P = < 0.0001).
- 73% reduction in CLD rates in VLBW infants occurred.

Main findings



Factors contributing to high compliance and success

- Setting-small, cohesive, consistent team.
- Engaging and equal voice to all the participants from various disciplines during Guideline creation and implementation.
- Period of intense education with specialist to specialist teaching in small groups.
- Real time compliance monitoring - “Compliance Data Sheet” for each VLBW infant.
- The team leader coordinating the efforts, overseeing all the steps and communicating compliance outcomes in a collegial way with the team during monthly meetings.
- Refresher activities every 12 months.
- Human factors: twice-daily multidisciplinary rounds, non-hierarchal approach to communication.
- As a result a new mental model of respiratory care created and a sense of pride and ownership amongst the team.

Evidence aka Why NIPPV?

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[Intervention Review]

Nasal intermittent positive pressure ventilation (NIPPV) versus nasal continuous positive airway pressure (NCPAP) for preterm neonates after extubation

Brigitte Lemyre[1], Peter G Davis[2], Antonio G De Paoli[3], Haresh Kirpalani[4]

[1]Division of Neonatology, Children's Hospital of Eastern Ontario, Ottawa, Canada. [2]The University of Melbourne, Melbourne, Australia. [3]Department of Paediatrics, Royal Hobart Hospital, Hobart, Australia. [4]Department of Pediatrics, University of Pennsylvania School of Medicine and Department of Clinical Epidemiology and Biostatistics, McMaster University, Philadelphia, Pennsylvania, USA

Contact address: Brigitte Lemyre, Division of Neonatology, Children's Hospital of Eastern Ontario, 401 Smyth Road, Ottawa, ON, KlH 8L1, Canada. blemyre@ottawahospital.on.ca.

Editorial group: Cochrane Neonatal Group.
Publication status and date: New search for studies and content updated (no change to conclusions), published in Issue 2, 2017.

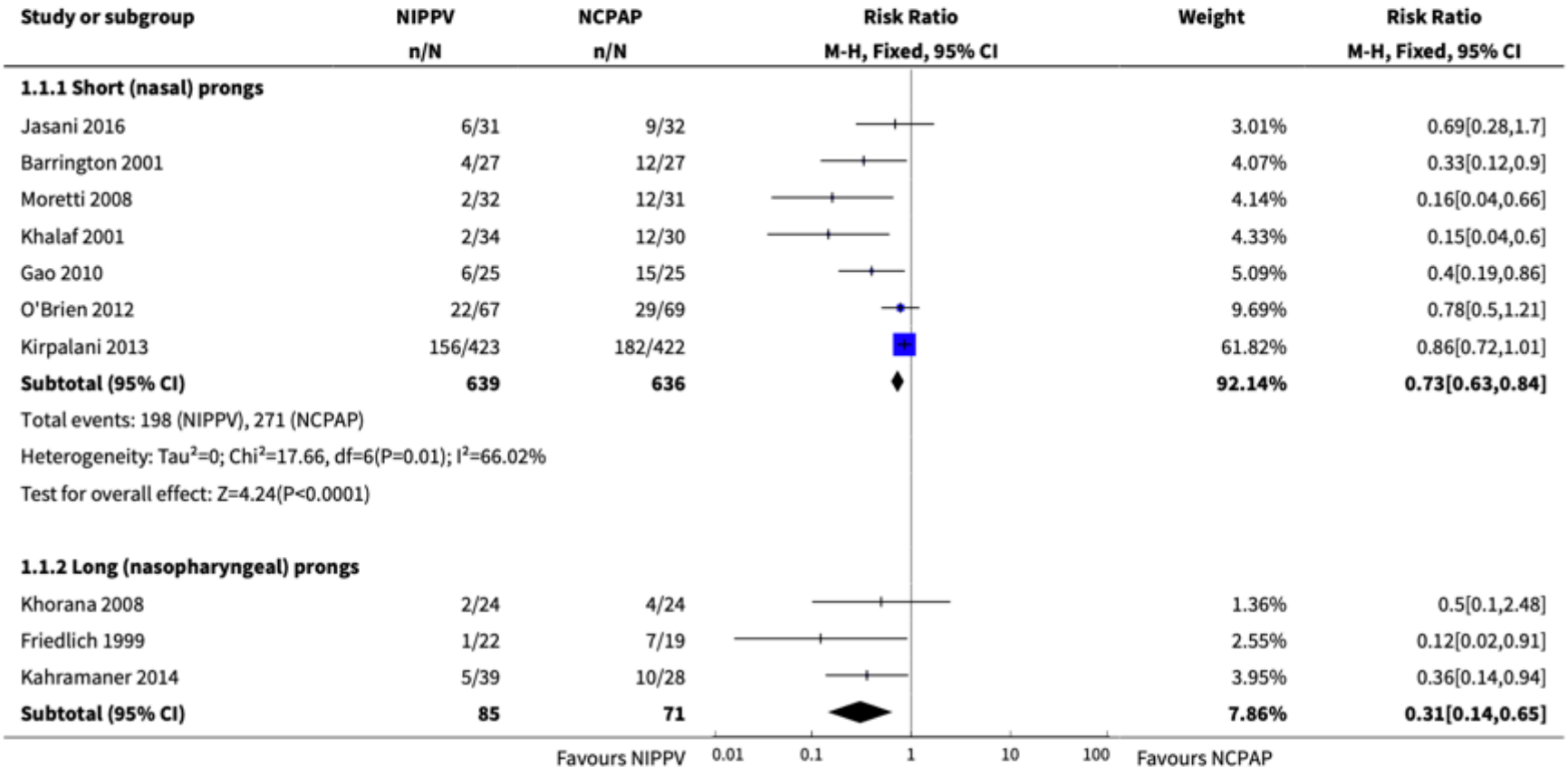
Citation: Lemyre B, Davis PG, De Paoli AG, Kirpalani H. Nasal intermittent positive pressure ventilation (NIPPV) versus nasal continuous positive airway pressure (NCPAP) for preterm neonates after extubation. *Cochrane Database of Systematic Reviews* 2017, Issue 2. Art. No.: CD003212. DOI: 10.1002/14651858.CD003212.pub3.

Authors' conclusions

Implications for practice

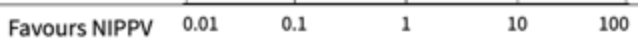
NIPPV reduces the incidence of extubation failure and the need for re-intubation within 48 hours to one week more effectively than NCPAP; however, it has no effect on chronic lung disease nor on mortality. Synchronisation may be important in delivering effective NIPPV. The device used to deliver NIPPV may be important; however, data are insufficient to support strong conclusions. NIPPV does not appear to be associated with increased gastrointestinal side effects.

Analysis 1.1. Comparison 1 NIPPV versus NCPAP to prevent extubation failure, Outcome 1 Respiratory failure post extubation.

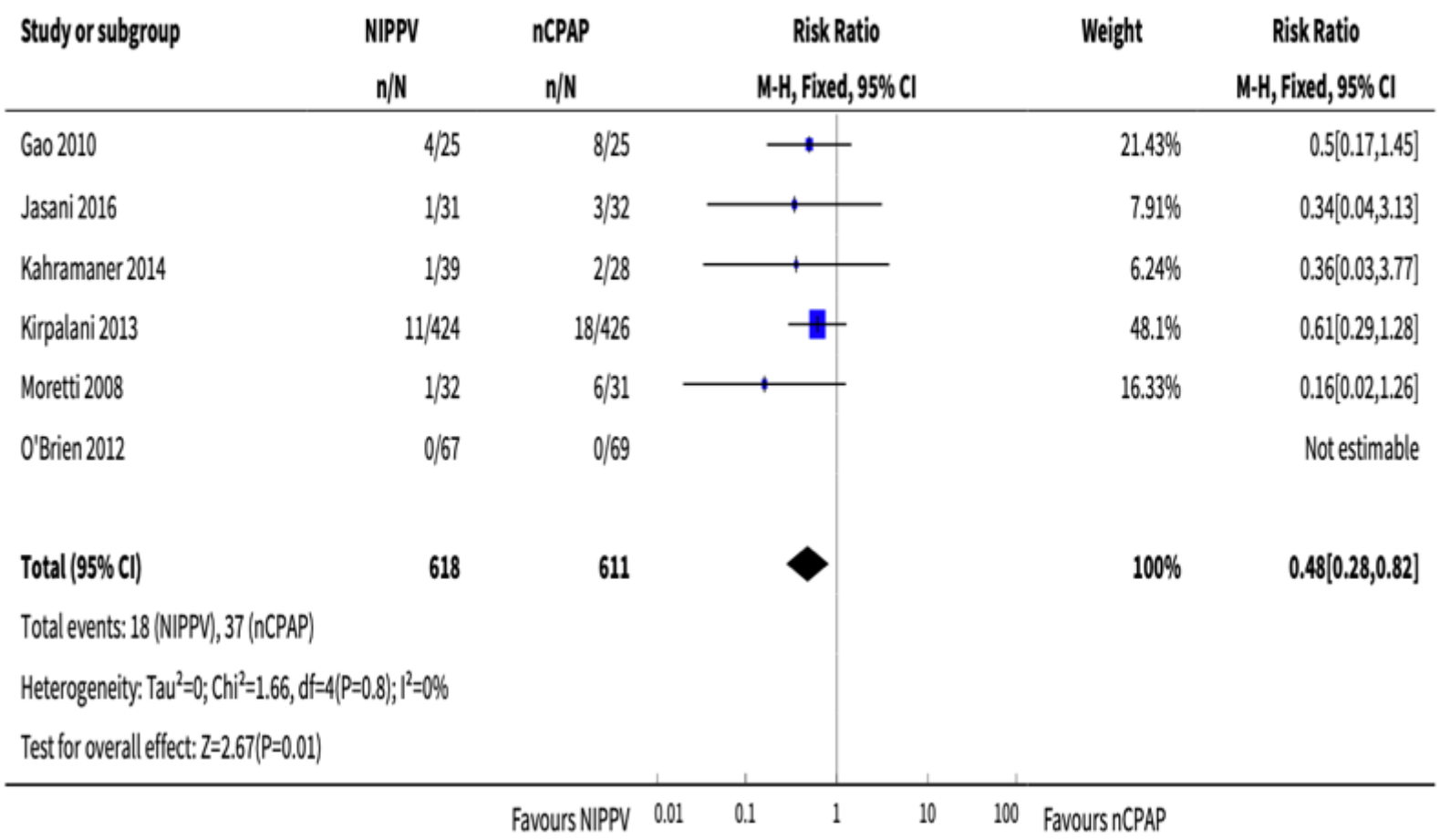


Analysis 1.2. Comparison 1 NIPPV versus NCPAP to prevent extubation failure, Outcome 2 Endotracheal re-intubation.

Study or subgroup	NIPPV n/N	NCPAP n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
Barrington 2001	3/27	3/27		1.17%	1[0.22,4.52]
Friedlich 1999	1/22	1/19		0.42%	0.86[0.06,12.89]
Gao 2010	6/25	15/25		5.84%	0.4[0.19,0.86]
Khalaf 2001	2/34	10/30		4.14%	0.18[0.04,0.74]
Khorana 2008	2/24	4/24		1.56%	0.5[0.1,2.48]
Kirpalani 2013	156/423	182/422		70.99%	0.86[0.72,1.01]
Moretti 2008	2/32	12/31		4.75%	0.16[0.04,0.66]
O'Brien 2012	22/67	29/69		11.13%	0.78[0.5,1.21]
Total (95% CI)	**654**	**647**		**100%**	**0.76[0.65,0.88]**
Total events: 194 (NIPPV), 256 (NCPAP)					
Heterogeneity: $Tau^2=0$; $Chi^2=13.71$, df=7(P=0.06); $I^2=48.96\%$					
Test for overall effect: Z=3.7(P=0)					



Analysis 3.2. Comparison 3 NIPPV versus NCPAP to improve pulmonary outcomes, Outcome 2 Air leaks.



?NIPPV

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

A Trial Comparing Noninvasive Ventilation Strategies in Preterm Infants

Haresh Kirpalani, B.M., M.Sc., David Millar, M.B., Brigitte Lemyre, M.D., Bradley A. Yoder, M.D., Aaron Chiu, M.D., and Robin S. Roberts, M.Sc., for the NIPPV Study Group*

ABSTRACT

BACKGROUND

To reduce the risk of bronchopulmonary dysplasia in extremely-low-birth-weight infants, clinicians attempt to minimize the use of endotracheal intubation by the early introduction of less invasive forms of positive airway pressure.

METHODS

We randomly assigned 1009 infants with a birth weight of less than 1000 g and a gestational age of less than 30 weeks to one of two forms of noninvasive respiratory support — nasal intermittent positive-pressure ventilation (IPPV) or nasal continuous positive airway pressure (CPAP) — at the time of the first use of noninvasive respiratory support during the first 28 days of life. The primary outcome was death before 36 weeks of postmenstrual age or survival with bronchopulmonary dysplasia.

RESULTS

Of the 497 infants assigned to nasal IPPV for whom adequate data were available, 191 died or survived with bronchopulmonary dysplasia (38.4%), as compared with 180 of 490 infants assigned to nasal CPAP (36.7%) (adjusted odds ratio, 1.09; 95% confidence interval, 0.83 to 1.43; P=0.56). The frequencies of air leaks and necrotizing enterocolitis, the duration of respiratory support, and the time to full feedings did not differ significantly between treatment groups.

CONCLUSIONS

Among extremely-low-birth-weight infants, the rate of survival to 36 weeks of postmenstrual age without bronchopulmonary dysplasia did not differ significantly after noninvasive respiratory support with nasal IPPV as compared with nasal CPAP. (Funded by the Canadian Institutes of Health Research; NIPPV ClinicalTrials.gov number, NCT00433212; Controlled-Trials.com number, ISRCTN15233270.)

From the Division of Neonatology, Children's Hospital of Philadelphia, Philadelphia (H.K.); the Department of Clinical Epidemiology and Biostatistics, McMaster University, Hamilton, ON (H.K., R.S.R.), the Department of Pediatrics, University of Ottawa, Ottawa (B.L.), and the Department of Pediatrics, University of Manitoba, Winnipeg (A.C.) — all in Canada; the Department of Neonatology, Royal Maternity Hospital, Belfast, United Kingdom (D.M.); and the Departments of Neonatology and Pediatrics, University of Utah School of Medicine, Salt Lake City (B.A.Y.). Address reprint requests to Dr. Kirpalani at the Division of Neonatology, Children's Hospital of Philadelphia, 34th St. and Civic Center Blvd., Philadelphia, PA 19104-4399, or at kirpalanih@email.chop.edu.

*The members of the Nasal Intermittent Positive-Pressure Ventilation (NIPPV) Trial study group are listed in the Supplementary Appendix, available at NEJM.org.

N Engl J Med 2013;369:611-20.
DOI: 10.1056/NEJMoa1214533

?NIPPV

e S1. Suggested Initiating and Maximal Settings for Respiratory Support by Group.

ngs	NIPPV		nCPAP
	Initial	Max	Initial
(breaths per minute)	10	40	N/A
:m H_2O)	10 above PEEP or 2-4 > vent PIP	18	N/A
	9-10 on infant flow advance or SiPAP		
P(cm H_2O)	5-6 or same as when intubated	8	5-6 or same as when intubated
(percent)	SaO_2 88-92%		SaO_2 88-92%
conds	0.3-0.5	0.5-1.0	N/A
(litres per minute)	8-12		8-12

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[Intervention Review]

Early nasal intermittent positive pressure ventilation (NIPPV) versus early nasal continuous positive airway pressure (NCPAP) for preterm infants

Brigitte Lemyre[1], Matthew Laughon[2], Carl Bose[2], Peter G Davis[3]

[1]Division of Neonatology, Children's Hospital of Eastern Ontario, Ottawa, Canada. [2]Department of Pediatrics, Division of Neonatal-Perinatal Medicine, The University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA. [3]The University of Melbourne, Melbourne, Australia

Contact address: Brigitte Lemyre, Division of Neonatology, Children's Hospital of Eastern Ontario, 401 Smyth Road, Ottawa, ON, KlH 8L1, Canada. blemyre@ottawahospital.on.ca.

Editorial group: Cochrane Neonatal Group.
Publication status and date: Edited (no change to conclusions), published in Issue 2, 2017.

Citation: Lemyre B, Laughon M, Bose C, Davis PG. Early nasal intermittent positive pressure ventilation (NIPPV) versus early nasal continuous positive airway pressure (NCPAP) for preterm infants. *Cochrane Database of Systematic Reviews* 2016, Issue 12. Art. No.: CD005384. DOI: 10.1002/14651858.CD005384.pub2.

Authors' conclusions

Early NIPPV does appear to be superior to NCPAP alone for decreasing respiratory failure and the need for intubation and endotracheal tube ventilation among preterm infants with respiratory distress syndrome. Additional studies are needed to confirm these results and to assess the safety of NIPPV compared with NCPAP alone in a larger patient population.

Avoidance of “too early” wean off CPAP and prolonged HFNC therapy

- Only in the smallest infants with the infant’s mouth fully closed and at higher levels of flow can clinically significant levels of CPAP be generated. The amount of CPAP generated unpredictable unless measured.
- With the mouth open, no pressures generated in any infant, at any flow rate.
- We speculated that at a given flow rate, larger infants will have a larger nasal leak and thus less pressure will be generated.
- **If the nasal leak is eliminated, dangerously high levels of distending pressure could be generated during periods when the mouth is closed. Pressure generated by these systems is not monitored, they should not be used unless it can be assured that a constant nasal leak is present.**
- **High flow nasal cannula should not be used as a replacement for CPAP therapy.**

Reference

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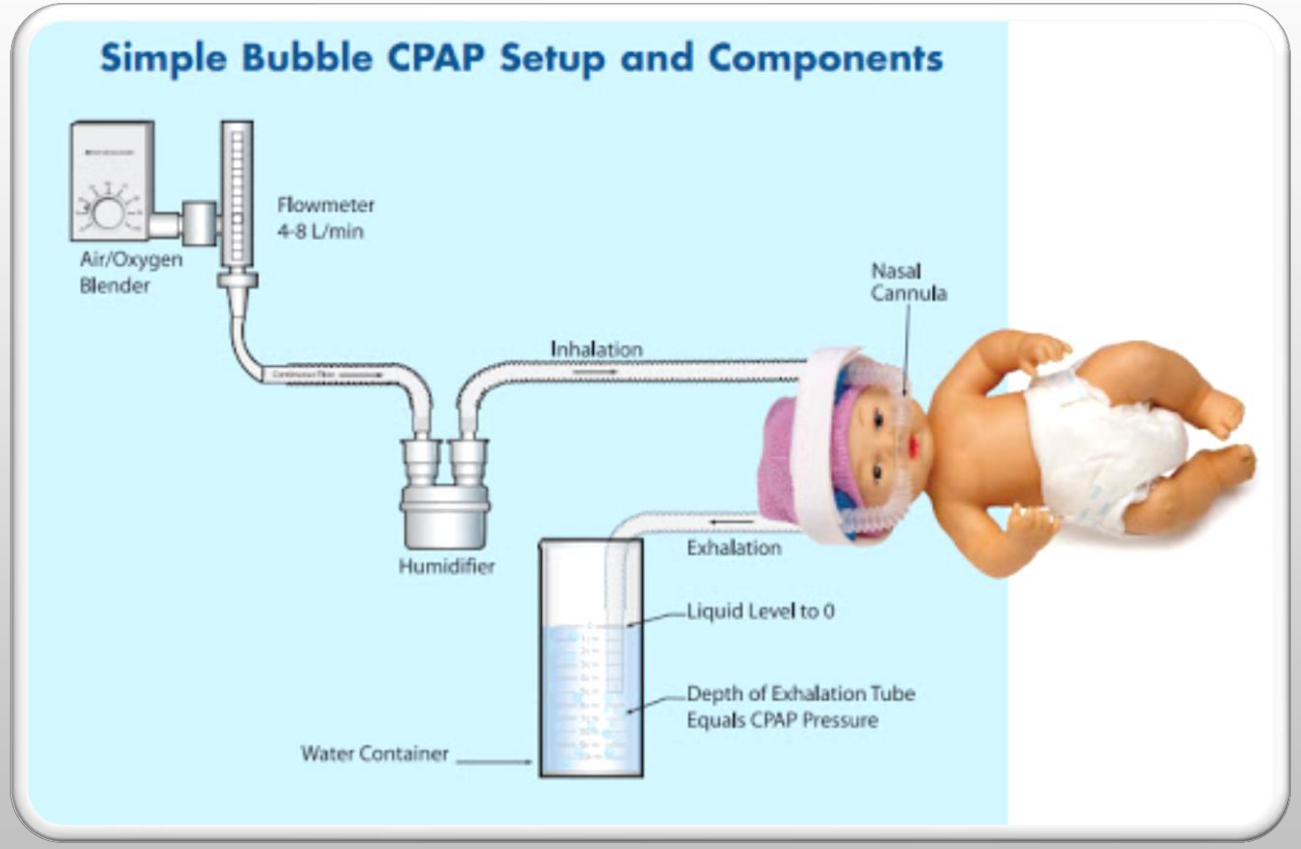
Thank you!

QUESTIONS?

REDUCING CLD BY LIMITING MECHANICAL VENTILATION: BUBBLE CPAP APPROACH



BERNADETTE LEVESQUE, MD*

BOSTON MEDICAL CENTER

JULY 22, 2020

*I have no conflicts. Opinions expressed are mine alone.

IMPLEMENTED NEARLY IDENTICAL INTERVENTIONS

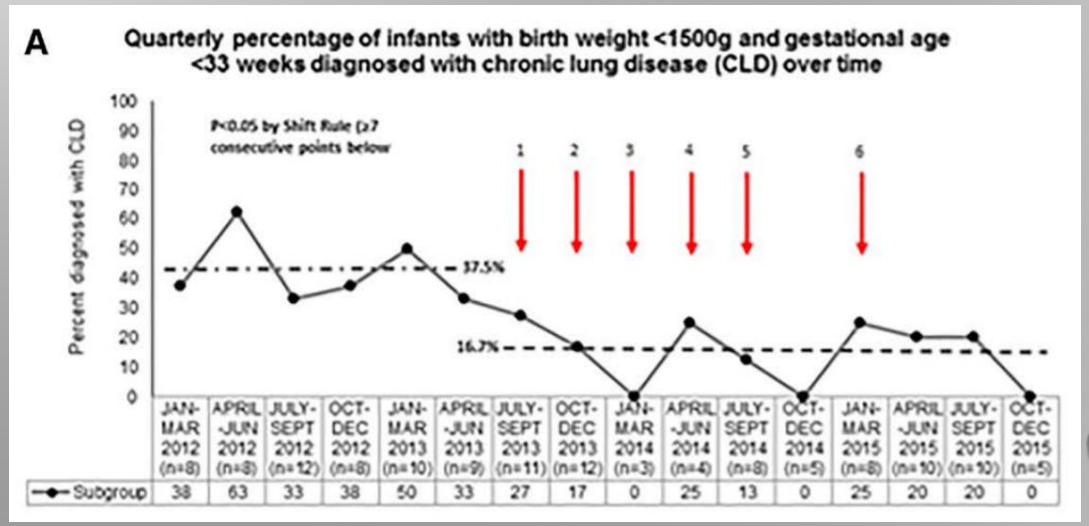
(BUBBLE CPAP, CPAP IN DR, INTUBATION & EXTUBATION CRITERIA, PROLONGED CPAP)

ST ELIZABETH'S, 2007

- SIGNIFICANT REDUCTION IN THE NEED FOR MV, SURFACTANT, AND SUPPLEMENTAL OXYGEN
- SIGNIFICANT REDUCTION IN HYPOTENSION
- BPD REDUCED BY 53% (NS BY STANDARD STATISTICS)

Pediatrics. 2011;128(1):e218-e226.

BOSTON MEDICAL CENTER, 2013



Pediatr Qual Saf. 2019;4(4):e193.

PRACTICAL ASPECTS OF THIS APPROACH

- BUBBLE VS. VENTILATOR CPAP
  - CPAP INTERFACES AND ACCESSORIES
- CPAP IN THE DELIVERY ROOM
- INTUBATION CRITERIA
- EXTUBATION CRITERIA
- PROLONGED CPAP
- VARIOUS COMPLICATIONS AND ANNOYANCES

BUBBLE VS. VENTILATOR CPAP

BUBBLE

- PROS
  - CHEAP, EASY TO INCREASE # UNITS
  - PORTABLE, RUNS ON COMPRESSED AIR/O2
  - IMPROVED GAS EXCHANGE AND LUNG RECRUITMENT VIA OSCILLATIONS
  - MAYBE LOWER RISK OF PNEUMOTHORAX
- CONS
  - NO BUILT-IN ALARM

VENTILATOR

- PROS
  - BUILT IN ALARMS
- CONS
  - EXPENSIVE, DELAY IN INCREASING
  - NOT PORTABLE
  - INFERIOR GAS EXCHANGE
  - HIGHER RISK OF PNEUMOTHORAX

CPAP INTERFACES

ONES I HAVE USED

- INCA
- HUDSON
- FISHER & PAYKEL MASK AND PRONGS
- BABI.PLUS
- RAM

ONES I PREFER

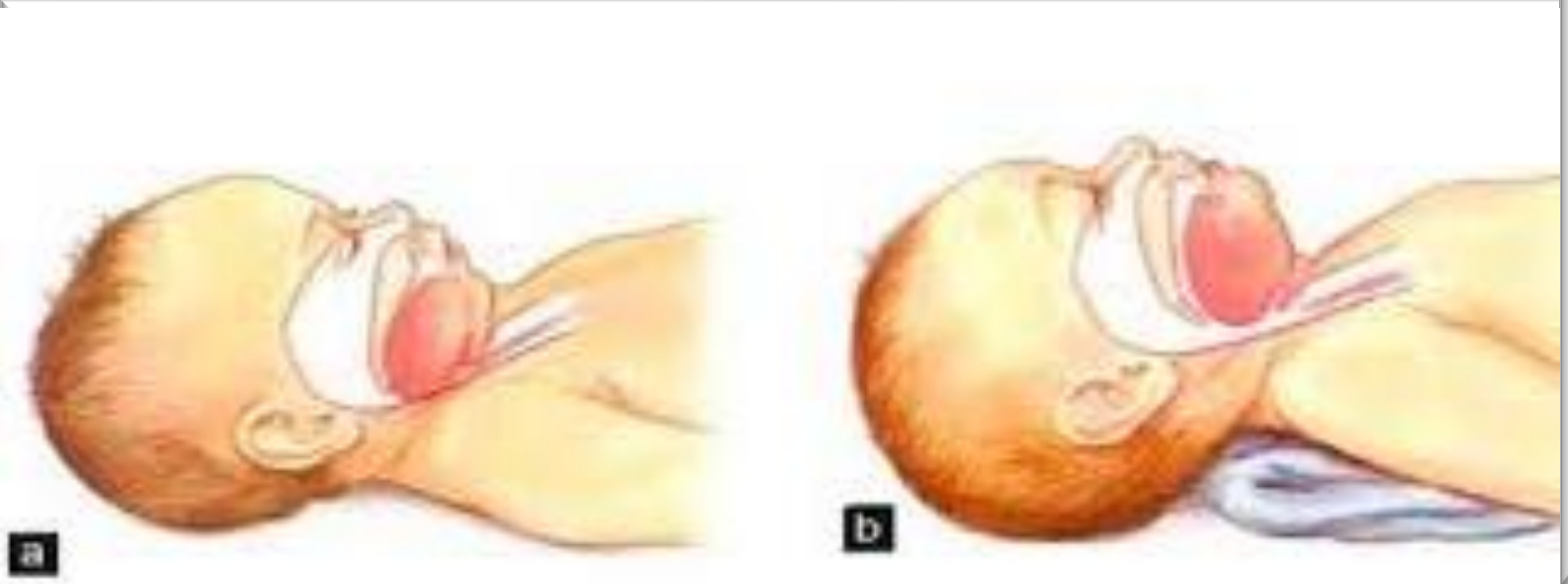
- HUDSON PRONGS SUPPLEMENTED WITH INCA 7.5 & 9 WITH BABI.PLUS HAT
- FISHER & PAYKEL MASK
- RAM…**ONLY** IN CERTAIN CIRCUMSTANCES

HUDSON

- CURVED PRONGS
- LOTS OF SIZES PLUS CAN SUPPLEMENT WITH **INCA 7.5 & 9**
- LONG TRACK RECORD
- LABOR INTENSIVE
- SEPTAL BREAKDOWN
- USE WITH **BABI.PLUS HAT** ELIMINATES NEED FOR SAFETY PINS AND RUBBER BANDS

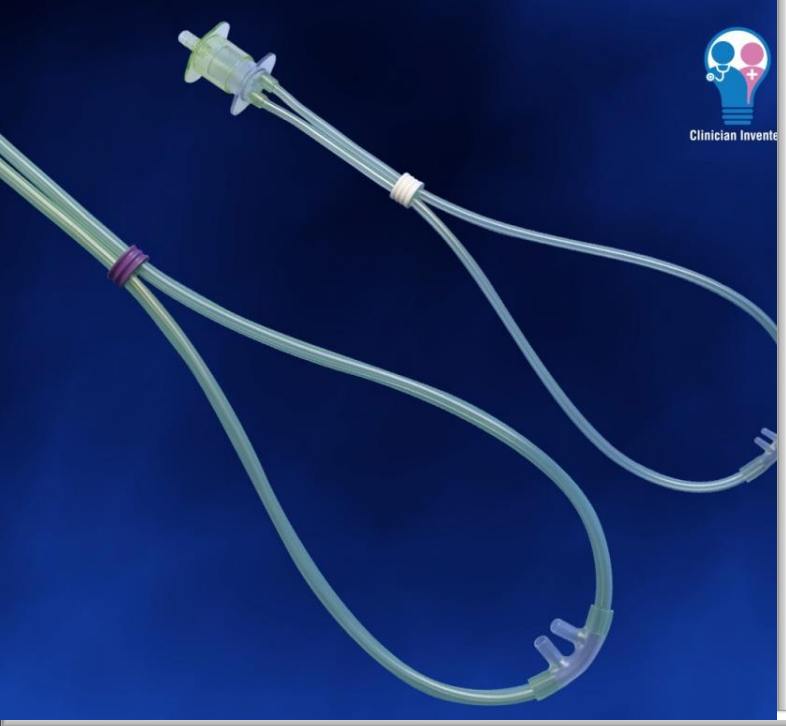
FISHER & PAYKEL MASK AND PRONGS

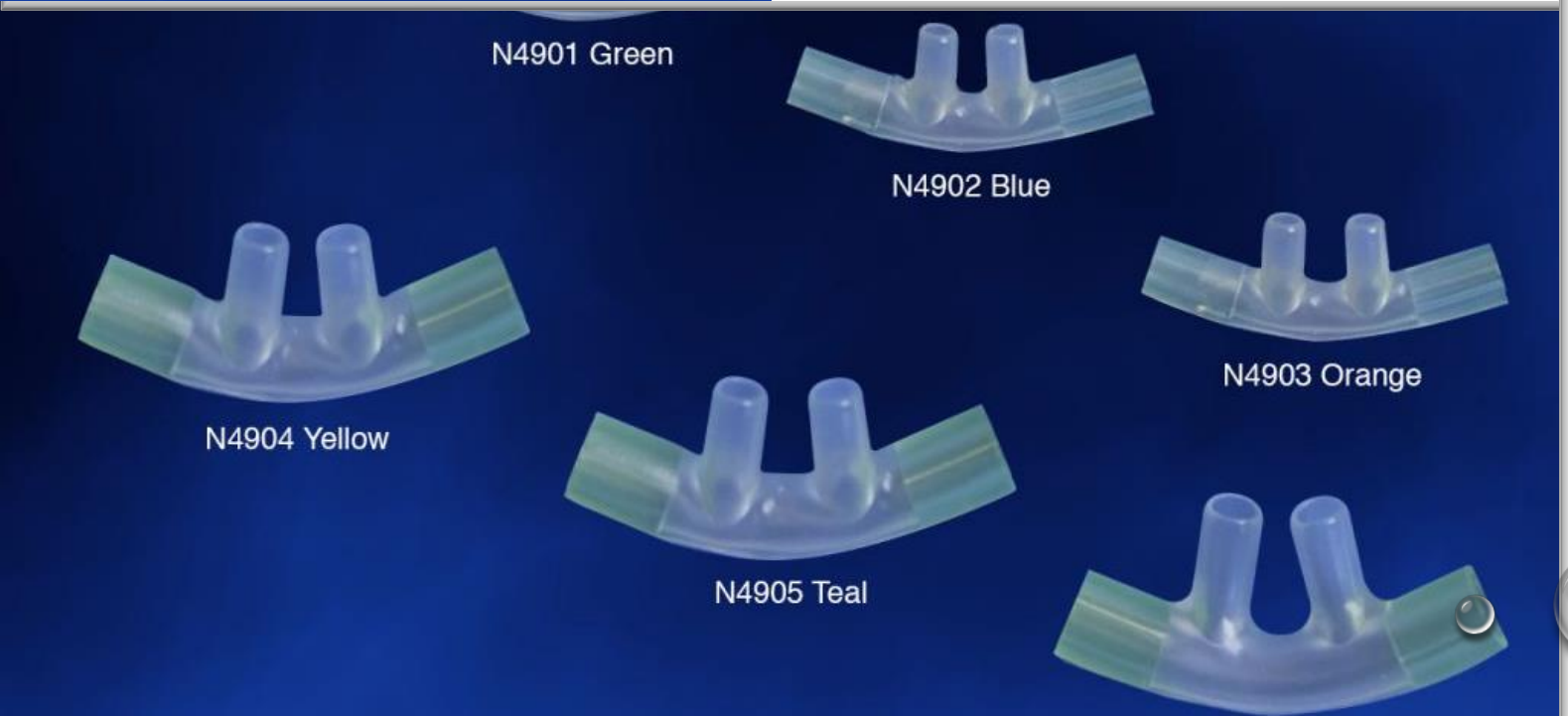
- MULTIPLE SIZES OF TRUNKS, MASKS, PRONGS
- EASY TO SET UP AND APPLY MASK
- IF TIGHTENED TOO MUCH CAUSES EYE EDEMA, DEPRESSED NASAL BRIDGE, SKIN BREAKDOWN
- PRONGS OFTEN NOT WELL TOLERATED
- BMC STAFF ALTERNATES 2 MASK SIZES



ACCESSORIES

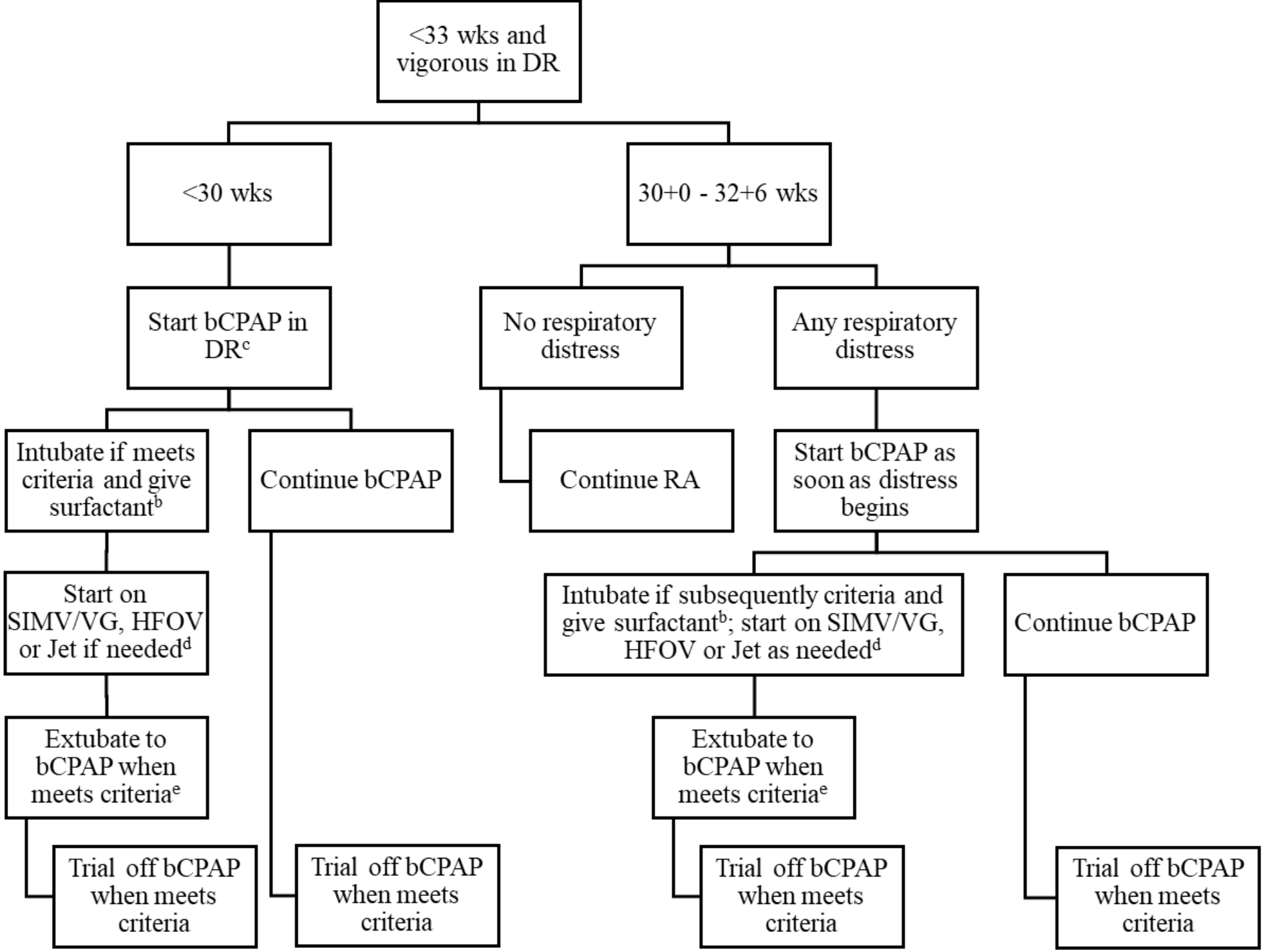
- CHIN STRAP
- 6.5 OR 8F OG TUBE
- SHOULDER ROLL

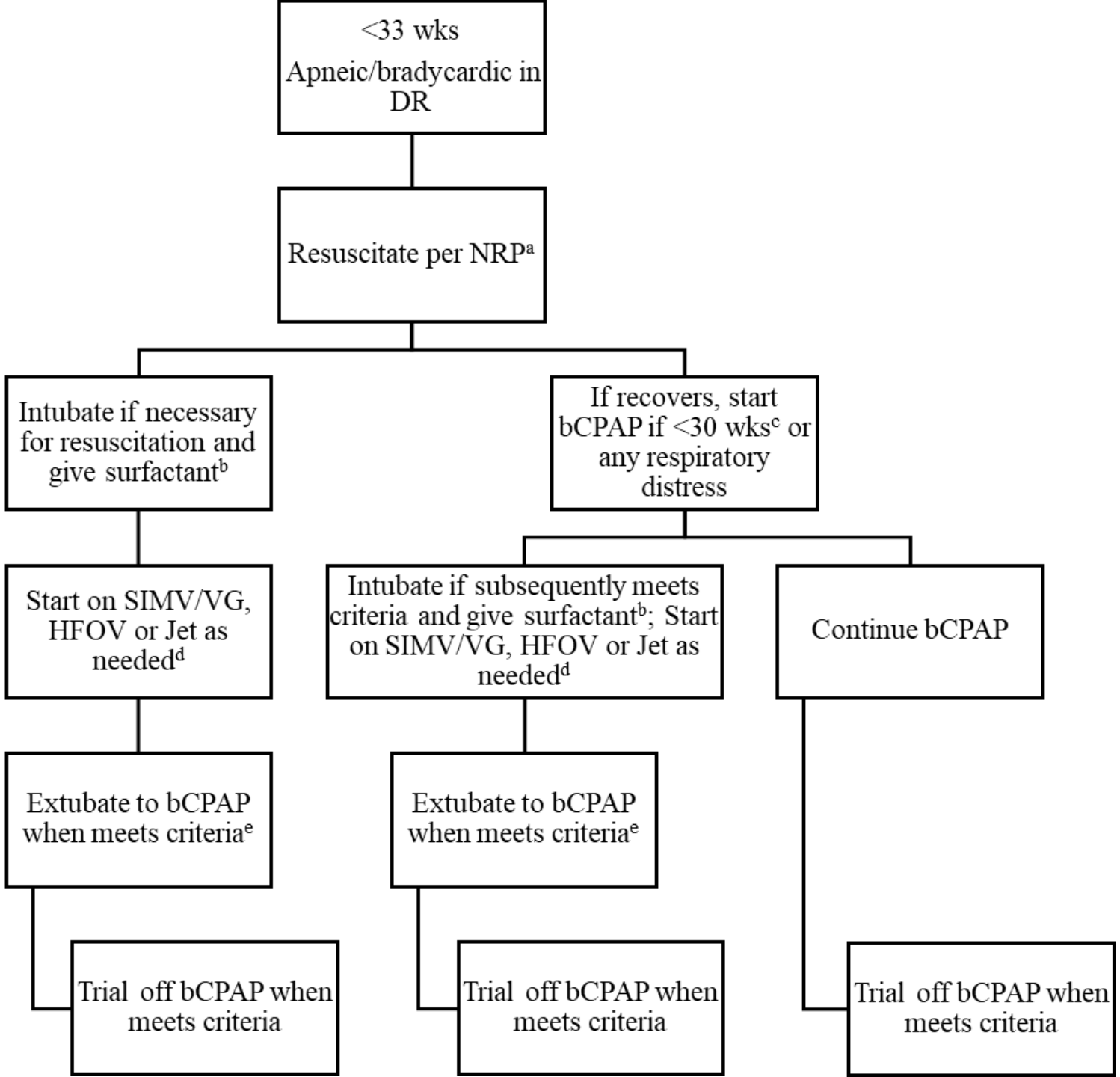




RAM CANNULA

- OFTEN A STAFF FAVORITE
- COMFORTABLE FOR BABY AND LOW MAINTENANCE
- MULTIPLE SIZES, MEANT TO FIT LIKE A NASAL CANNULA (NOT TO FILL NARE)
- HIGH RESISTANCE
- DOES NOT DELIVER INTENDED PRESSURE
- HIGHER RATES OF CPAP FAILURE
- BMC USES FOR LATE PRETERM, TERM INFANTS AND PCA >32-34 WEEKS


<33 wks and vigorous in DR
<30 wks
30+0 - 32+6 wks
Start bCPAP in DR[c]
No respiratory distress
Any respiratory distress
Intubate if meets criteria and give surfactant[b]
Continue bCPAP
Continue RA
Start bCPAP as soon as distress begins
Start on SIMV/VG, HFOV or Jet if needed[d]
Intubate if subsequently criteria and give surfactant[b]; start on SIMV/VG, HFOV or Jet as needed[d]
Continue bCPAP
Extubate to bCPAP when meets criteria[e]
Extubate to bCPAP when meets criteria[e]
Trial off bCPAP when meets criteria
Trial off bCPAP when meets criteria
Trial off bCPAP when meets criteria
Trial off bCPAP when meets criteria


<33 wks
Apneic/bradycardic in DR
Resuscitate per NRP[a]
Intubate if necessary for resuscitation and give surfactant[b]
If recovers, start bCPAP if <30 wks[c] or any respiratory distress
Start on SIMV/VG, HFOV or Jet as needed[d]
Intubate if subsequently meets criteria and give surfactant[b]; Start on SIMV/VG, HFOV or Jet as needed[d]
Continue bCPAP
Extubate to bCPAP when meets criteria[e]
Extubate to bCPAP when meets criteria[e]
Trial off bCPAP when meets criteria
Trial off bCPAP when meets criteria
Trial off bCPAP when meets criteria

Intubation/Re-intubation Criteria	Extubation Criteria	Trial off bCPAP Criteria
• FiO_2 ≥0.40[a] • Significant WOB/retractions • Frequent apneic episodes (>6/6 hrs requiring vigorous stimulation or more than 1 requiring PPV) • Arterial pH <7.20 and $PaCO_2$ >65 mmHg on 2 gasses >30 minutes apart • Capillary pH <7.19 and $PcCO_2$ >68 mmHg on 2 gasses >30 minutes apart • Venous pH <7.17 and $PvCO_2$ >71 mmHg on 2 gasses >30 minutes apart • Refractory metabolic acidosis • Need for anesthetic or intervention requiring intubation	• FiO_2 <0.3[a] • PaCO2 <60 mmHg • Peak inspiratory pressure <20 cmH_2O • Ventilator rate <20 • Spontaneous breathing over the ventilator • Consider extubating to bCPAP 7-9 cmH_2O if prolonged MV, evidence of lung disease, and/or FiO2 ≥0.25[a] • Caffeine for all infants <1250 gram birth weight and/or per attending discretion	• bCPAP 5 x RA for ≥48 hrs[a] • No significant retractions/WOB • Infrequent spells • RR <60 for past 24 hours • Restart bCPAP if RR >70, requires supplemental O_2, ↑WOB or ↑spells • Generally should wait 2-5 days between trials off bCPAP. • If unable to wean off bCPAP to RA and >34 weeks PMA, may consider continuing bCPAP (nasal mask or prong or RAM cannula) *OR* sprinting off bCPAP on either RA or HFNC *OR* weaning to HFNC • bCPAP may be used to re-recruit lung volumes in infants on RA or NC, as needed.

STARTING CPAP IN THE DELIVERY ROOM

- SET UP:
  - <30 WEEKS GA, BE FULLY PREPARED TO APPLY CPAP IMMEDIATELY AFTER BIRTH
  - 30-33 WEEKS GA, BE ABLE TO START WITHIN MINUTES
  - >33 WEEKS, CPAP WITH BAG AND MASK OFTEN GOOD ENOUGH
- DRY, SUCTION, STIMULATE, PLACE ON CPAP IMMEDIATELY (<30WEEKS) OR AT FIRST SIGN OF DISTRESS
  - IF NEEDED, PROVIDE PPV AND THEN START CPAP
  - IF UNABLE TO ESTABLISH ADEQUATE RESPIRATORY EFFORT, INTUBATE IN DR
- PLACE OG TUBE AND CHIN STRAP PRIOR TO LEAVING DR
- IF INADEQUATE RESPIRATORY EFFORT/APNEA/BRADYCARDIA/HYPOXIA ON CPAP, THEN INTUBATE

INITIAL MANAGEMENT OF RDS

- HUDSON: START WITH CPAP 5, FISHER & PAYKEL START WITH CPAP 6
- TITRATE UP IF NECESSARY, TO 6-7 (NOT 8), BUT IF FIO2 REACHES 40%, EVEN BRIEFLY, INTUBATE
- GENERALLY, INFANTS WHO WILL SUCCEED ON CPAP USUALLY WEAN TO CPAP X RA IN DR OR SHORTLY AFTER ADMISSION TO THE NICU, THEN MAY INCREASE TO 30-32% IN THE FIRST DAY, THEN WEAN BACK TO RA CPAP
- INFANTS WHO NEVER WEAN TO CPAP X RA WILL LIKELY FAIL
- INFANTS WHO MET CRITERIA FOR SURFACTANT BUT ARE NOT INTUBATED HAVE A HIGH RISK OF PNEUMOTHORAX
- CUROSURF FOR SURFACTANT REPLACEMENT

MECHANICAL VENTILATION

- START WITH CONVENTIONAL VENTILATION
  - ST E'S: PRESSURE-CONTROLLED SIMV VENTILATION
  - BMC: SIMV VOLUME-GUARANTEE VENTILATION
- INITIAL SETTINGS
  - PRESSURE-CONTROLLED SIMV 20-25/5 X 20-25, ITIME 0.35, PS 5
  - SIMV VOLUME-GUARANTEE 5 ML/KG X 20-25, ITIME 0.35, PS 5
- HIGH FREQUENCY VENTILATION FOR RESCUE
  - JET IF AIR LEAK/PIE

EXTUBATION TO CPAP

- SUCCESSFUL EXTUBATION TO CPAP VARIES BY GESTATIONAL AGE
  - 23-26 WEEKERS, ROUGHLY 50% FAIL AT BMC (IF FAILING, RE-INTUBATE THIS AGE GROUP QUICKLY)
- IF MEETS CRITERIA BUT NOT EXTUBATED, WILL SEE GRADUAL WORSENING OVER NEXT FEW DAYS
- PROCEDURE TO FOLLOW
  - ENSURE BREATHING OVER THE VENTILATOR, CAFFEINE GIVEN
  - HAVE BUBBLE CPAP COMPLETELY SET UP WITH MASK/PRONGS OF APPROPRIATE SIZE ATTACHED
  - SUCTION ETT, MOUTH, NARES, POSTERIOR PHARYNX
  - PLACE ROLL UNDER SHOULDERS
  - PLACE ON CPAP IMMEDIATELY AFTER EXTUBATION
  - PLACE OG TUBE TO GRAVITY
  - APPLY CHIN STRAP

WEANING OFF CPAP

- GENERALLY TRY TO KEEP ELBW INFANTS ON CPAP FOR AS LONG AS POSSIBLE
- WEAN PRESSURE BY 1 CMH20 EVERY 1-2 DAYS IF RESPIRATORY RATE <60 UNTIL ON CPAP5
- IF UNABLE TO WEAN OFF CPAP BY 32-34 WEEKS PCA, CAN ELECT TO TRANSITION TO RAM
- IF ESTABLISHED CLD, TRANSITION TO HFNC AFTER 36 WEEKS, GRADUALLY WEAN FLOW

VARIOUS COMPLICATIONS AND ANNOYANCES

- SKIN BREAKDOWN
  - MAINTAIN CUSHION OF AIR BETWEEN SEPTUM AND PRONGS, OPTIMIZE POSITIONING
  - MEPELEX ON BRIDGE OF NOSE FOR MASK USE
- RAIN OUT
  - SET HEATER/HUMIDIFIER AT 37 DEGREES
  - IF ISOLETTE >34 DEGREES KEEP TEMP PROBE OUT OF ISOLETTE
  - IF ISOLETTE <34 DEGREES CAN HAVE PROBE IN ISOLETTE BUT REMOVE EXTENSION TUBING
  - EMPTY CIRCUIT FREQUENTLY

CPAP BELLY

- PRONE POSITIONING
- GLYCERINE SUPPOSITORY
- INCREASE VENTING TIME
- GIVE FEEDS OVER SHORTER DURATION
- GIVE FEEDS Q4 INSTEAD OF Q3
- LARGER OG TUBE (8F INSTEAD OF 6.5F)
- TWO TUBES INSTEAD OF ONE
- MORE RIGID OG TUBES
- REDUCE CPAP FLOW RATE
- CONSIDER TRANSITIONING TO RAM

THANK YOU

HAPPY TO ANSWER QUESTIONS