Reproducibility of Bubble CPAP

Hany Aly, MD, MSHS, FAAP
Chair, Department of Neonatology
Cleveland Clinic Children's Hospital
Cleveland, OH

BPD Overtime at GW

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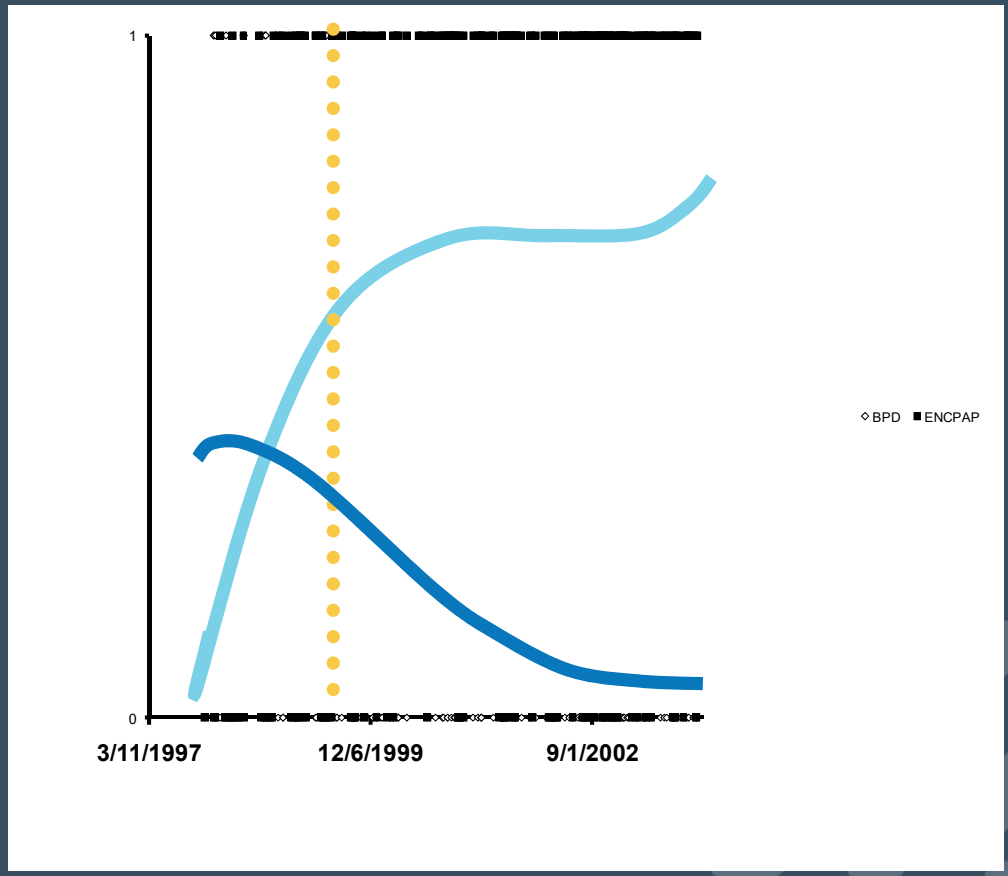
Does the Experience With the Use of Nasal Continuous Positive Airway Pressure Improve Over Time in Extremely Low Birth Weight Infants?

Hany Aly, Joshua D. Milner, Kantilal Patel and Ayman A.E. El-Mohandes

Pediatrics 2004;114;697
DOI: 10.1542/peds.2003-0572-L



Aly et al, Pediatrics 2005

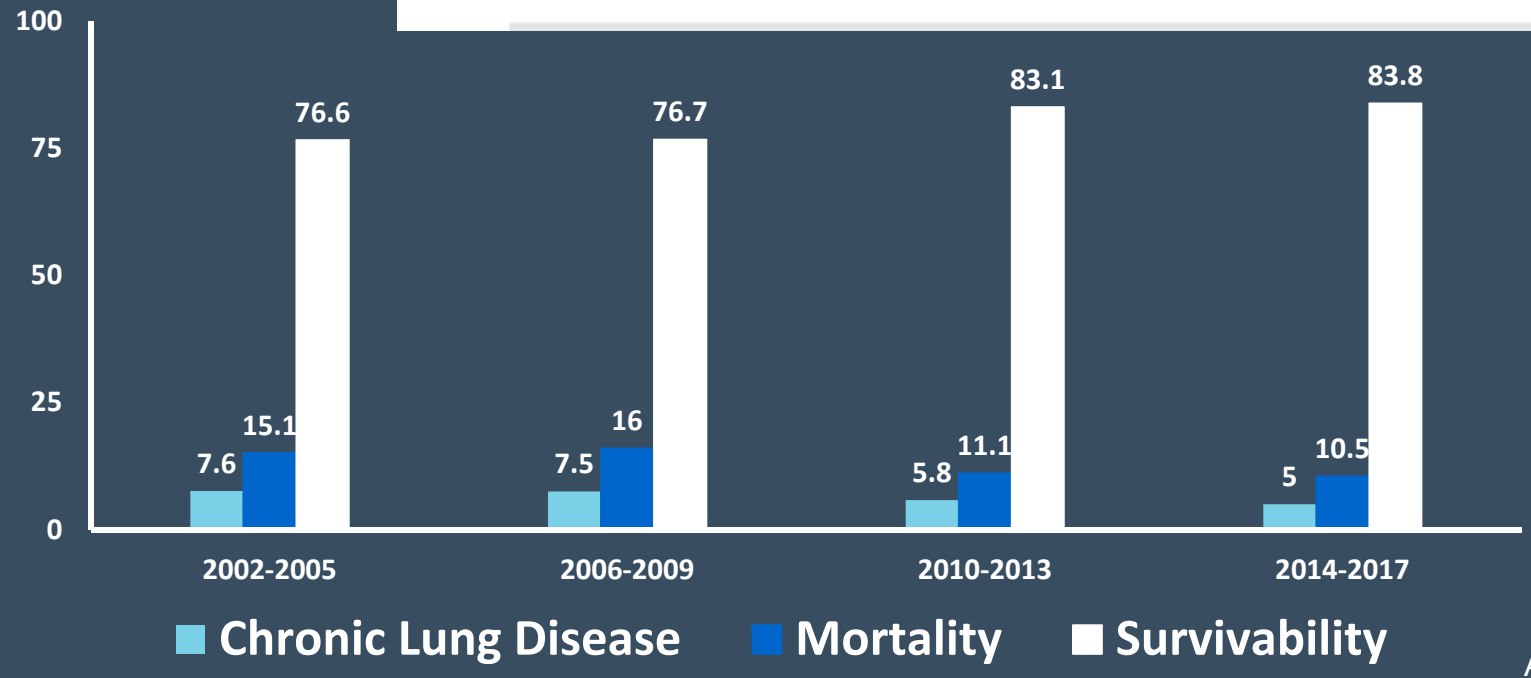
www.nature.com/pr

Pediatric RESEARCH

CLINICAL RESEARCH ARTICLE

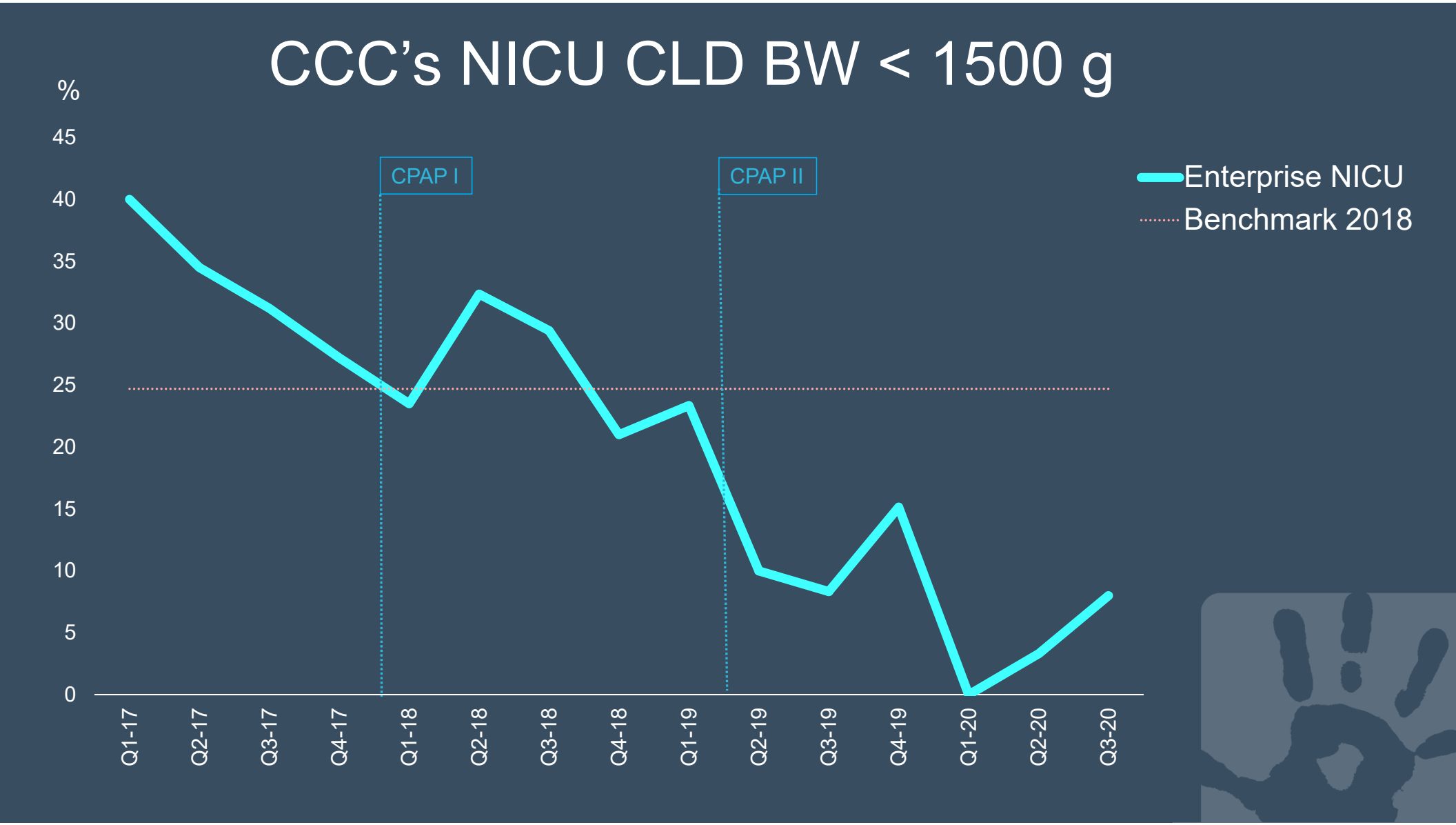
An experience with a bubble CPAP bundle: is chronic lung disease preventable?

Hany Aly[1,2] and Mohamed A. Mohamed[1]



Aly & Mohamed Pediatr Res 2020

CCC's NICU CLD BW < 1500 g

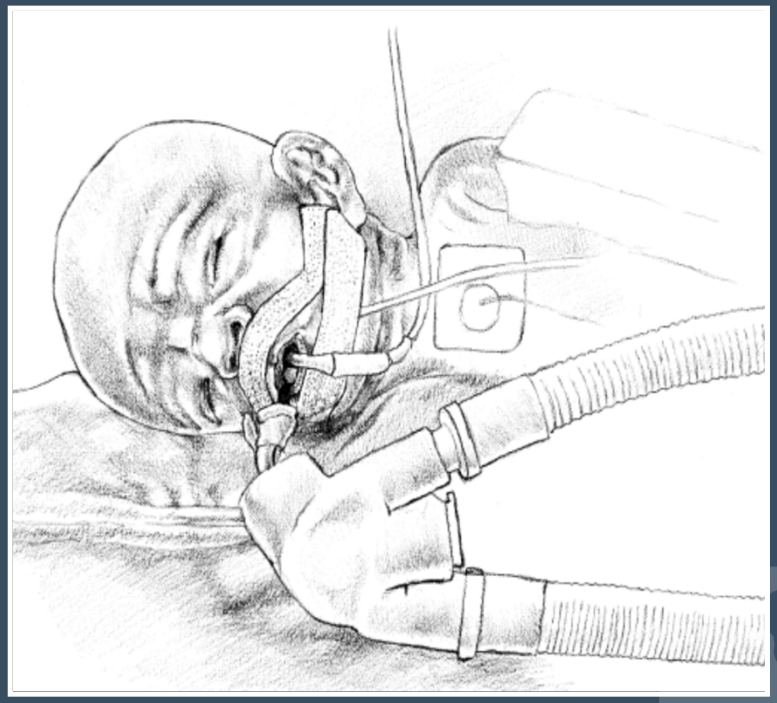


Objectives

- Identify the mechanism of ventilator associated lung injury
- Recognize the variation in chronic lung disease outcome among institutions
- Implement bubble CPAP in the NICU

- Concept (Why?)
- Skill (How?)

Respiratory Support



BPD

- Which of the following could prevent the development of BPD?
  - PTV (synchronized ventilation)
  - HFOV
  - Surfactant
  - Prenatal steroids
  - SOD (superoxide dismutase)
  - PDA ligation

Lung Injury Equation

RDS + ETT → CLD

Lung Injury...

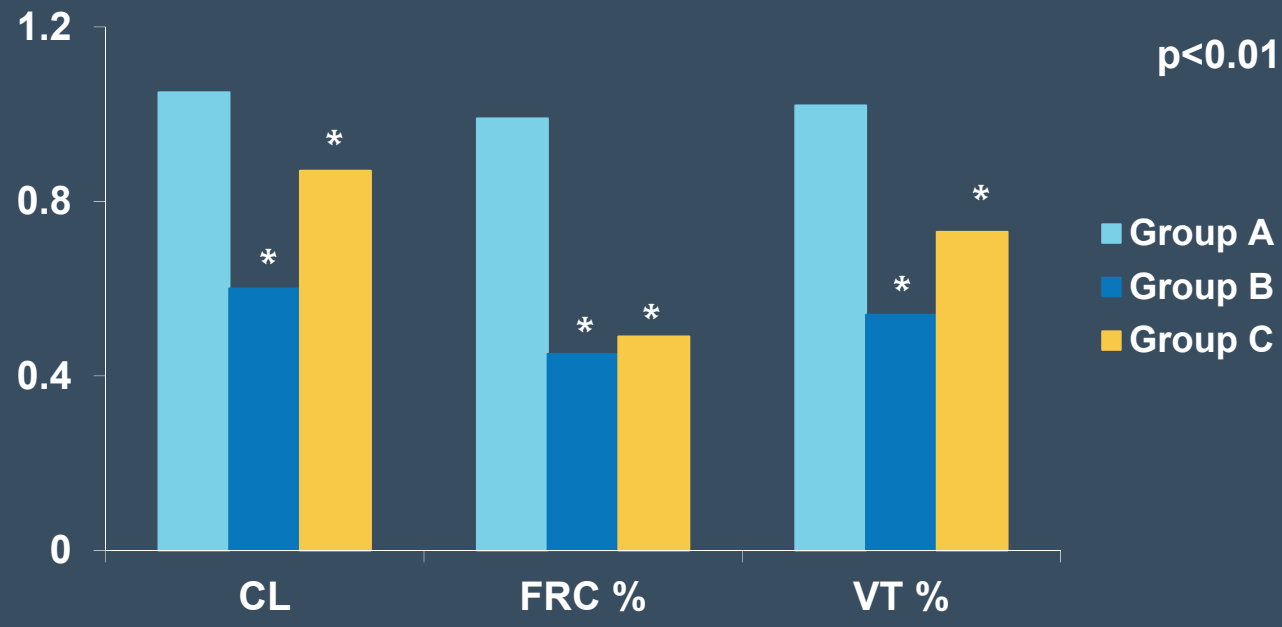
- 25 young adult sheep (wt 26 kg) were ventilated for 48 hours:
  - Group A (n=9): PIP <20 cm H_2O, FiO_2 =40%
  - Group B (n=7): PIP = 50 cm H_2O, FiO_2=40%
  - Group C (n=9):PIP= 50 cm H_2O, 3.8% CO_2
- Measurement:
  - Survival
  - CL, V_T, FRC
  - Histology

Kolobow et al, 1987

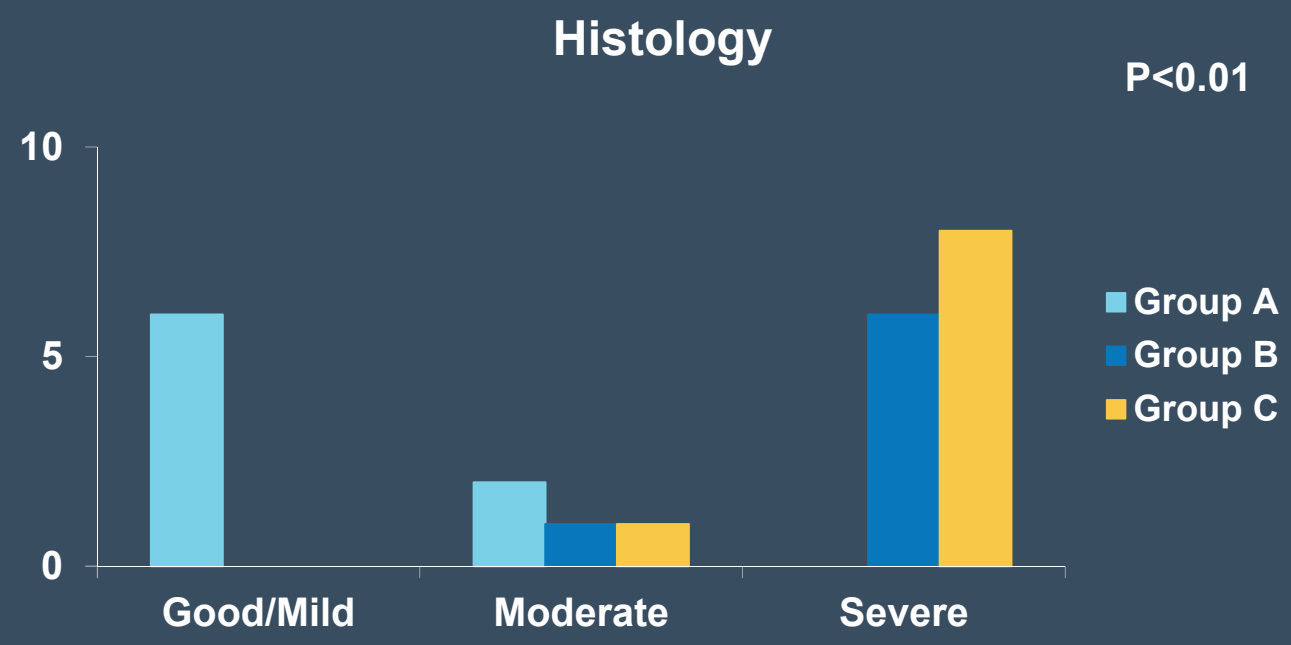
Lung Injury...

- All but 1 animal in Group A survived
- All animals in Group B died at a median of 23 hours (range 2 to 35 hours)
- 3 out of 9 animals in Group C survived. The median age of the remaining was 36.1 hours (range 10 to 44 hours)

Lung Injury...



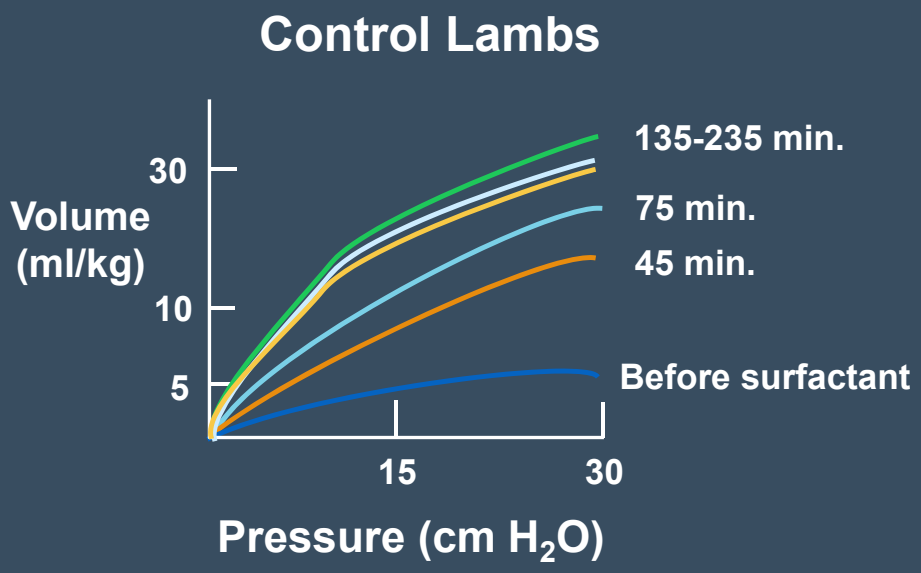
Lung Injury….

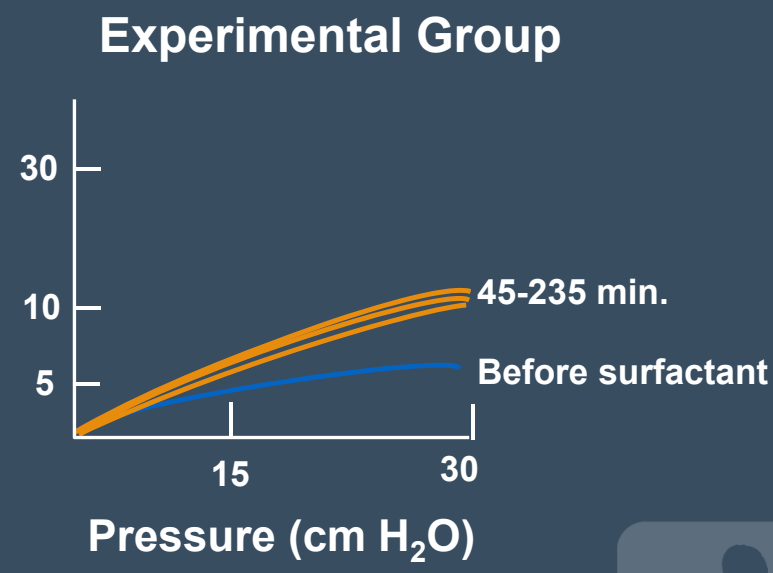

Histology
P<0.01
10
5
0
Good/Mild
Moderate
Severe
Group A
Group B
Group C

Delivery Room PPV

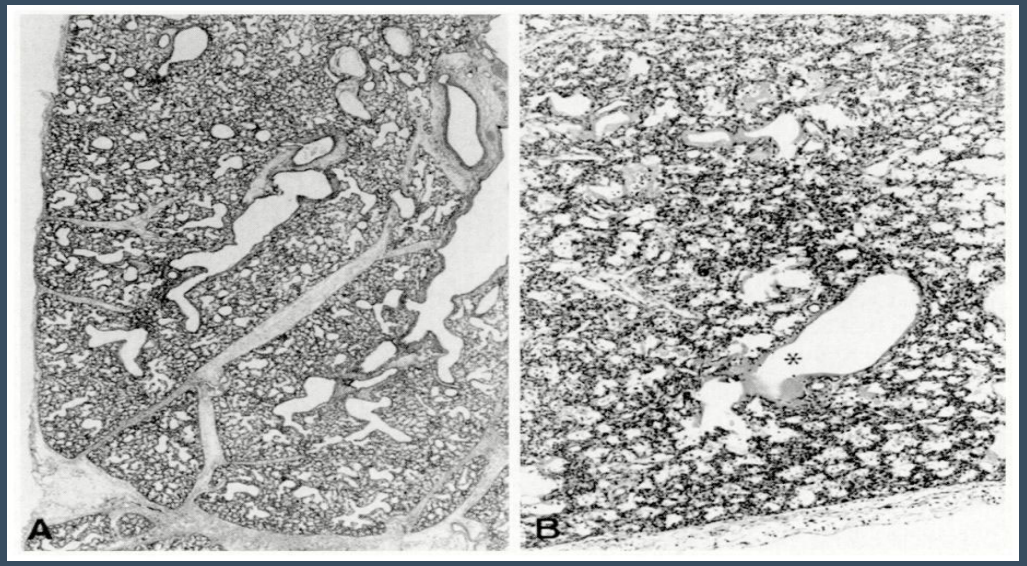
- Manual positive pressure ventilation with large breaths x 6 in premature lambs was associated with a decrease in compliance to 1/3 after surfactant administration.

Compliance after PPV in DR

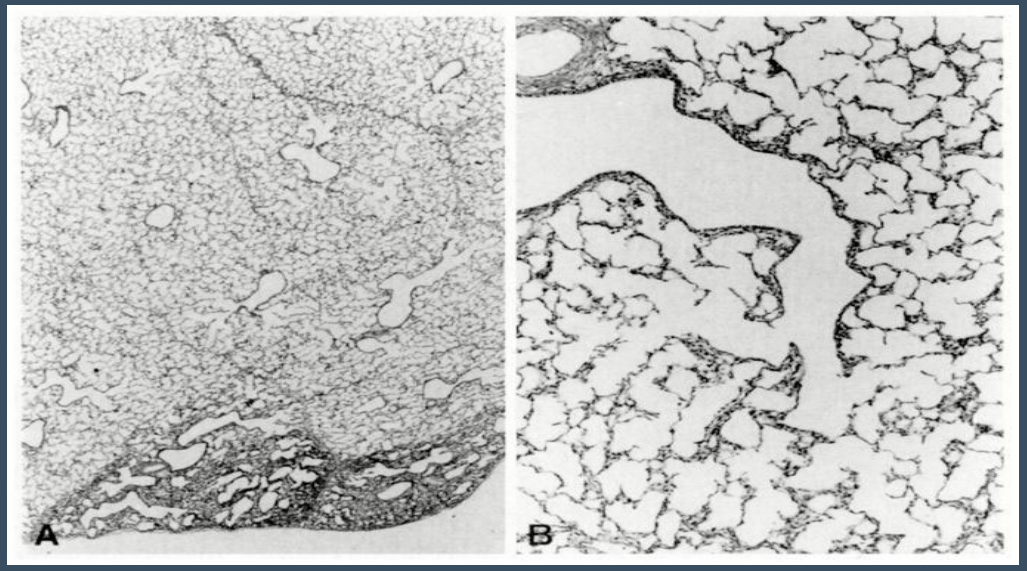




Bjorkland et al Ped. Res. 42: 348, 1997

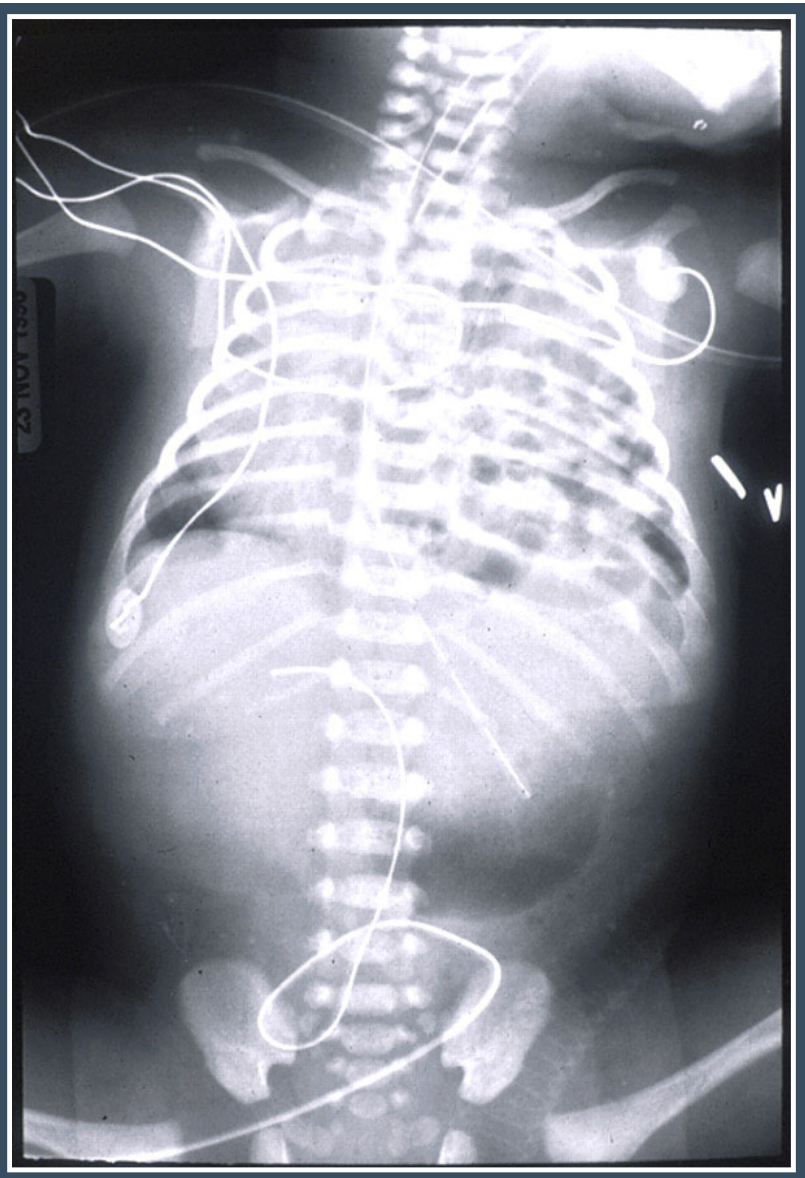


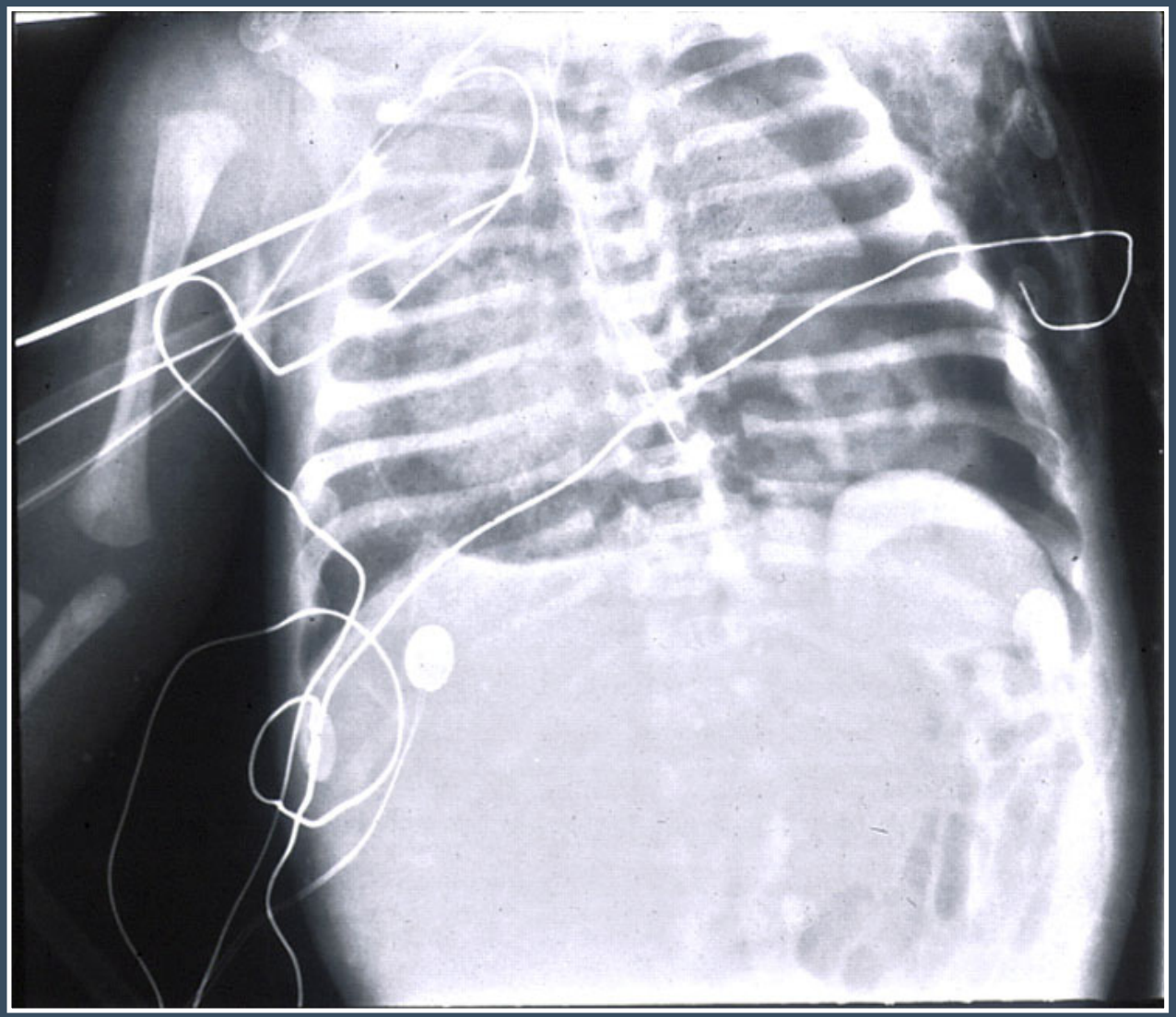
With Large PPV

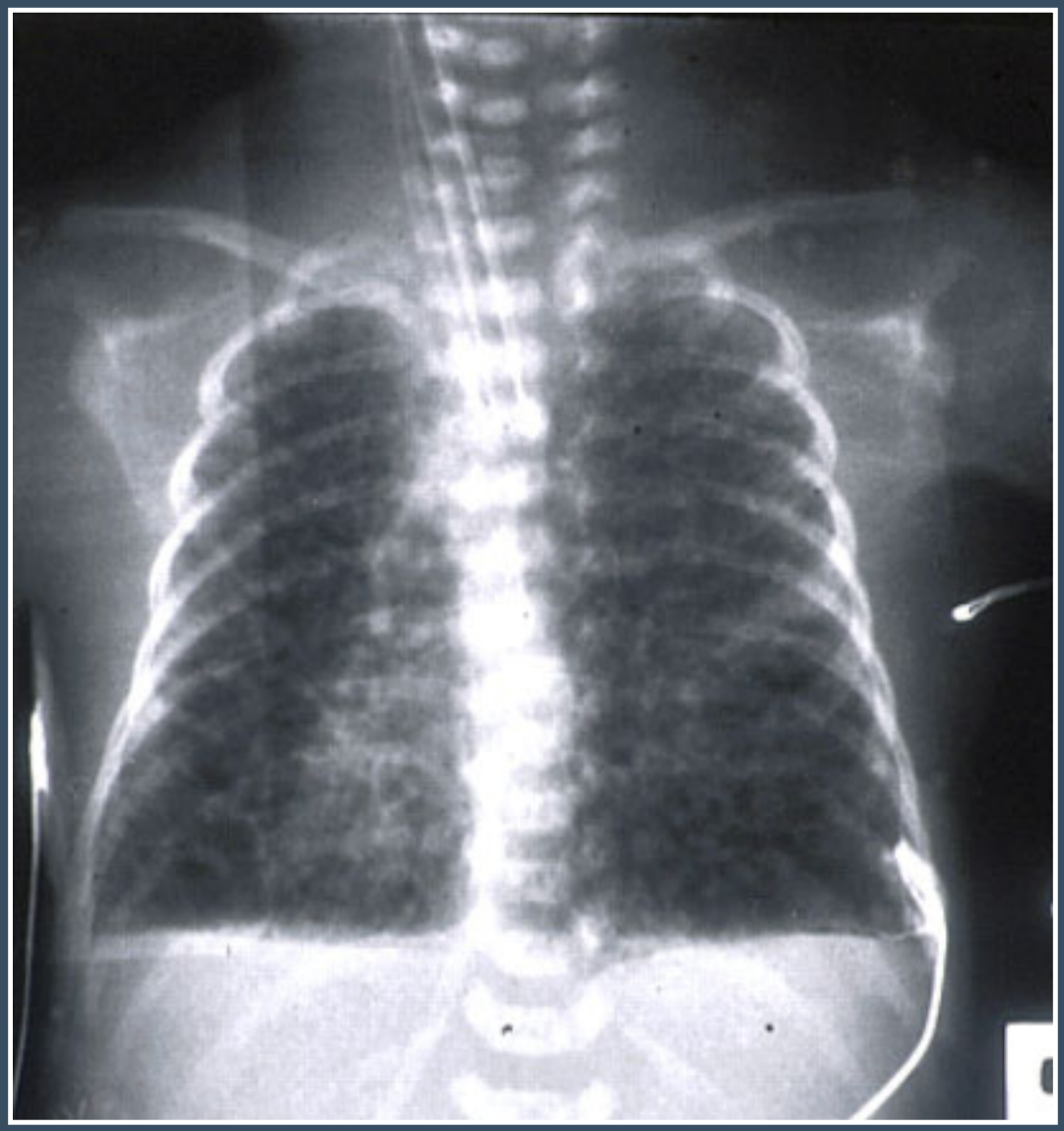


With Normal PPV

Bjorkland et al Ped. Res. 42: 348, 1997







Concept

- Neonatal lung is a *delicate* organ
- Pulmonary intervention even for a brief period can have serious long-term effects
- Pulmonary adverse outcomes are mostly related to pulmonary interventions rather than to the underlying disease itself
- *Therefore,* the least pulmonary support may produce the best outcomes

Non-invasive Tools

NIPPV
sNIPPV

HFNC

Ventilator CPAP

Bubble CPAP

RAM cannula

SiPAP

Nasal
cannula

The HIPSTER Trial- Early HFNC

- This multicenter trial comparing nasal high-flow therapy with CPAP as primary support for preterm infants ≥28 weeks with respiratory distress showed a significantly higher treatment-failure rate with high-flow therapy

Roberts et al, NEJM 2016

Primary Outcome: $FiO_2 \geq 0.4$ and Intubation $\leq$ 72 hrs

Outcome	High-Flow Group (N = 278)	CPAP Group (N = 286)	Risk Difference (95% CI)*	P Value
	no./total no. (%)		*percentage points*	
Primary intention-to-treat analysis				
Treatment failure within 72 hr	71/278 (25.5)	38/286 (13.3)	12.3 (5.8 to 18.7)	<0.001
Gestational age <32 wk	46/140 (32.9)	27/149 (18.1)	14.7 (4.8 to 24.7)	0.004
Gestational age ≥32 wk	25/138 (18.1)	11/137 (8.0)	10.1 (2.2 to 18.0)	0.01
Intubation within 72 hr	43/278 (15.5)	33/286 (11.5)	3.9 (–1.7 to 9.6)	0.17
Gestational age <32 wk	30/140 (21.4)	24/149 (16.1)	5.3 (–3.7 to 14.3)	0.25
Gestational age ≥32 wk	13/138 (9.4)	9/137 (6.6)	2.9 (–3.5 to 9.3)	0.38
Per-protocol analysis				
Treatment failure within 72 hr	64/264 (24.2)	36/279 (12.9)	11.3 (4.8 to 17.8)	<0.001
Intubation within 72 hr	39/264 (14.8)	33/279 (11.8)	2.9 (–2.8 to 8.7)	0.31

Roberts CT et al. N Engl J Med 2016;375:1142-1151

The HUNTER Trial- Early HFNC

- This multicenter trial comparing nasal high-flow therapy with CPAP as primary support for preterm infants ≥ 31 weeks with respiratory distress showed a significantly higher treatment-failure rate with high-flow therapy
- Failure rates ≤ 72 hours: 20.5% vs 10.2%

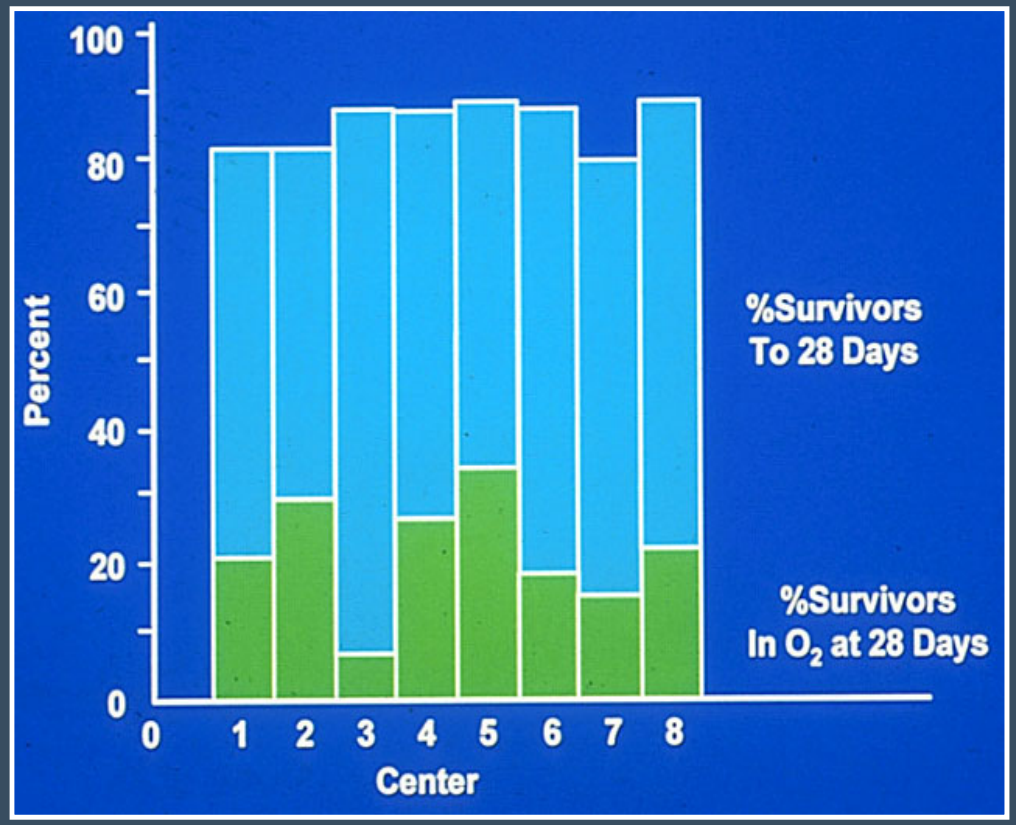
Manley et al, NEJM 2019

Conclusions

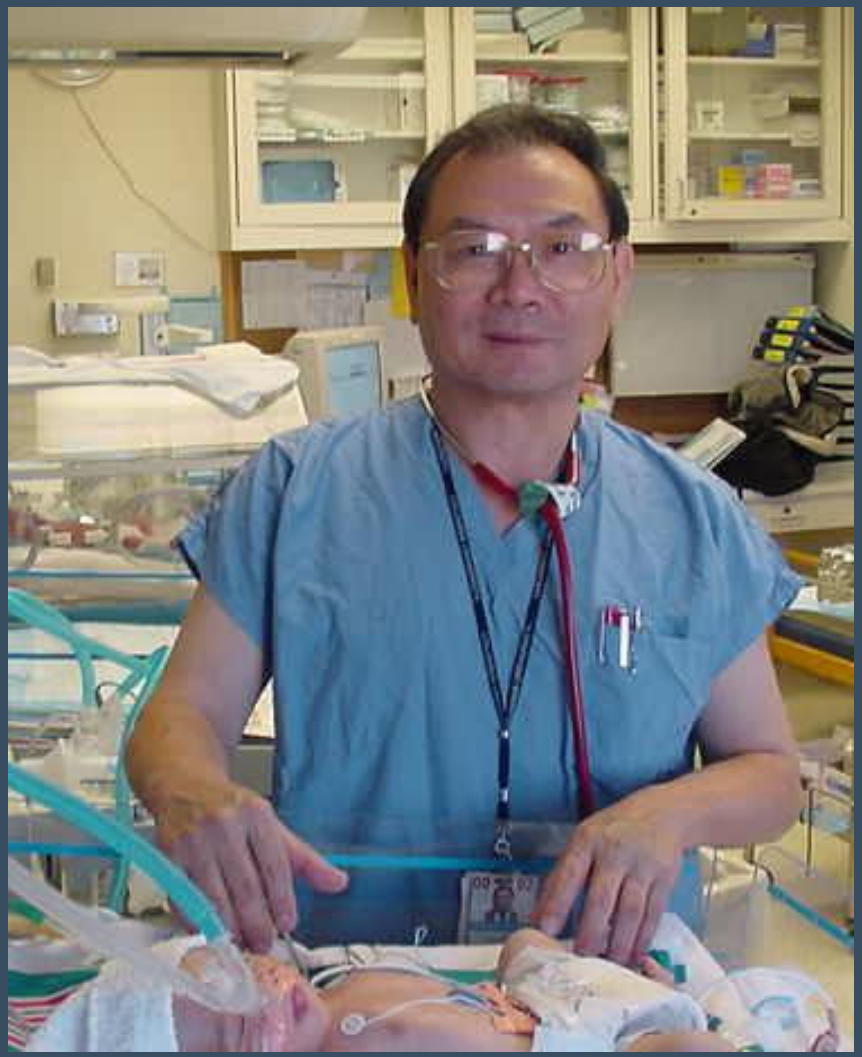
- When used as a primary support for preterm infants with respiratory distress, high-flow therapy resulted in a significantly higher rate of treatment failure than did CPAP

Mary Ellen Avery, MD

Infants on O_2 at 28 Days of Age



Avery M, et al., J Pediatric, 1987



Jen Tien Wung, MD

CPAP Effects

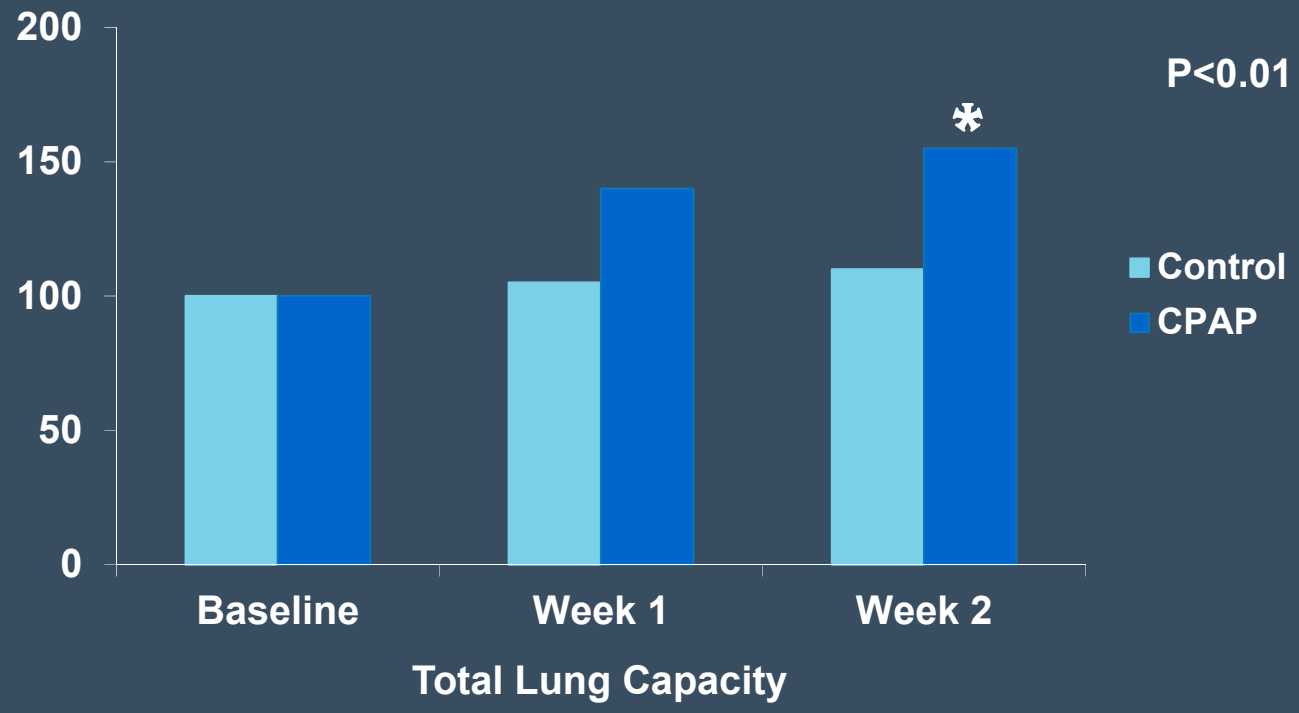
- Increases FRC
- Prevents alveolar collapse
- Increases compliance
- Conserves surfactant
- Splints airway and diaphragm
- Stimulates lung growth

CPAP and Lung Growth

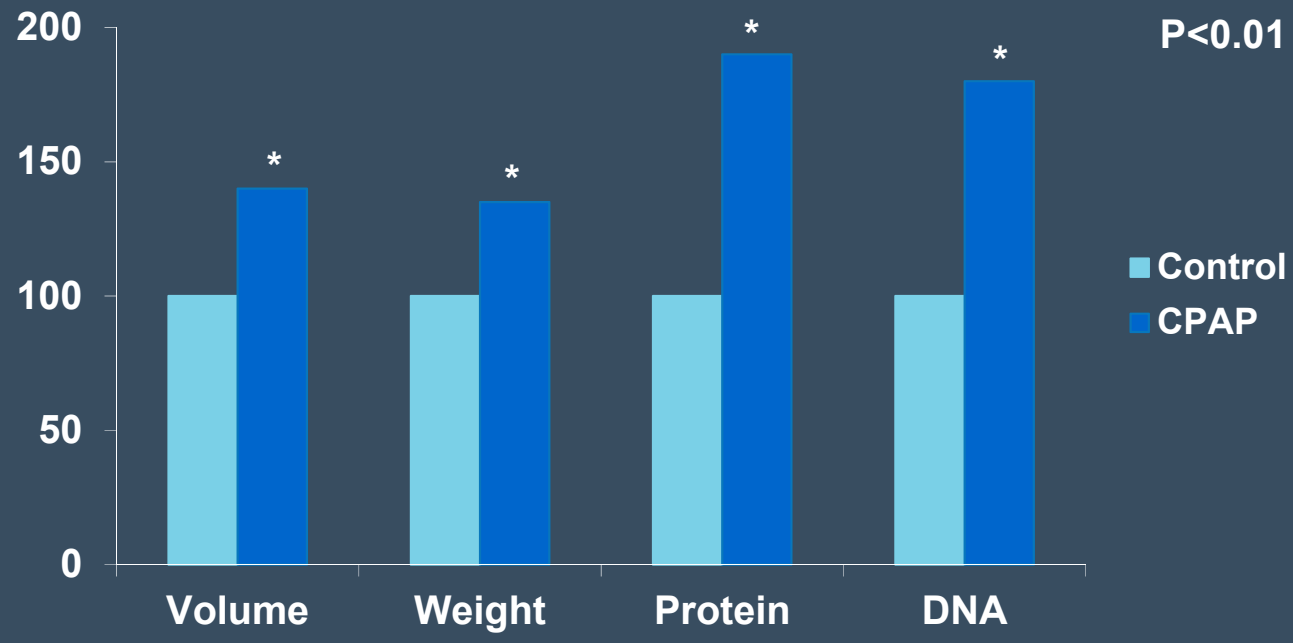
- 50 young male ferrets (wt= 350 g) were studied
- After having tracheostomy, they were randomly assigned to 2 groups:
  - CPAP Group (6 cm H_2O)
  - Control Group
- Measurement after 2 wks:
  - Lung volumes
  - Lung weight
  - Lung protein and DNA content

JAP, 1996:81:1471

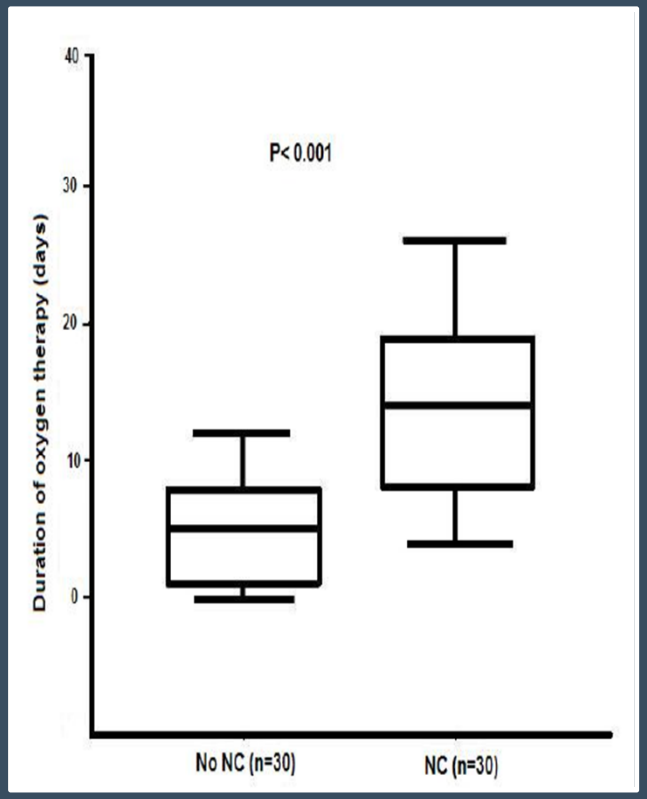
“Chronic” Use of CPAP

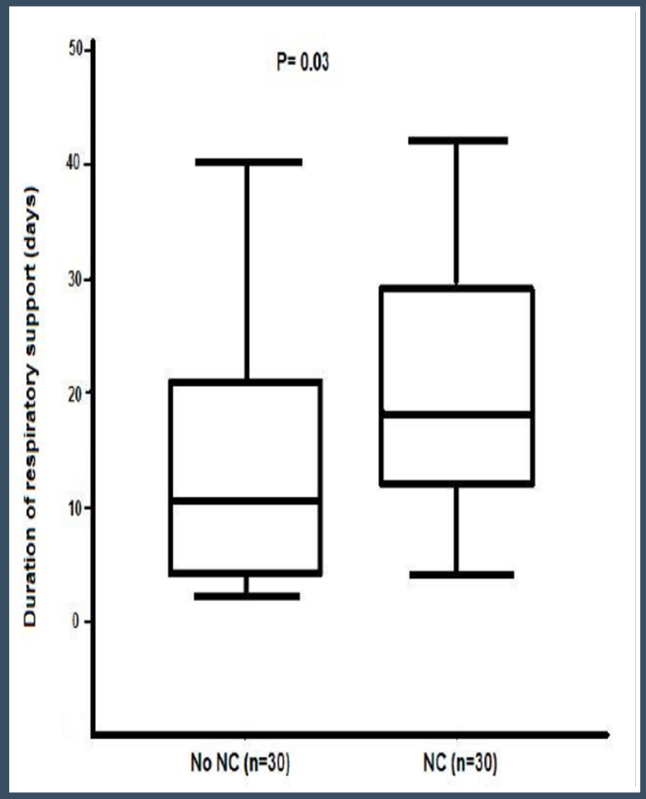


Lung Growth..



Weaning from CPAP to HF-NC



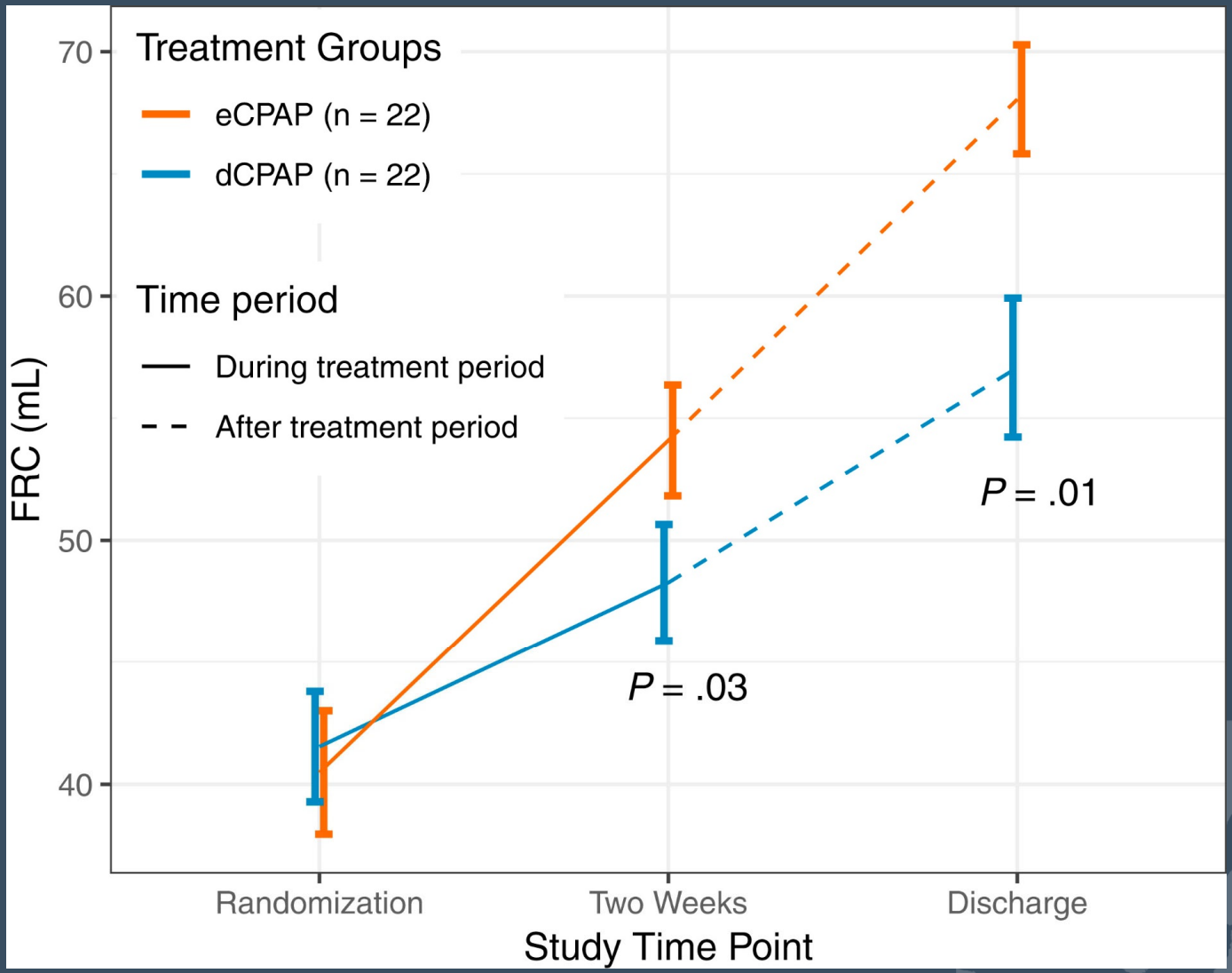


Abdel-Hady, Shouman, Aly, Early Hum Dev 2011

The Effect of Extended CPAP on Lung Volume

Lam R, J Pediatr (2020)

≤32 weeks infants required CPAP >24 hrs



The COIN Trial

- **Randomized** controlled trial for CPAP (no surfactant vs. ETT and vent (with surfactant)
- Less O_2 need at 28 days in CPAP group
- No difference at 36 weeks, but the trend is favorable for CPAP

Morley et al, NEJM 2008

COIN Trial Outcomes

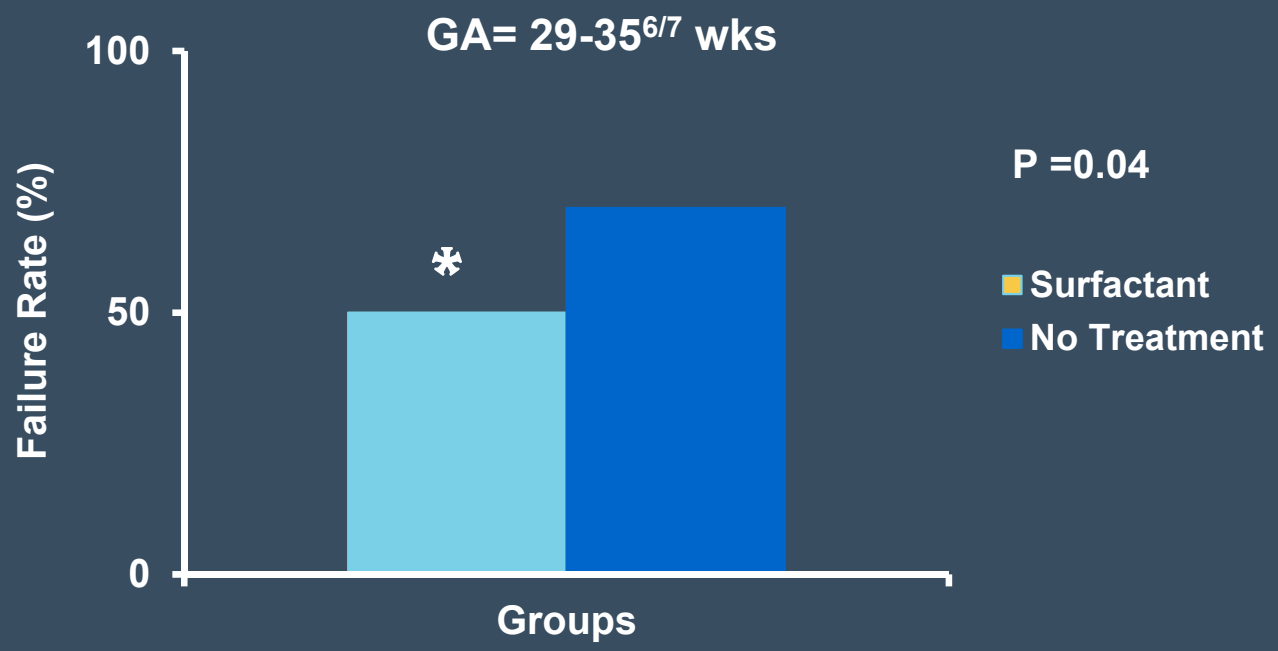
	CPAP	Intubation
Surfactant (%)	38	77
Days on CPAP	13	16
Days on O_2	42	49
Air leak (%)	14.6 *	6.6

* CPAP pressure = 8 CmH_2O

Relevance of the Current "Evidence-Based Medicine"

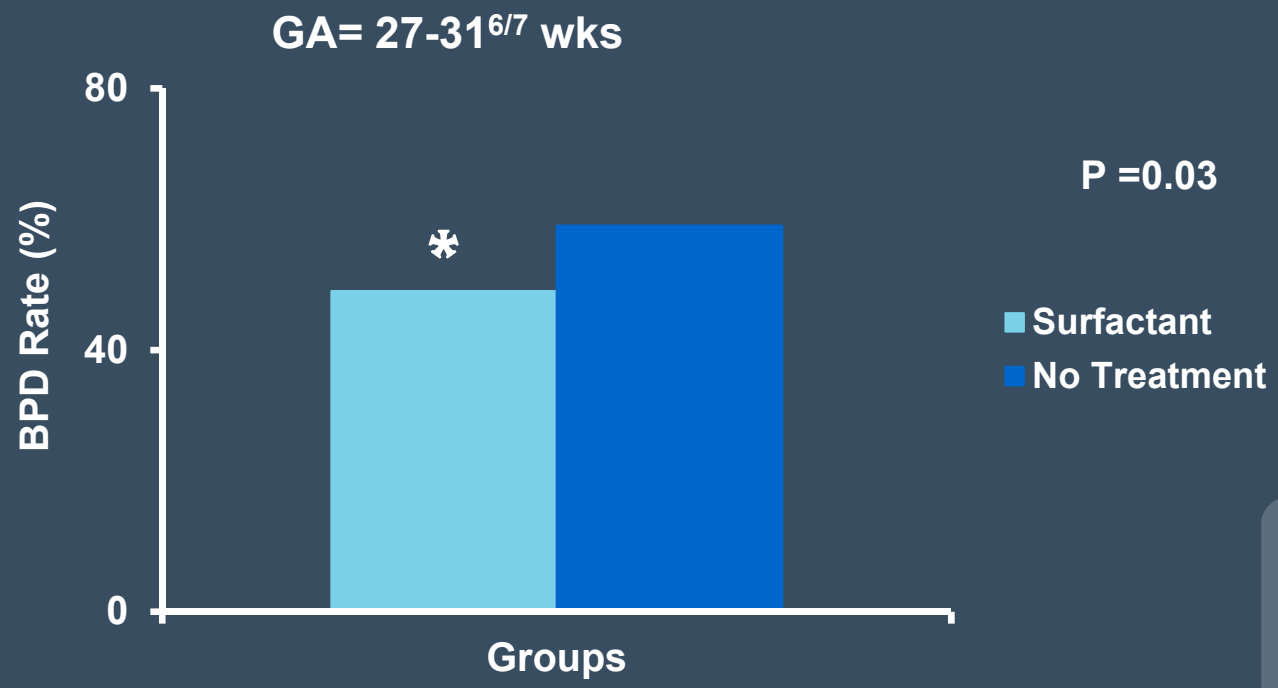
- Absence of evidence is not evidence of absence
- Presence of evidence:
  - Is the *process* scientific?
  - Does the *content* make sense?
- The current EBM practice should not preclude the use of ***common sense***

Surfactant and CPAP Success



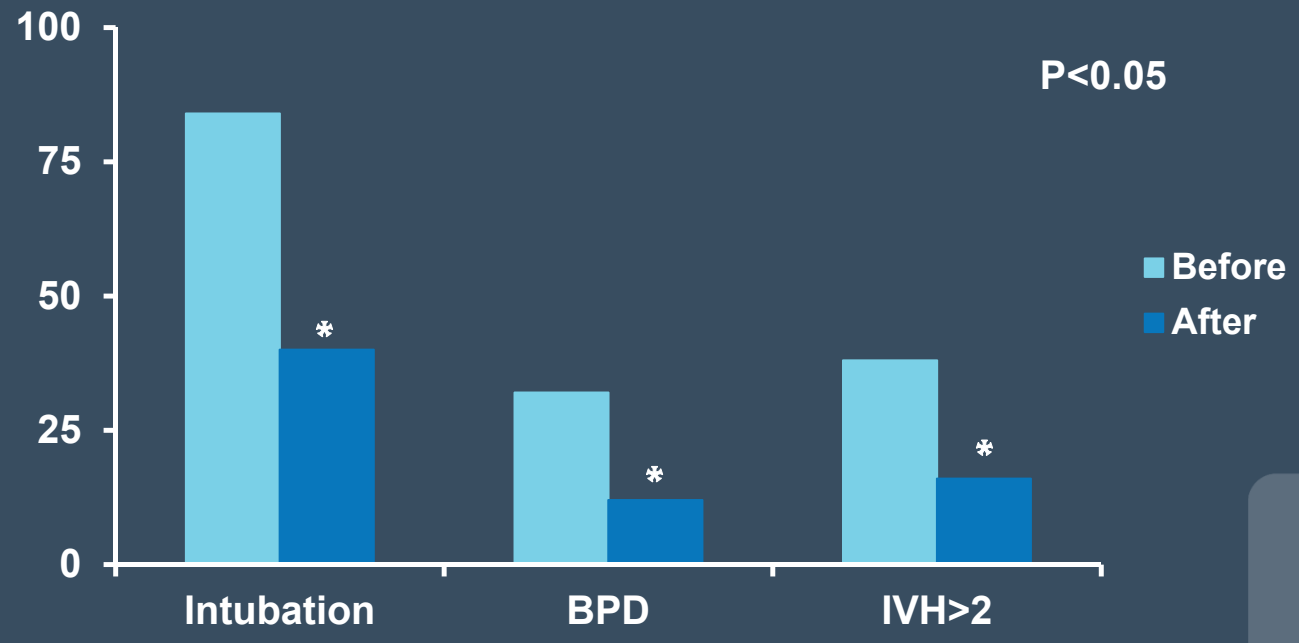
Reininger A, et al, 2005

Very Early Surfactant in CPAP Supported VLBW Infants



Rojas et al, Pediatrics 2009

CPAP in ELBW Infants



Linden et al, Pediatrics; 1999

IVH in VLBW Infants (n=342)

- In regression model, incidence of IVH was associated with:
  - Smaller birth weights (P=0.01)
  - DR intubation (P=0.03), the adjusted odds ratio for severe IVH in VLBW infants intubated in the DR was (OR= 2.7, CI: 1.1 – 6.6, P=0.03)
  - Cumulative mechanical ventilation during the first 3 days (P= 0.001).

Aly----Wung, Brain Dev, 2011

IVH & Intubation Attempts

- In 308 VLBW infants, severe IVH correlated with the number of intubation attempts in DR (OR 1.317, 95% CI 1.052-1.649, P = .016)
- In 102 infants with BW <750 g, severe IVH correlated with the number of intubation attempts during he first 4 days of life (OR 1.395, 95% CI 1.090-1.786, P = .008)

Sauer, J Pediatr. 2016;177:108-13

Early aEEG and NDO of VLBW infants

- 100 VLBW infants
- Infants with adverse NDO at 9 and 18 months were more likely to:
  - Be intubation in the delivery room (45% vs. 16%)
  - Have severe IVH (27% vs 5%)
  - Have abnormal EEG at 1 week (31% vs 8%)

El-Dib— Aly, Pediatr Int, 2011

BPD Overtime at GW

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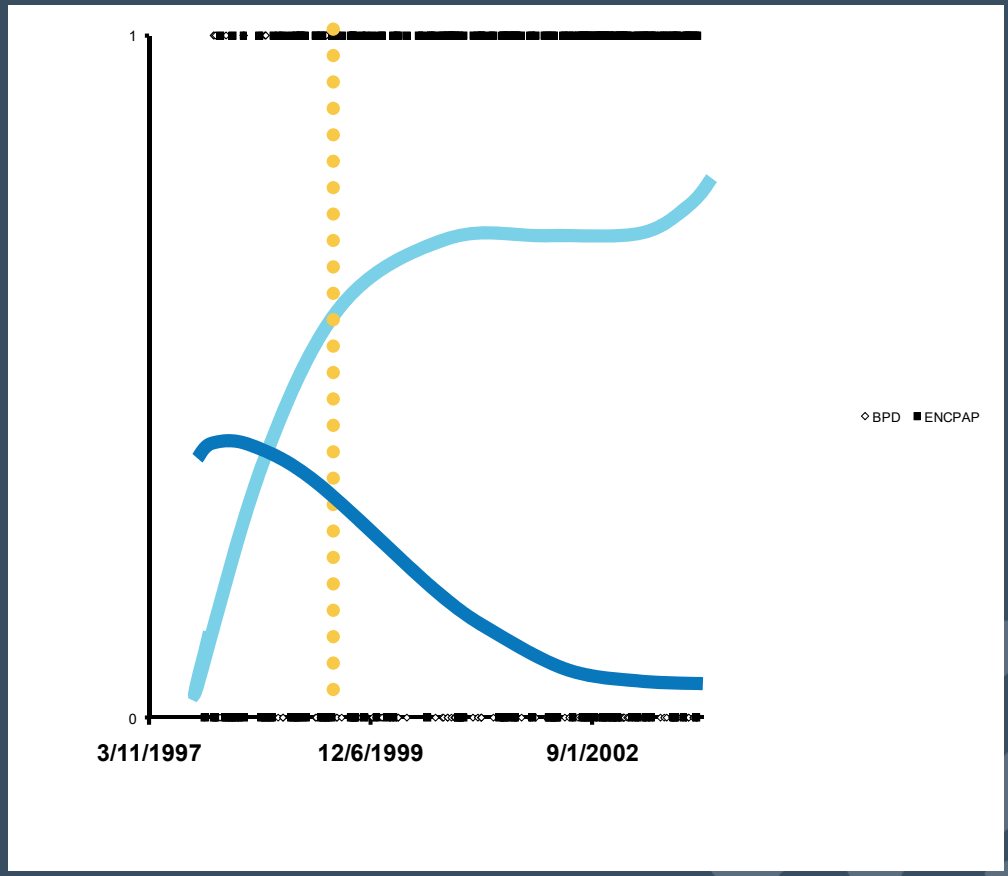
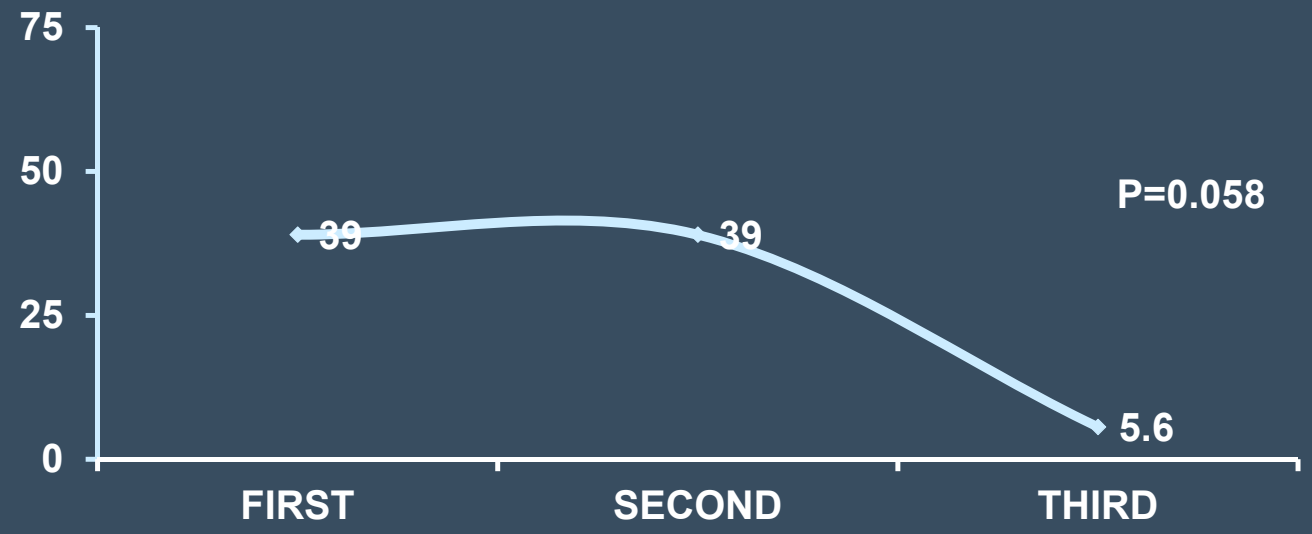
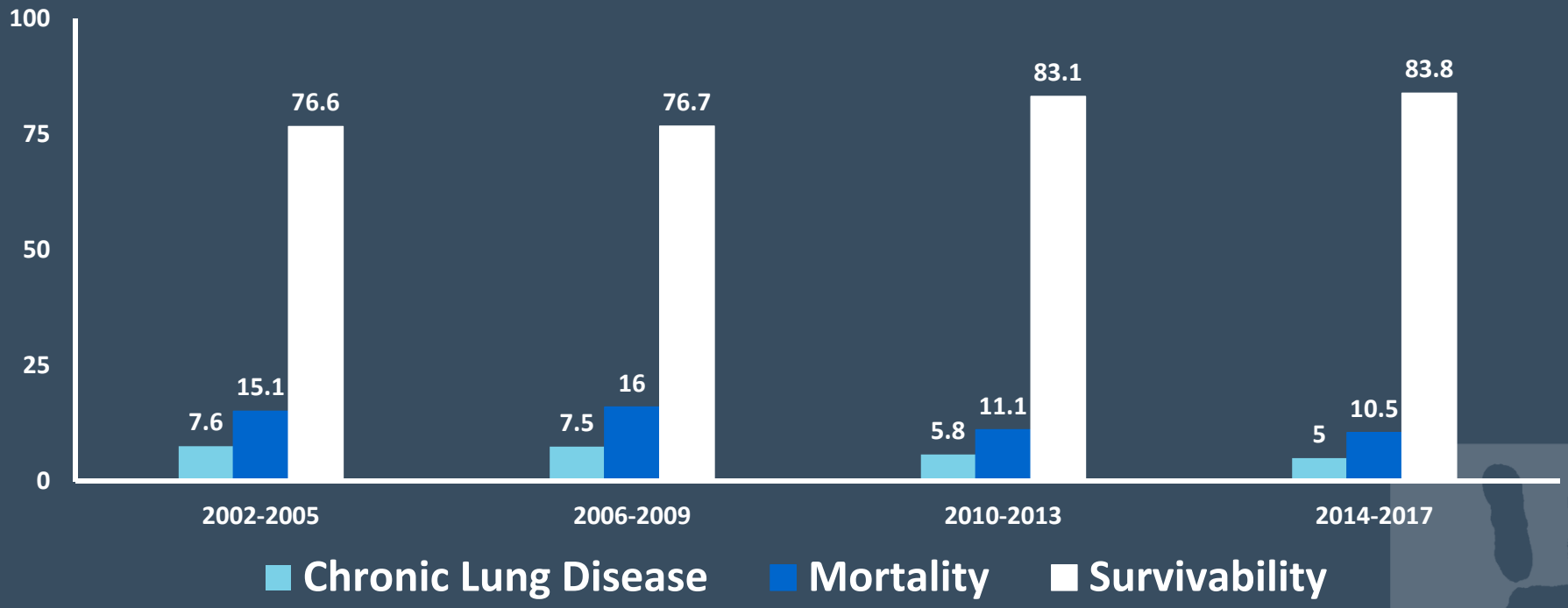


Aly et al, Pediatrics 2005

Failure of CPAP: Improves with Experience



BPD at GW - 16 years



Aly & Mohamed Pediatr Res 2020

BPD Rates in RCTs CPAP vs MV

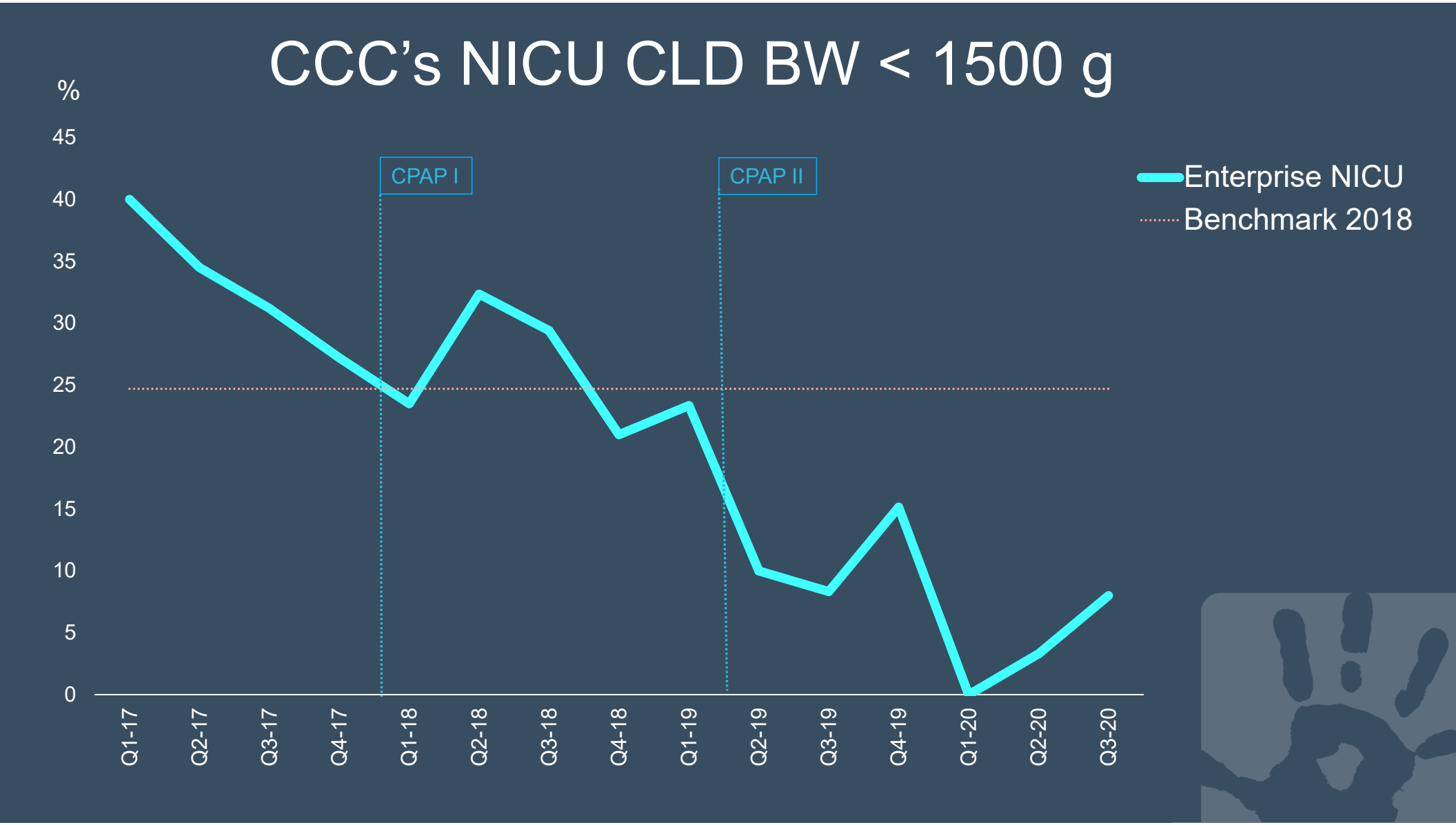
	GA	BPD (%)
SUPPORT	24-27	40 vs 44
COIN	25-28	29 vs 35
Dunn et al.	26-29	26 vs 25

BPD (RR=0.91, CI: 0.81 – 1.01)
Death or BPD (RR= 0.91, CI: 0.84- 0.99)

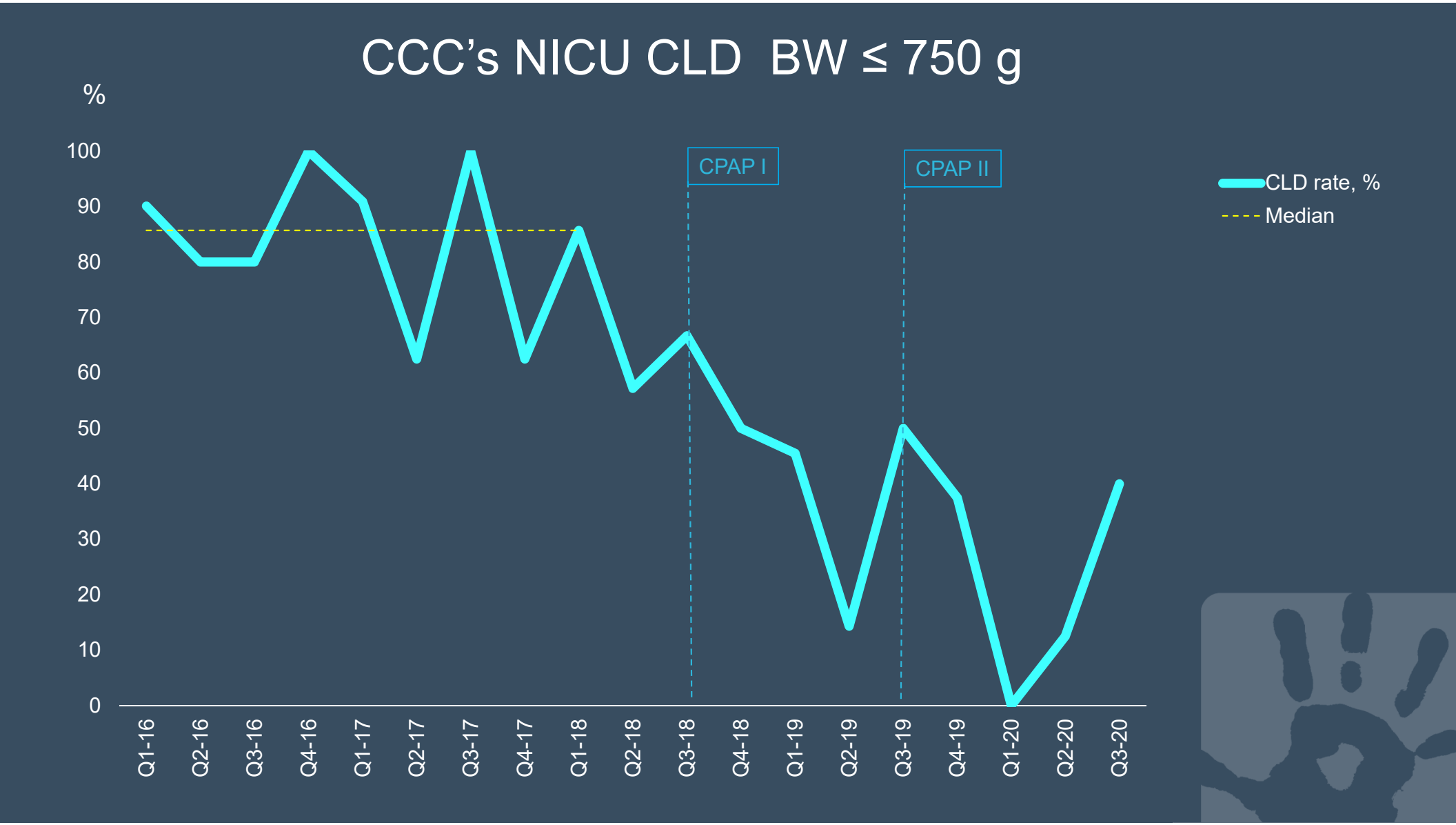
Schmölzer et al., BMJ 2013

The Cleveland Clinic Experience

CCC's NICU CLD BW < 1500 g



CCC's NICU CLD BW ≤ 750 g



Keys for Success

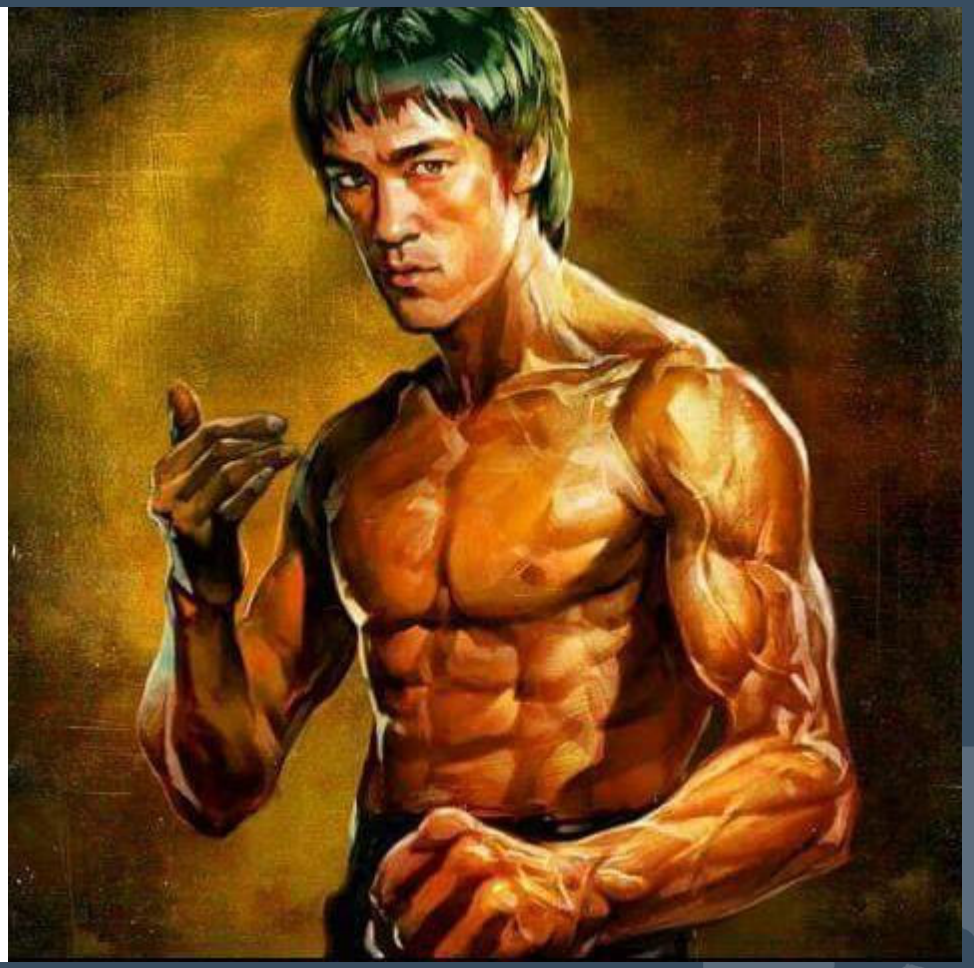
- CPAP set-up is always ready in the NICU
- CPAP is applied in DR via T-piece free flow system
- Premature infants are transferred to NICU and immediately started on CPAP

Keys for Success

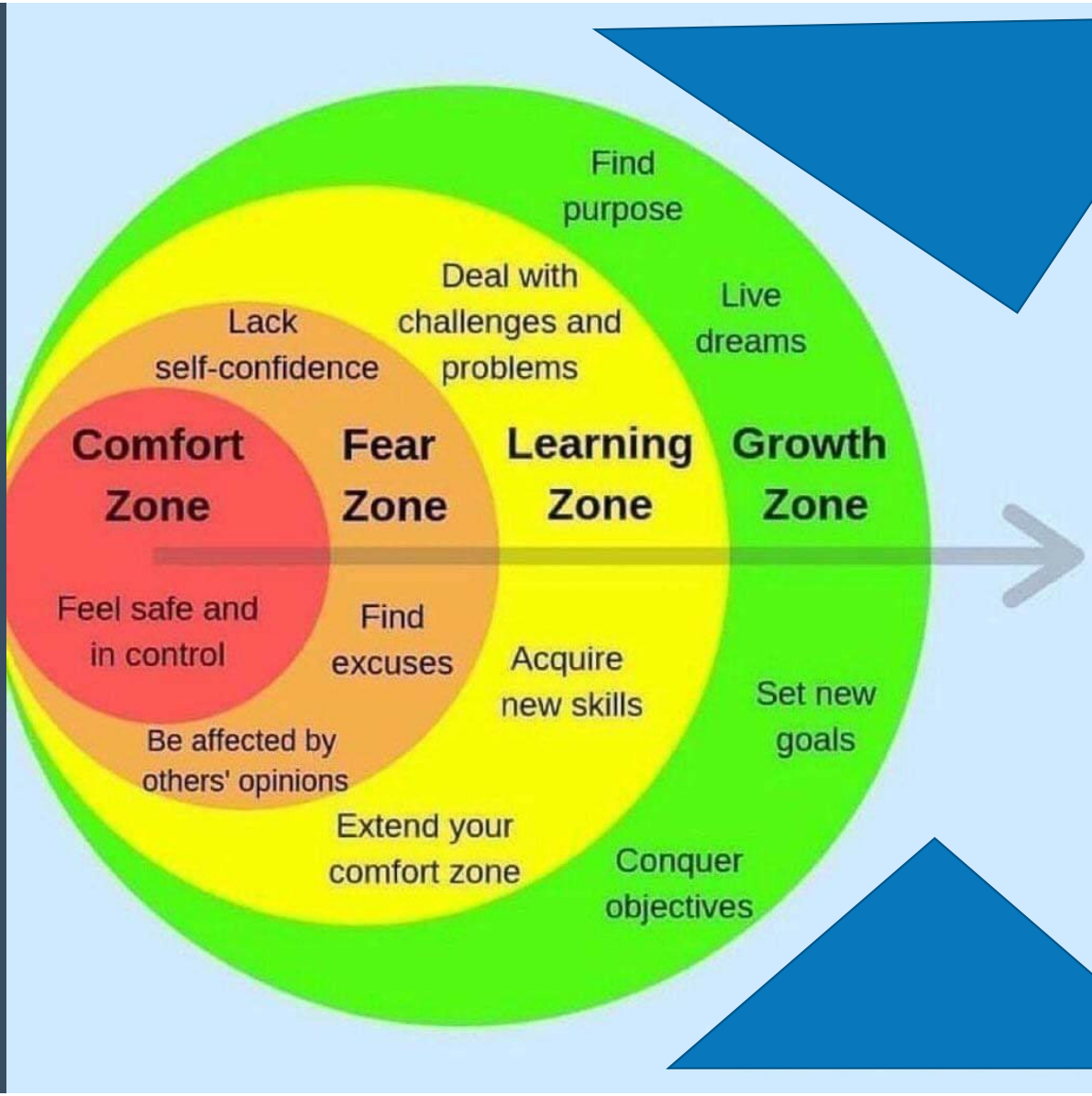
- Meticulous attention to the airway every 3 hours is recommended
- Infants are usually on NCPAP up to 1200 grams of body weight
- Increasing daily intervals off CPAP are then attempted
- CPAP is restarted if tachypnea, retraction or O_2 desaturation is noted

I am not afraid of a person who knows 10000 kicks. But I am afraid of a person who knows one kick but practices it for 10000 times

BRUCE LEE



Stages before growth can happen



Bubble CPAP Training

Cleveland Clinic Children's

Cleveland Clinic Children's and MetroHea

4th State-of-the-Art Reviews

Neonatal-Perinatal

September 12-14, 2019

InterContinental Hotel and Bank of America

5th State-of-the-Art Reviews in

NEONATAL-PERINATAL MEDICINE

Bubble CPAP use in the NICU

PART 2 MOC

THE AMERICAN BOARD of PEDIATRICS

October 8, 2020

Live-Virtual Event

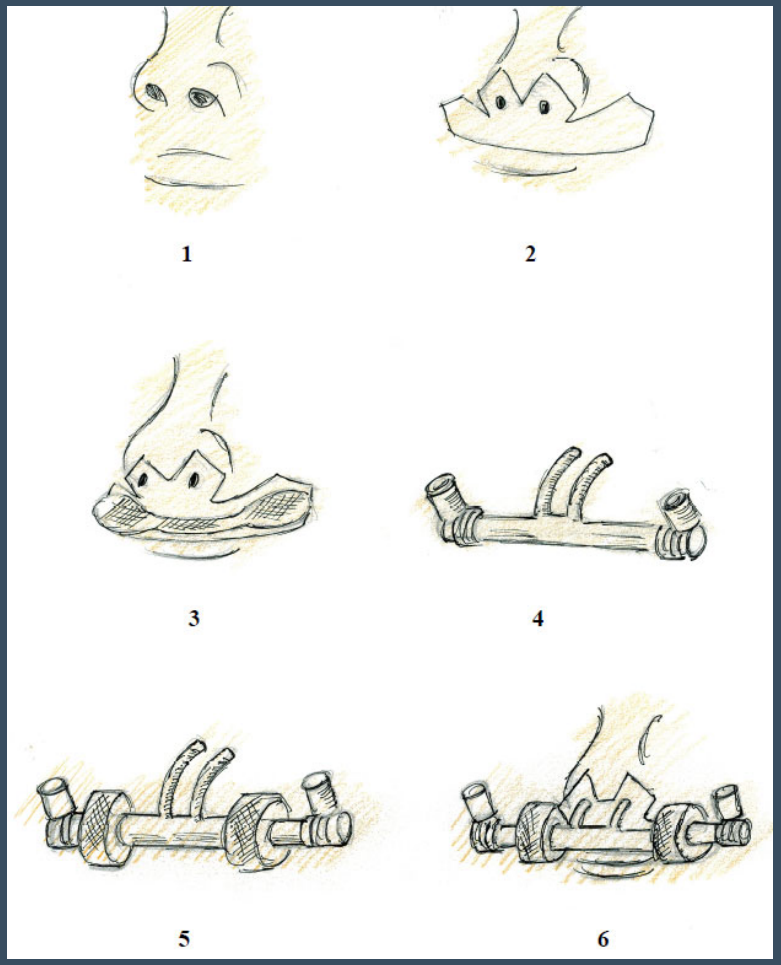
Keys for Success

- Have a clear policy
- Training of nurses and fellows
- Hands on management from the delivery room
- Have an algorism for infants who have troubles on CPAP

What Type of CPAP?

- Only Bubble CPAP

What Type of Prongs?



Aly & Mohamed,
Atlas of Procedures
in Neonatology 2012

CPAP Checklist

Bedside Checklist for Each Infant while on N-CPAP

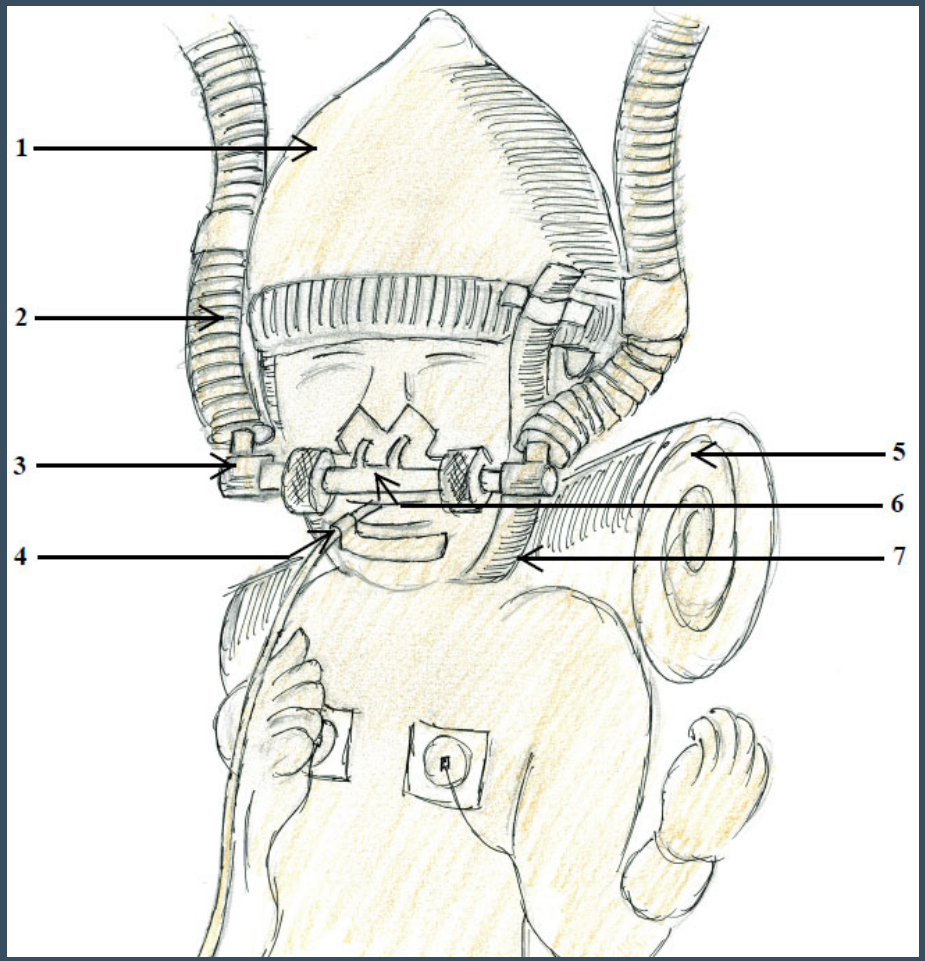
To Be Filled by Infant's Nurse Each Shift

CHECKPOINT	DATE	DATE	DATE
Blended air/oxygen supply is appropriate			
Flow meter at 5 –7 l/min			
Humidifier water lever is correct			
Excess rainout in the afferent tubing is drained			
Nasal Prong size is correct			
Nasal prongs positioned correctly and not touching the septum			
Hat fits snugly			
Corrugated tubing correctly placed			
Moustache is correctly placed			
Septum is intact			
Neck roll correct size and position			
Head Position is correct			
Preductal oxygen saturation probe			
Excess rainout in the efferent tube is drained			
Tape at 7cm at base of bottle			
Acetic acid level at 0 cm			
Tubing securely fixed at 5 cm under acetic acid			
Gas bubbling continuously			
Date Circuit is due for a change (7 days max)			
Date CPAP Prongs is due for a change (3 days max)			
Nurse Signature			

Comments:

CPAP Prong Sizes

Weight	Size
<700g	0
700-1000g	1
1000-2000g	2
2000-3000g	3



Aly & Mohamed,
Atlas of Procedures
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Process Confirmation Audit Card

1 Headband/Hat
(If hat, is it documented?)

2 Velcro wrapped around the tubing?

3 Prongs in correct position?

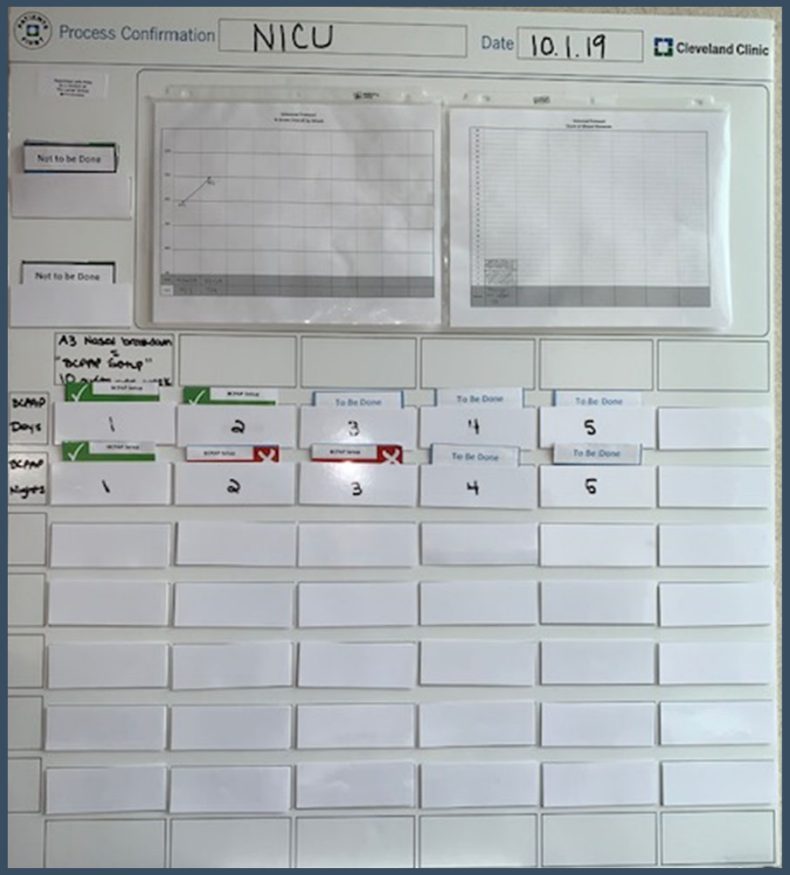
4 Is checklist up to date with current shift?

Responding to deviation or abnormality: Upon completion, ensure the deviation or abnormality is communicated and corrected to align with the process standard.

Comments:

- Real-time discussion of nasal interface application
- Real-time education
- Opportunity to discuss barriers
- Collecting process data
- Focus on areas for improvement

Process Confirmation Board Initiation



- Team of auditors
- Visual data chart
- Audit card pockets
- 10 audits per week
- Report out in monthly Quality and Practice meeting

Bubble CPAP NICUs

- Early CPAP in DR (no intubation)
- Early extubation
- No HFNC

Conclusions

- There is no evidence to support efficacy of HFNC in preventing BPD
- NICUs with the lowest incidence of BPD use bubble CPAP exclusively
- Strategies that improve outcomes should be favored over those that offer easier care

Conclusions

- Agree on the concept of lung injury
- Have a clear policy
- Train your staff (How?)
- Involve leadership and get feedbacks


Thank you!
Cleveland Clinic