NEONATAL RESPIRATORY DISTRESS SYNDROME

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NEONATAL RESPIRATORY DISTRESS SYNDROME

Hyaline membrane disease (glassy appearance of proteins and dead cells, hyalos in greek means transparent)

Disease of RS (alveoli)

Respiration; breath in and out

Distress; difficulty breathing

Syndrome; associated signs and symptoms of a disease (NRDS) - cyanosis (bluish discoloration), grunting (rough sound), nasal flaring, tachypnea (RR > 60), chest wall retraction, xiphoid retraction, hypoxia (spo2 < 90)

CAUSE

Inadequate surfactant

RISK FACTORS

Gynecological conditions that lead to preterm delivery i.e. born before 37 weeks (34 in this case because of surfactant)

Besides prematures what reduces neonatal surfactant in older neonates;

Maternal - family hx, CS (labour increases surfactant, less lung fluid absorption -1/3 in SVD, diabetes (Insulin delays surfactant), perinatal sepsis (inflammation)

Foetal - twin gestation (birth weight - IUGR, hypocortisolemia, substrates), hypothermia (increased oxygen consumption and pulmonary vasoconstriction), congenital PDA, male (androgens vs estrogens in lung maturation)

RDS increases with decreasing gestational age

- The risk of RDS is inversely proportional to gestational age; occurs in approximately:

- RDS is seen soon after birth, worsens during the first few hours of life
- In contrast to Transient Tachypnea of the Newborn (TTN), worse at birth but improves within hours of birth

Sweet LR, Keech C, Klein NP, et al. Respiratory distress in the neonate: Case definition & guidelines for data collection, analysis, and presentation of maternal immunization safety data. Vaccine. 2017;35(48 Pt A):6506-6517. doi:10.1016/j.vaccine.2017.01.046

Clinical Course of RDS

Neonates present within the first several hours of life

- **Hours after birth**

If untreated the disease worsens

- **24 - 48 hours**

The course of RDS is self-limited

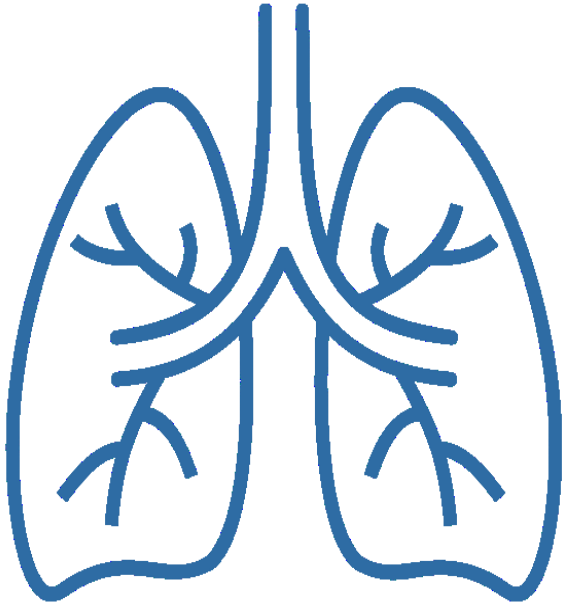
- **5 - 7 days**

Very preterm infants will not be able to make it without support.

Sweet D, G, Carnielli V, Greisen G, Hallman M, Ozek E, te Pas A, Plavka R, Roehr C, C, Saugstad O, D, Simeoni U, Speer C, P, Vento M, Visser G, H, A, Halliday H, L: European Consensus Guidelines on the Management of Respiratory Distress Syndrome – 2019 Update. Neonatology 2019;115:432-450. doi: 10.1159/000499361

Periods of Treatment for RDS

RDS was first described by Hochheim 14 in **1903,** who noted unusual membranes in the lungs of 2 infants who died shortly after birth



eriod 1 - Before 1950s: No widely used treatment

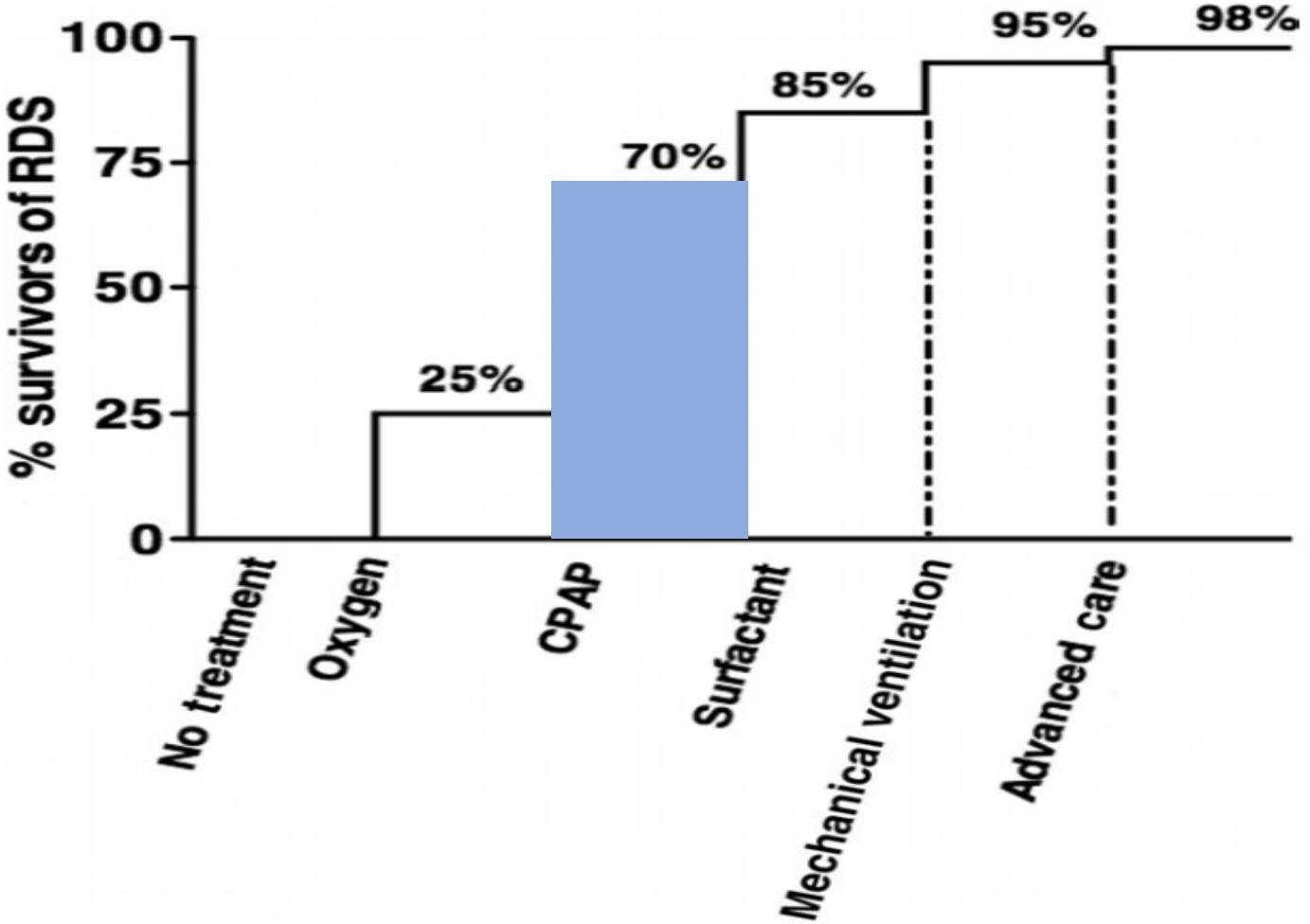
eriod 2 – 1950 – 1969: Oxygen therapy was the specific ıtervention

eriod 3 – 1970 – 1989: CPAP therapy was the specific intervention. ater on use of mechanical ventilation was attempted

Period 4 – After 1990: Antenatal corticosteroids, surfactant, advanced care technologies e.g. high frequency oscillation

Beena D. Kamath, Emily R. MacGuire, Elizabeth M. McClure, Robert L. Goldenberg and Alan H. Jobe,Neonatal Mortality From Respiratory Distress Syndrome: Lessons for Low-Resource Countries,Pediatrics June 2011, 127 (6) 1139-1146

Increased % in RDS survivors with introduction of specific treatments



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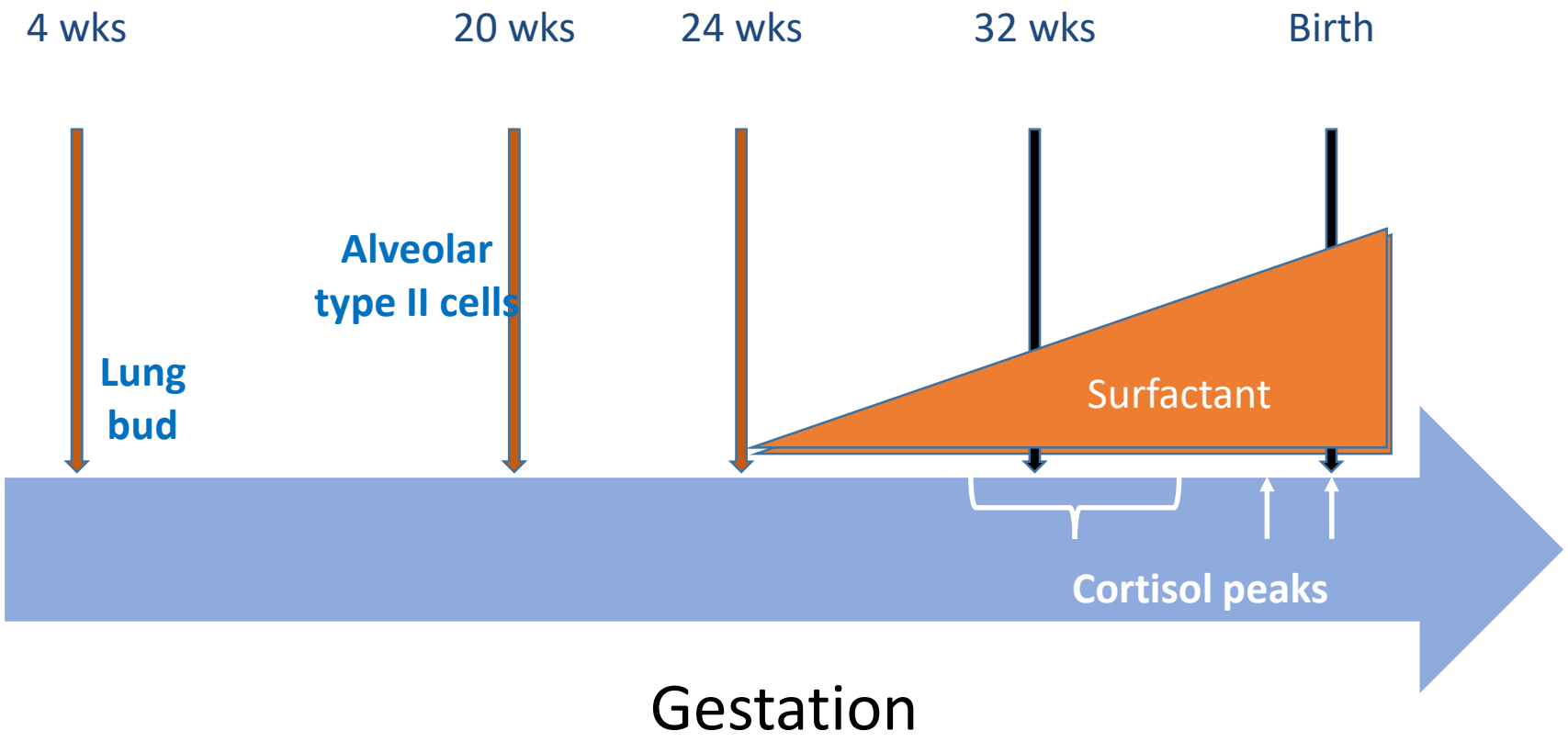
Lung growth and Development



Schittny, Johannes C. "Development of the lung." Cell and tissue research vol. 367,3 (2017)

Transition to extrauterine life

Cortisol

- ✓ Levels increase at **30 - 36 wks**, **prior** to term labor & peak **at labour**
- ✓ Regulates thyroid hormones and catecholamine release

Fetal lungs | **Birth** | **Neonatal lungs**

- ✓ Fetal fluid secreted into lungs
- ✓ Promotes development
- ✓ Maintains distension
- ✓ Pressure = 2 - 4cmH_20
- ✓ Mechanical stretch stimulates surfactant production

- ✓ Fluid replaced by air (labour & delivery, first breath and cry)
- ✓ Reduced secretion; increased absorption (regulated by hormones)
- ✓ Surfactant coats alveoli

Source - Neonatal Asphyxia, Resuscitation and Beyond. Dipak, Rashmi, Padmapriya. Chapter 1 – intrauterine and Natal Cardiopulmonary physiology
Hillman, Noah H et al. "Physiology of transition from intrauterine to extrauterine life." Clinics in perinatology vol. 39,4 (2012)

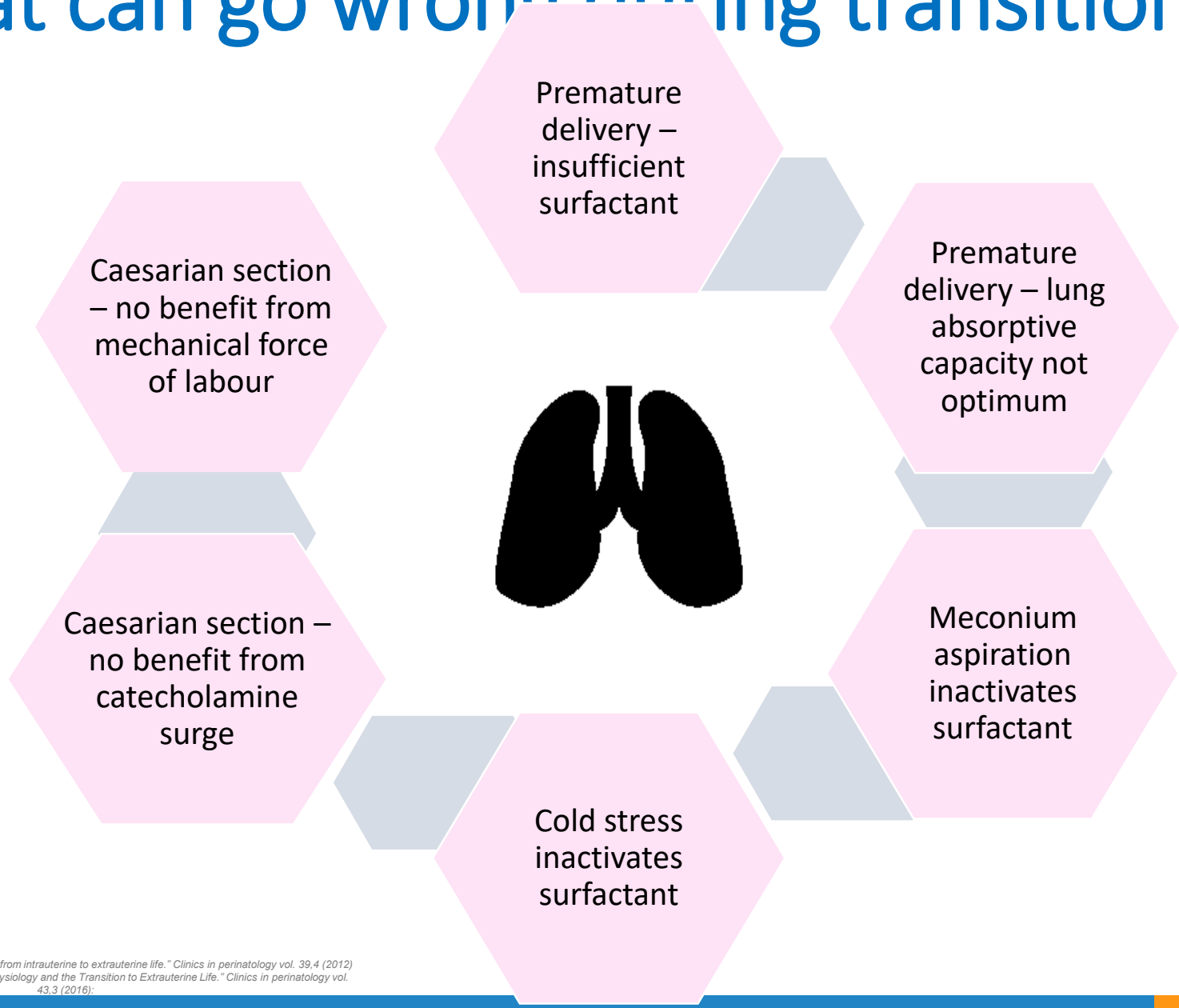
Surfactant

- A complex mixture of phospholipids and proteins
- Reduces surface tension at the air-liquid interface of the alveoli
- Prevents collapse of alveoli during end exhalation
- Secretion is stimulated by hormones like thyroxine as well as glucocorticoids
- Mechanical stretch (distension and hyperventilation) can stimulate secretion from Alveolar type II cells

Surfactant production can be hindered by inflammation, genetic defects, infection

Nkadi, Paul O et al. "An overview of pulmonary surfactant in the neonate: genetics, metabolism, and the role of surfactant in health and disease." Molecular genetics and metabolism vol. 97,2 (2009):

What can go wrong during transition?



Hillman, Noah H et al. "Physiology of transition from intrauterine to extrauterine life." Clinics in perinatology vol. 39,4 (2012)
Morton, Sarah U, and Dara Brodsky. "Fetal Physiology and the Transition to Extrauterine Life." Clinics in perinatology vol. 43,3 (2016):

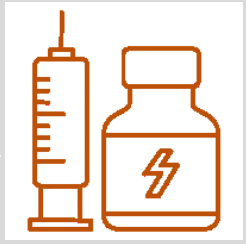
Antenatal steroids and the fetal lung

1

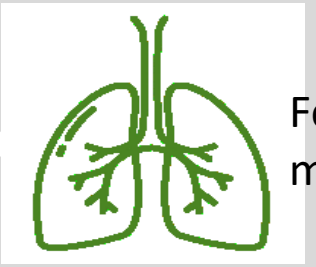
Improved antenatal care – to reduce risk of premature deliveries

2

Premature labour 24 - 34 weeks



Administration of antenatal corticosteroids (ACS)



Fetal lung maturation

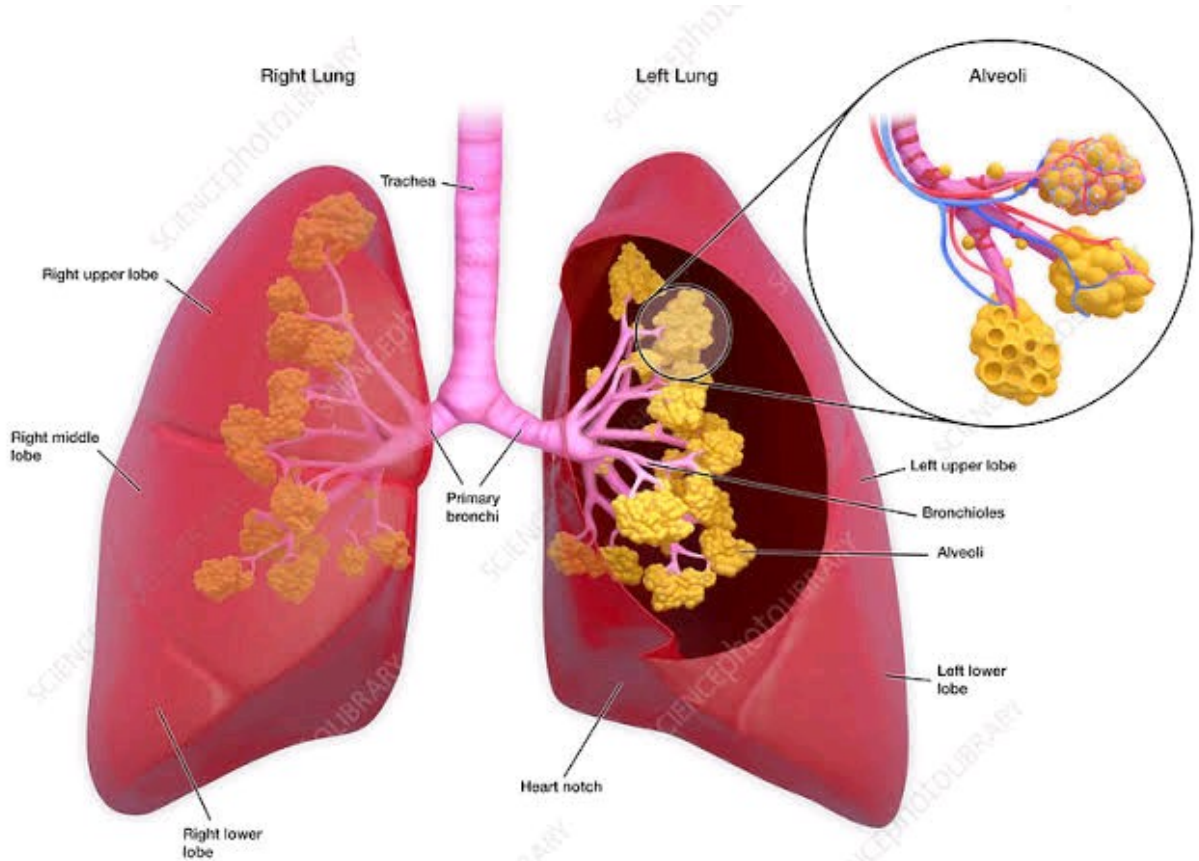
ACS not recommended for those with chorioamnionitis and those undergoing c/s for late preterms

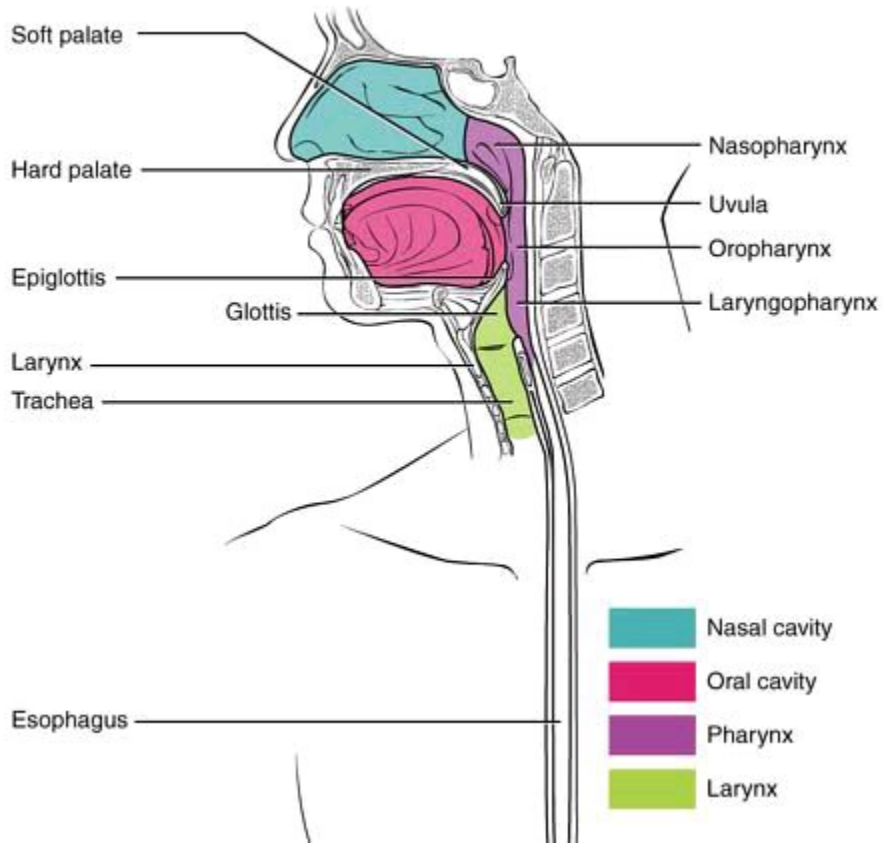
Glucocorticoids and Lung Development in the Fetus and Preterm Infant R J Bolt, M M van Weissenbruch, H N Lafeber, H A Delemarre-van de Waal 2001

Antenatal Corticosteroids for Accelerating Fetal Lung Maturation for Women at Risk of Preterm Birth Devender Roberts, Julie Brown, Nancy Medley, Stuart R Dalziel, 2015

ANATOMY

Nose/mouth, laryngopharynx (Epiglottis) Trachea, Bronchus, brochioles, alveoli (wet balloons)


Right Lung
Left Lung
Alveoli
Trachea
Right upper lobe
Right middle lobe
Primary bronchi
Left upper lobe
Bronchioles
Alveoli
Left lower lobe
Heart notch
Right lower lobe


Soft palate
Hard palate
Epiglottis
Glottis
Larynx
Trachea
Esophagus
Nasopharynx
Uvula
Oropharynx
Laryngopharynx
Nasal cavity
Oral cavity
Pharynx
Larynx

ALVEOLI (WET BALLOONS)

Has alveolar fluid inside and interalveolar septum outside (elastic fibre containing capillaries and pores of kohn - balance interalveolar pressure)

Alveolar fluid: water, wbc, complement, electrolytes and surfactant,

Type 1 pneumocytes - alveolar epithelium and continuous with capillary endothelium (for gaseous diffusion)

Type 2- Make surfactant, replace type 1

ALVEOLI

SURFACTANT

Phospholipoprotein - DPPC mainly (90% phospholipids, 10% surfactant proteins)

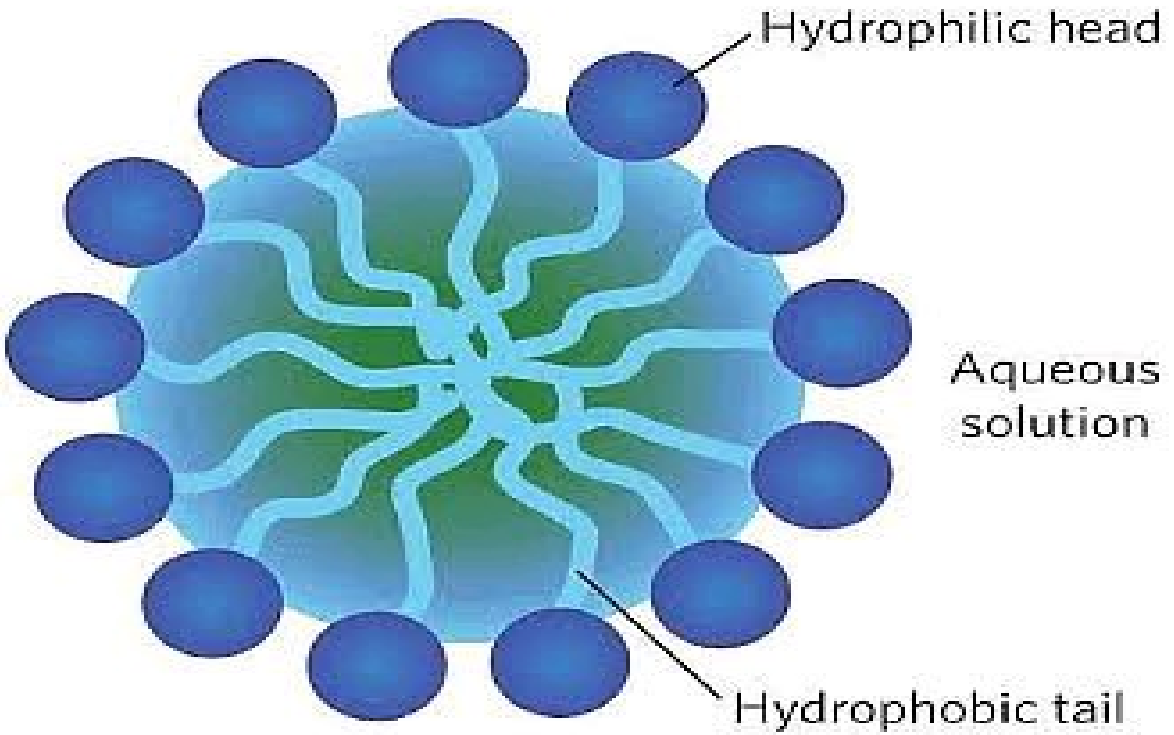
Hydrophilic head (phosphate and protein AD) faces alveolar epithelium and hydrophobic tail (lipid and proteins BC) tail faces the air forming micelle.

Mechanism;

Reduce surface tension of alveolar fluid

Prevent alveolar collapse and stabilize size, increase lung compliance (expansion and contraction) hence decrease work of breathing, prevent fluid accumulation (pulmonary edema).

MICELLE



Micelle Structure & Formation

DIAGNOSIS

History and Physical exam (risk factors, signs and symptoms)

Silverman Anderson Score (SAS)

0; No distress

1-3; Mild distress

4-6; Moderate distress

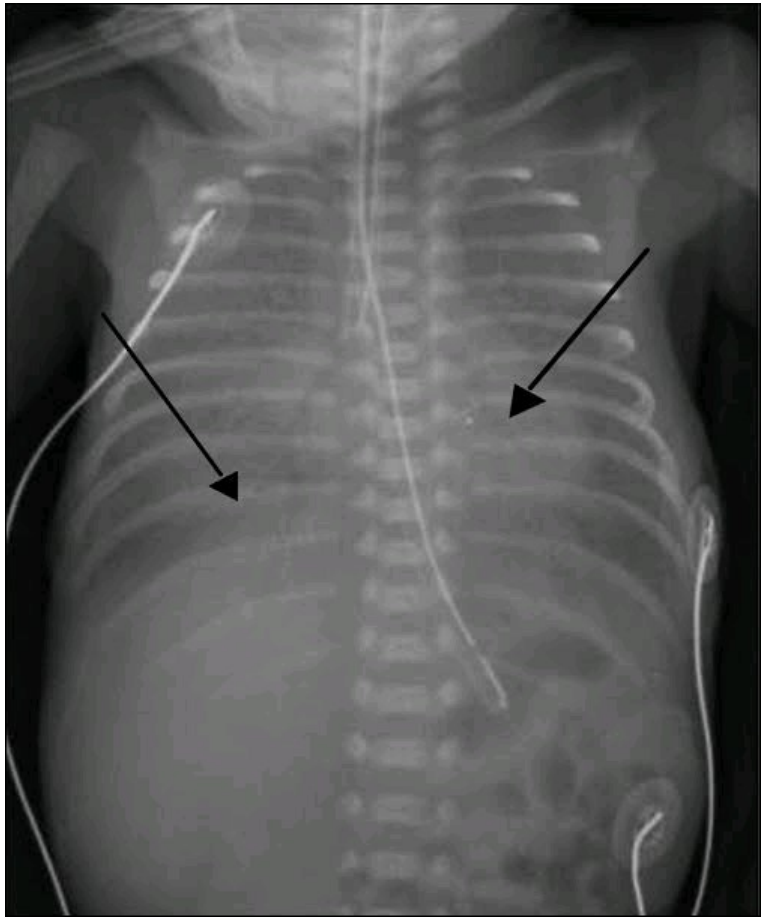
7-10; Severe distress

	Score		
Feature observed	0	1	2
Chest movement	 Synchronized respirations	 Lag on respirations	 Seesaw respirations
Intercostal retraction	 None	 Just visible	 Marked
Xiphoid retraction	 None	 Just visible	 Marked
Nares dilation	 None	 Minimal	 Marked
Expiratory grunt	 None	 Audible by stethoscope	 Audible by unaided ear

INVESTIGATIONS

Spo2 (<90), rbs (hypoglycemia), temperature (hypothermia) fhg (leukocytosis, anemia), uec (aki), cxr (ground glass), BGA (acidosis), cranial ultrasound (IVH)

CXR-ground glass appearance of RDS



TREATMENT

ABC, resuscitate, oxygen, CPAP/ mechanical vent (higher PIP 20cm of water), synthetic surfactant, antibiotics, parenteral fluids and feeds, radiant warmer, caffeine citrate (reduce need for oxygen and cpap, prevents pda by better pulmonary mechanics, anti-inflammatory, increase angiogenesis and alveolarization, neuroprotective - myelination, treat AOP - stimulates respiratory center, sensitivity to co2, muscle tone, oral or IV loading dose 20mg/kg, 5-10mg/kg maintenance). Methylxanthines?

Neonatal Resuscitation

For trained health workers - Anticipate and prepare

Note for all newborns:

- Practice immediate cord clamping and cutting for newborns requiring resuscitation
- For newborns with good heart rate and spontaneous breathing, practice delayed cord clamping and cutting (1-3 mins)

PREPARE BEFORE DELIVERY - EQUIPMENT, WARMTH, GETTING HELP

Ventilation should be started within 60 secs **(Golden Minute)**

Initial steps of stabilization:

- Dry & stimulate baby with warm towel
- Observe for Crying/breathing (not laboured?) Good muscle tone?
- Cover with warm dry towel

Is baby crying/breathing (not laboured?) Good muscle tone?

No to any one

Immediate cord cutting & transfer to radiant warmer

Yes

Place on mother's abdomen for skin-to-skin care, delayed cord cutting, initiate breastfeeding & essential newborn care

- Check if airway is clear
  If secretions are visible, suction to clear
- Put head in **sniffing** position

Is baby breathing?

Yes

Laboured breathing?

Yes

Oxygen/ CPAP

No

- Keep warm
- Monitor rate of breathing and heart rate

Poor or No breathing/gasping

SHOUT FOR HELP!
Start ventilation with **room air** ensuring the chest rises at **40 - 60 breaths/min**
After 1 min, check heart rate for 5-10 secs

Is heart rate > 60bpm?

Yes

Continue ventilations for 1 min at **40 - 60breaths**

No

- Connect 100% oxygen
- Give 1 EFFECTIVE breath for every 3 chest compressions for 1 min

Reassess ABC after 1 minute

Regular breathing (RR >30bpm) + HR >100bpm:

- Give oxygen & titrate against SpO_2 (90-95%)
- IVF/EBM
- Blood sugars 2hrs after birth
- Keep warm & maintain at 36.5 - 37.5°C
- Essential Newborn Care - Vit K, cord care, eye care
- Treat infections if indicated
- Family centered care
- Ensure HIV risk is known

Newborn Care Management guidelines

VAYU bCPAP SYSTEM IN NBU HBCTRH

COMPLICATIONS OF RDS

Death, ROP (excess oxygen disrupts growth factors), IVH (cerebral perfusion and inflammation), PH (inflammation), BPD (excess o2 causing dysregulated inflammation, proteases and fibrosis- chronic rds), CP (cerebral perfusion - motor development), AOP

Management of RDS

Approach to management

Keep warm and Maintain neutral thermal environment - Reduce oxygen consumption

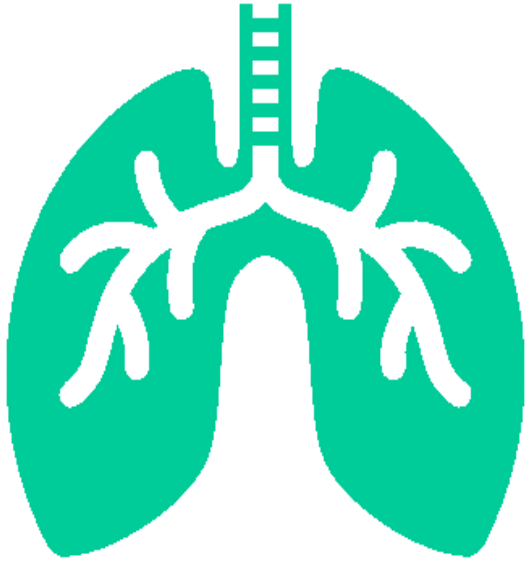
Airway patency should be ensured

Breathing - Specific management; Surfactant use and Respiratory Support (CPAP)

Circulation- feeds and fluids; Initiation of early feeds & Maintenance fluids

D - Close monitoring of vitals; Blood sugars, Hypotension common in early RDS, Antibiotics, Caffeine

Continuous Positive Airway Pressure (CPAP)



- Non invasive method of **oxygen delivery**

Provides **continuous distending pressure** that's keeps alveoli open during expiration

Reduces work of breathing therefore improves oxygenation

Decreases atelectasis and respiratory fatigue

Why use CPAP?

In-utero

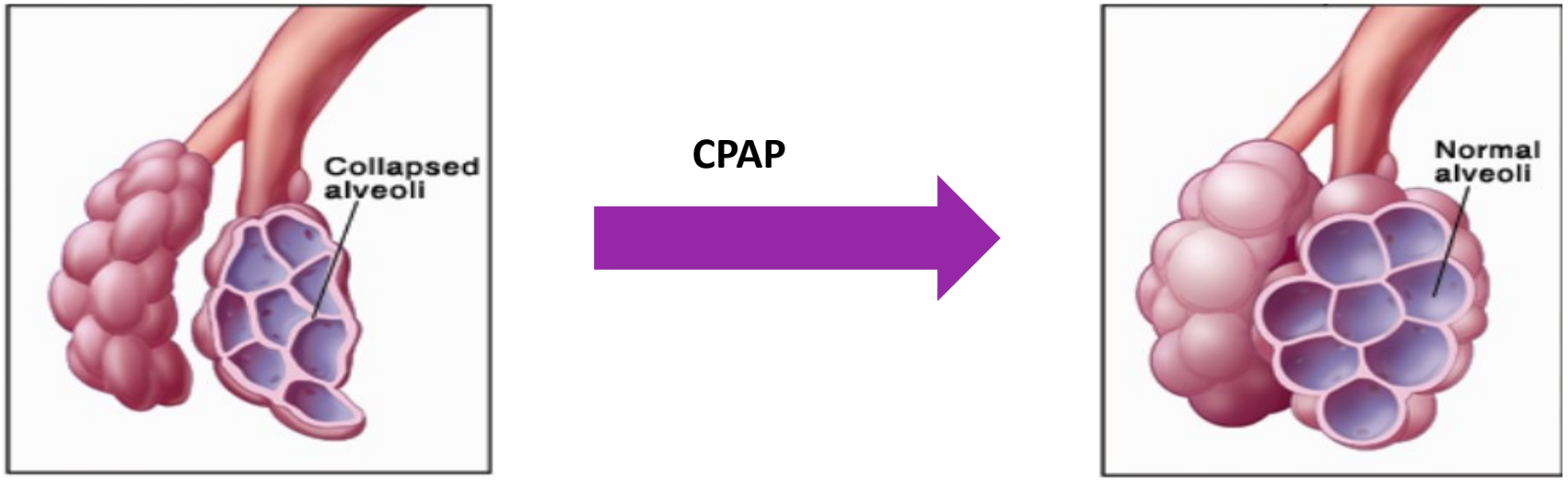
- Fetal lungs in utero remain distended due to the 2-4 cm H_20 maintained by the fluid in the fetal lungs

CPAP

- CPAP mimics normal physiology.
- Constant distending pressure at 2-3cm H_20.

Nasal Continuous Positive Airway Pressure (CPAP)for the Respiratory Care of the Newborn Infant Robert M DiBlasi RRT-NPS 2009
Image borrowed from https://consultqd.clevelandclinic.org/bubble-cpap-for-prevention-of-chronic-lung-disease-in-premature-infants/

Benefits of using CPAP



1. Improves oxygenation
2. Continuous distending pressure keeps alveoli open which maintains functional residue capacity
3. Promotes lung growth and development.
4. Promote surfactant production

Image borrowed from https://newbornsbaby.blogspot.com/2019/01/premature-baby-lung-complications.html

Prophylactic versus Rescue CPAP

Prophylactic CPAP

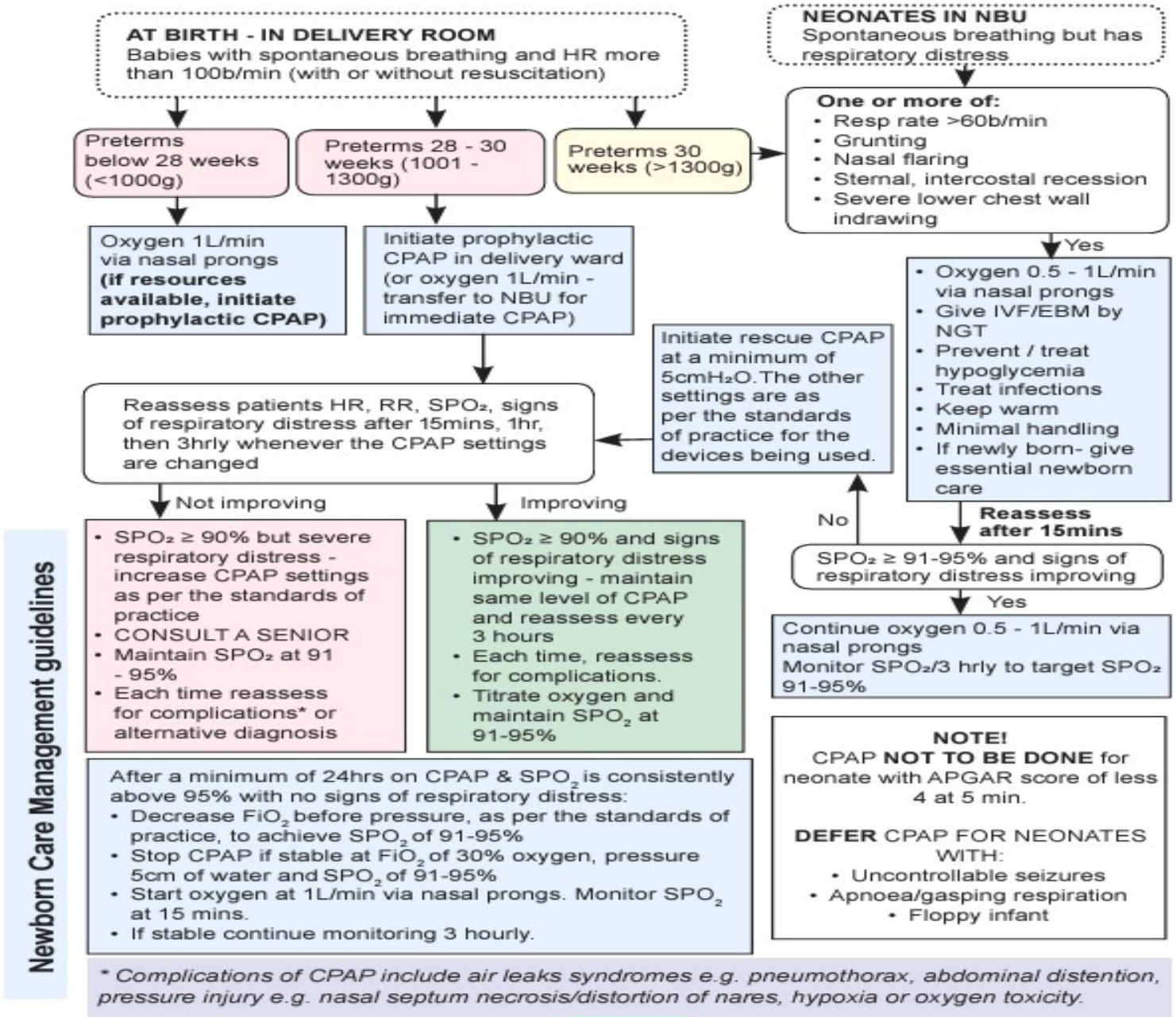
Rescue CPAP

- **28 - 30 weeks (1-1.3kgs)**
- Initiated as soon as possible within the delivery room
- For the newly born with good cardiac activity and breathing spontaneously
- Not in respiratory distress
- Intended to avoid mechanical ventilation

- **Above 30 weeks (>1.3kgs)**
- Initiated after trial of oxygen therapy
- Neonate with increased work of breathing and SpO_2< 90% on nasal prongs at 1L/min

Nasal Continuous Positive Airway Pressure (CPAP)for the Respiratory Care of the Newborn Infant Robert M DiBlasi RRT-NPS 2009

Continuous Positive Airway Pressure (CPAP)



Newborn Care Management guidelines

CPAP

- Complications

Skin Complications

- Constant pressure on nares, ears, head and forehead can lead to reduced skin integrity and injury causing pressure ulcers.

First sign of skin breakdown is nasal erythema.

Prevention

- **Frequent observation**
- **Minimize points of contact**
- **Keep skin dry and clean**
- **Avoid tight fitting hat over forehead, ears and bony prominences**

*Fischer C, Bertelle V, Hohlfeld J, et alNasal trauma due to continuous positive airway pressure in neonates Archives of Disease in Childhood - Fetal and Neonatal Edition 2010;**95**:F447-F451.newborn care protocols. Queensland Clinical Guidelines. Respiratory distress and CPAP Guideline No. MN20.3-V7-R25. Queensland Health. 2020.*

Nasal Complications

Nasal septal injury

Nasal flaring

Nasal snubbing

Prevention

a) Maintain 2mm distance between columella and nasal prongs
b) The prongs should fill the entire nare without blanching the external nare
c) Ensure appropriate size of the nasal prongs and positioning of the whole interface

Source: Respir Care 2009; 54(9):1209-1235 –Comprehensive newborn care protocols, connect.springerpub.com, Queensland Clinical Guidelines. Respiratory distress and CPAP Guideline No. MN20.3-V7-R25. Queensland Health. 2020.

Lung Complications

Pneumothorax
CPAP increases risk of air leaks.

Prevention

a) **Always check CPAP pressure**
b) **Do not exceed pressures of 8cm H_20.**
c) **Check for any air leaks in circuit**

PRIYADARSHI, A., HINDER, M., BADAWI, N., LUIG, M., TRACY, M.. Continuous Positive Airway Pressure Belly Syndrome: Challenges of a Changing Paradigm. **International Journal of Clinical Pediatrics**, North America, 9, Feb. 2020,
Queensland Clinical Guidelines. Respiratory distress and CPAP Guideline No. MN20.3-V7-R25. Queensland Health. 2020.
Abdominal distension image borrowed from https://ep.bmj.com/content/102/3/166

Lung Complications

Hyperinflation of lungs

- Occurs due to high CPAP pressures.
- Results in reduced cardiac output secondary to reduced venous return.

Prevention

a) **Always check CPAP pressure**
b) **Do not exceed pressures of 8cm H_20.**

PRIYADARSHI, A., HINDER, M., BADAWI, N., LUIG, M., TRACY, M.. Continuous Positive Airway Pressure Belly Syndrome: Challenges of a Changing Paradigm. **International Journal of Clinical Pediatrics**, North America, 9, Feb. 2020,
Queensland Clinical Guidelines. Respiratory distress and CPAP Guideline No. MN20.3-V7-R25. Queensland Health. 2020.
Abdominal distension image borrowed from https://ep.bmj.com/content/102/3/166

Abdominal Complications

Abdominal distention

- Excessive swallowed air
- Feeding intolerance and desaturation episodes.

Prevention

a) **Insert an OGT**
b) **Leave OGT open**
c) **If OGT is used for feeding, close for 30mins after feeding the baby then open OGT**

PRIYADARSHI, A., HINDER, M., BADAWI, N., LUIG, M., TRACY, M.. Continuous Positive Airway Pressure Belly Syndrome: Challenges of a Changing Paradigm. **International Journal of Clinical Pediatrics**, North America, 9, Feb. 2020,
Queensland Clinical Guidelines. Respiratory distress and CPAP Guideline No. MN20.3-V7-R25. Queensland Health. 2020.
Abdominal distension image borrowed from https://ep.bmj.com/content/102/3/166

Oxygen Therapy Complications

Hypoxia
SPO_2 - 85 - 89%

- Increases mortality
- Does not alter rates of developing;
  a) Chronic lung disease- BPD
  b) Blindness
  c) Neurodevelopmental impairment.

Hyperoxia
SPO_2 - > 95%

- Free radicals that cannot be metabolized by immature antioxidant systems.
- Chronic lung disease - BPD
- Eye Injury - RoP

Prevention

a) Monitor SpO_2
b) Aim for O_2 saturation of 90-95%
c) Titrate the FiO_2 based on SpO_2

Walsh BK, Smallwood CD. Pediatric Oxygen Therapy: A Review and Update. Respir Care. 2017;62(6):645-661. doi:10.4187/respcare.05245

CPAP Failure

CPAP leads to a 35% reduction in death and use of assisted ventilation[1].

It however can fail

A diagnosis of CPAP failure is made on any baby who has been on correctly applied CPAP for 72 hours and who continues to have;

1. Moderate to severe recessions and grunting
2. SpO_2 < 90%
3. Recurrent apneas even on a maximum CPAP pressure of 8cm H_20

Ho JJ, Subramaniam P, Davis PG. Continuous distending pressure for respiratory distress in preterm infants. Cochrane Database of Systematic Reviews 2015, Issue 7. Art. No.: CD002271. DOI: 10.1002/14651858.CD002271.pub2Wright CJ, Sherlock LG, Sahni R, Polin RA. Preventing Continuous Positive Airway Pressure Failure: Evidence-Based and Physiologically Sound Practices from Delivery Room to the Neonatal Intensive Care Unit. Clin Perinatol. 2018;45(2):257-271. doi:10.1016/j.clp.2018.01.011

Risk factors for CPAP failure

Newborn Characteristics

- Weight <1000g
- Gestation <28 weeks
- Sex - Male

Maternal Factors

- Poor antenatal steroid coverage
- PPROM

Severity of the Disease

- Moderate or Severe RDS
- Delayed onset of treatment

Ho JJ, Subramaniam P, Davis PG. Continuous distending pressure for respiratory distress in preterm infants. Cochrane Database of Systematic Reviews 2015, Issue 7. Art. No.: CD002271. DOI: 10.1002/14651858.CD002271.pub2Wright CJ, Sherlock LG, Sahni R, Polin RA. Preventing Continuous Positive Airway Pressure Failure: Evidence-Based and Physiologically Sound Practices from Delivery Room to the Neonatal Intensive Care Unit. Clin Perinatol. 2018;45(2):257-271. doi:10.1016/j.clp.2018.01.011

Summary

1. CPAP promotes lung growth/development and protects lung – all babies deserves the best care.
2. CPAP should be initiated at an FiO2 of 50%, which then is titrated upwards or downwards to achieve oxygen saturation targets of 90-95%
3. Regularly monitor patient to optimize CPAP benefits and reduce risk of complications


USAID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World Prematurity Day