Optimal use of CPAP

This module is designed to improve knowledge, skills and clinical practice of all stakeholders involved in the care of preterm neonates in optimising use of continuous positive airway pressure

Learning objective

The participants will learn:

- To understand the science behind the use of CPAP, surfactant and antenatal steroids in prevention and treatment of respiratory distress in preterm neonates
- To be able to promote timely and rational use of antenatal corticosteroid therapy in preterm newborn infants
- To be able to use CPAP equipment safely and effectively
- To be able to use CPAP therapy rationally in various clinical situations in preterm newborn infants
- To be able to identify neonates who can benefit from surfactant administration and to be able to administer surfactant by intubation surfactant and extubation (INSURE) approach
- To be able to audit and improve practices related to use of antenatal steroids, surfactant and CPAP in the unit

Module contents

This module includes following elements:

- **Script:** Easy to read format, gives quick introduction and is an essential reference material for the participants
- **Key messages:** After having read through the script, these key messages summaries the important learning points in the webinar and the script
- **Video demonstration:** The videos in this module covers: the setting up of bubble CPAP machine, connecting ventilator CPAP, fixation of binasal prongs, hudson prongs, ram's cannula, and humidified heated high flow nasal cannula (H3FNC), and finally, some videos as a part of assessment of respiratory distress
- **Webinar:** The webinar in this module shall help the participant to gain knowledge on (i) science behind use of CPAP, (ii)optimal management of respiratory distress, (iii) antenatal corticosteroid therapy, (iv) initiation, monitoring, weaning of CPAP and types of CPAP, (v) complications and supportive care while on CPAP;(vi) identifying neonates who need surfactant therapy, (vii) interpretation of chest X-ray, (viii) intubation and fixation of endotracheal tube and (ix) administration of surfactant using INSURE approach
- **Poster demonstration:** The participant shall learn about respiratory distress scoring, standard treatment protocol (STP) on management of baby with respiratory distress, CPAP mega code poster, CPAP monitoring charts, fixation of nasal prongs, circuit and machine preparation chart, audit sheet on use of CPAP, antenatal steroids, and surfactant use
- **Self-assessment:** This will be done at the end of each objective, based on what you have already learnt. Feel free to consult your text material, if you need assistance in recapitulating
- **Checklist:** There will be two checklists: one on CPAP machine and one on surfactant administration
- **Skill check (OSCE):** The skill check includes evaluation of your skills onsilverman scoring, interpreting X-ray for diagnosis, assembling the CPAP circuit, readying humidifier for use, CPAP interface fixation, endotracheal intubation and tube fixation, surfactant administration and interpreting X-ray for adequacy of CPAP usage and complications
- **Simulation:** After reading through the text material, viewing videos, webinars and pictorial posters with messages, you shall be asked to perform on the case scenarios; (i) baby with respiratory distress started on CPAP, (ii) baby with respiratory distress needing surfactant therapy and (iii) baby having CPAP failure. While performing as a team, individual feedback and debriefing by team will be done

Learning Objective 1

Understanding the science behind the use of CPAP, surfactant and antenatal steroids in prevention and treatment of respiratory distress in preterm neonates

This objective covers the science behind the use of CPAP, surfactant and antenatal steroids in prevention and treatment of respiratory distress in preterm neonates and will be delivered as:

- Webinar
- Script
- Key messages
- Self-check MCQ's

After viewing and listening to the webinar, and reading the script along with the key messages, you shall undergo a self-evaluation based on what you have already learnt.

1.1:Webinar

You will view and listen to webinar on the concept of science behind use of CPAP, surfactant and antenatal corticosteroids along with your facilitator. You are free to interrupt your facilitator anytime for any clarifications or suggestions. The power point slides of the webinar are given here

Science behind use of Antenatal Corticosteroids, CPAP and Surfactant

DR. Sushma Nangia
MD, DM (Neonatology)
Director Professor & Head,
LHMC & Kalawati Saran Children's Hospital, New Delhi

What shall we learn?

- How do Antenatal steroids(ANS) work?
- How does CPAP work?
- How does Surfactant work?
- Synergistic action of ANS, CPAP and surfactant

Introduction

- India
  - Highest number of preterm births and
  - Highest number neonatal deaths due to prematurity
- Births - 2.6 crore live births/year
- Preterm births - 35 lakh/year
- Preterm deaths - 3 lakh babies (10%)

Vulnerability in prematurity

- Fetal lung immaturity-principal contributor for neonatal mortality
- Primary focus of strategies to improve the survival -Lung
- Strategy for prevention and treatment of RDS
  - Acceleration of fetal lung maturation by ANS therapy to the mother
  - CPAP to the neonate
  - Surfactant to neonate

How do Antenatal Steroids work?

- **Accelerate development of Pneumocytes , improve lung mechanics (maximal lung volume, compliance), gas exchange**
- **Increases surfactant production**
- **Induction of surfactant release, absorption of alveolar fluid, increase lung antioxidant enzymes**

↓

Reduction in RDS, moderate to severe RDS

Reduction in Intraventricular hemmorhage, Necrotising enterocolitis, mortality, systemic sepsis

What is CPAP?

CPAP – Continuous positive airway pressure

Application of continuous pressure during both inspiration and expiration in a spontaneously breathing baby

What does CPAP do?

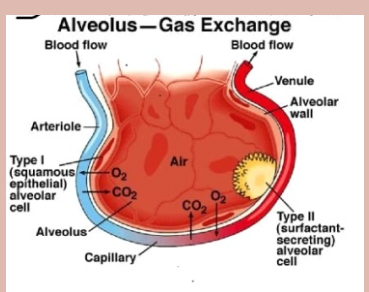
- Provides constant airway pressure
  - Keeps the alveoli open
  - Keeps airways splinted & open (improves FRC)
- Leads to
  - Better breathing
  - Better gas exchange – Less lung injury

How does CPAP work?

Pulmonary

- Increases FRC
- Decreases V/Q mismatch
- Splints upper airway – airway resistance
- Increased Tidal volume
- Decreased Work of breathing
- Conserves surfactant
- Increased lung compliance

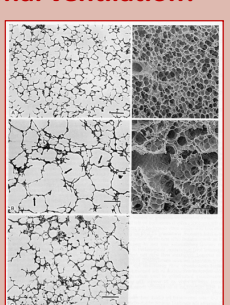
GAS EXCHANGE and FRC



Why not conventional ventilation?

No Ventilation →

24 hrs Ventilation →



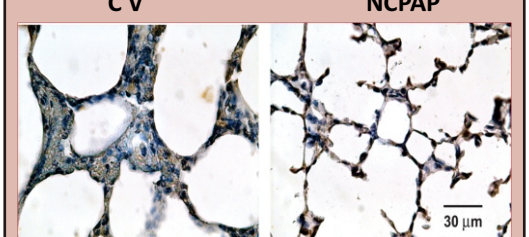
Limitations of premature lung

- Underdeveloped architect to hold the lung open
- Thicker and few septa so less surface area for gas exchange

Pinkerton KE, et al J Appl Physiol, 1994

Preterm Lambs at 72 Hours Distal Airspace Wall Thickness

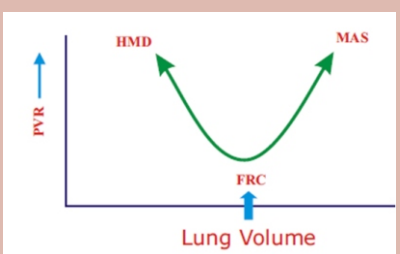
C V NCPAP



CPAP Magic

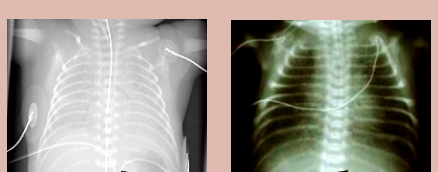
- Opens the lung at FRC
- Keeps it open by minimal constant pressure –least baro and volutrauma
- No ET tubes- no biotrauma
- Pulmonary arterial pressure are least hence less V/Q mismatch

Effect on Pulmonary Vascular Resistance



Optimal CPAP – Keeps lung open at the FRC
PVR is least at FRC

PVR Increases at Lung Volumes Below and Above FRC

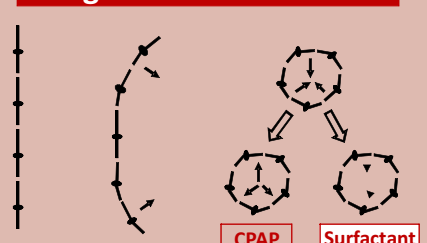


Inc. PVR Inc. PVR

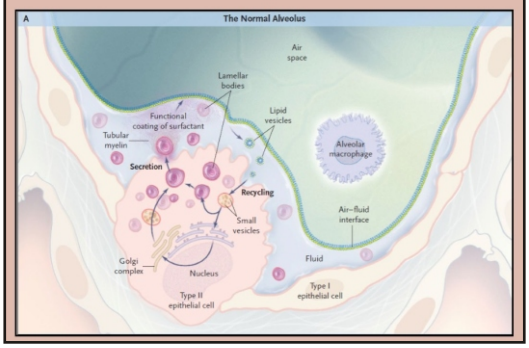
PVR min at FRC

CPAP and Surfactant Together!

Imagine a human chain !!



Surfactant production



What did we learn ?

- CPAP is safe as it causes less lung injury
- Give optimal CPAP to open the lung at FRC as PVR is least with maximum blood flow
- Surfactant and CPAP together is beneficial in RDS
- CPAP will give maximum dividends if used with antenatal steroids and early surfactant when required
- Good delivery room care and use early CPAP
- Acceptance by TEAM

What did you learn from this webinar?

1. .....
2. .....
3. .....

What are the queries which come to your mind?

1. .....
2. .....
3. .....

1.2:Script

Science behind use of CPAP

This script shall help you to understand the concept of science behind use of CPAP.

Preterm neonates are vulnerable and fetal lung immaturity is the principal contributor for neonatal mortality. Therefore, lung has been the primary focus of strategies to improve the survival of newborn infants. Strategies for the prevention and treatment of respiratory distress syndrome (RDS) have been directed towards the acceleration of fetal lung maturation in utero mainly by administering antenatal corticosteroids (ANS) to the mother and CPAP, with or without surfactant to neonate

Antenatal corticosteroids

- Antenatal steroids accelerate development of pneumocytes, thus improving lung mechanics (maximizing lung volume and compliance) and thus gas exchange
- They increase surfactant production
- There is not just induction of surfactant release but also absorption of alveolar fluid and increase of lung antioxidant enzymes; resulting in reduction in RDS, reduction in intraventricular hemmorhage, necrotizing enterocolitis, systemic sepsis and mortality

CPAP

- It refers to application of continuous pressure to the airways during both inspiration and expiration in a spontaneously breathing baby
- It keeps the alveoli open by providing constant airway pressure, and splints the airways so that they do not collapse; thus increasing the functional residual capacity (FRC) of the lungs resulting in better breathing and better gas exchange(reduced FRC allows alveoli to collapse at end of expiration)
- It splints the upper airways preventing obstructive apnea and dilates the lower airways thus reducing the airway resistance
- Overall the tidal volume improves and the work of breathing decreases. With improved physiology, the type II pneumocytes which produce surfactant, functions better with better recycling and production of surfactant
- Overall this culminates in improved lung compliance and better gas exchange
- Endotracheal tube causes the greatest hazard to a preterm infant by the mechanism of biotrauma
- In conventional ventilation (CV), many alveoli at the end of expiration collapse due to low peak end expiratory pressure; – the sudden opening and closing of alveoli leads to atelectotrauma; while in CPAP due to constant continuous pressure, this injury is minimal
- Pulmonary vascular resistance (PVR) is least once the lung is open at the FRC, at this, the blood flow is maximum with best ventilation perfusion matching and gas exchange

Insure

- Alveoli are lined with water molecules which tend to pull alveoli towards centre – this can be nullified by CPAP pressure or by reducing the surface tension by giving surfactant and if both are done simultaneously, synergistic action can be obtained. This has gone into clinical practice and is called as INSURE.(Intubate, surfactant and extubate to CPAP)

Surfactant

- Pulmonary surfactant is a surface-active lipoprotein complex (phospholipoprotein) formed by type II alveolar cells
- The proteins and lipids that make up the surfactant have both hydrophilic and hydrophobic regions. By adsorbing to the air-water interface of alveoli, with hydrophilic head groups in the water and the hydrophobic tails facing towards the air, the main lipid component of surfactant, dipalmitoyl phosphatidyl choline (DPPC), reduces surface tension
- They, thus increase pulmonary compliance, prevent atelectasis (collapse of the lung) at the end of expiration and also facilitate recruitment of collapsed airways

1.3:Key messages

- CPAP is safe as it causes less lung injury
- One should give optimal CPAP to open the lung at functional residual capacity (FRC) as pulmonary vascular resistance is least with maximum blood flow
- Use of surfactant and CPAP together is beneficial in RDS
- CPAP will give maximum dividends if you use antenatal steroids for preterm labor, early surfactant when required and have good delivery room care

1.4:Webinar

You will view and listen to webinar on how optimal management of respiratory distress helps prevent Retinopathy of prematurity along with your facilitator. You are free to interrupt your facilitator anytime for any clarifications or suggestions. The power point slides of the webinar are given here

Management of RD for Prevention of ROP

DR. Sushma Nangia
MD, DM (Neonatology)
Director Professor & Head,
LHMC & Kalawati Saran Children's Hospital, New Delhi

Objectives

- How inappropriate management of RD causes ROP
- How to prevent ROP

Management of RD causing ROP

Birth
- Un-monitored oxygen in the labor room

Transport
- Hypothermia, Hypoxia and Hyperoxia

NICU
- Un-monitored use of Oxygen
- Hypoxia and Hyperoxia
- Suboptimal use of CPAP and Surfactant

Prevention of ROP

- Birth
  - Resuscitation with blended oxygen at birth
  - Monitoring for saturations with pulse oximeter
  - Saturation targets not more than 95%
- Transport
  - Skin to skin contact
  - Warmth, Feeds or Fluids
  - Pulsoximeter to maintain SpO_2 targets 90% to 95%

Prevention of ROP

NICU
- Monitor all on oxygen with pulse oximeter
- Always use SpO_2 targets 90% to 95%
- Careful use of Hood oxygen (port holes)

- Optimize use of CPAP and Surfactant
  - Reduced ventilation
  - Reduced Infections
  - Reduced hypoxia, hyperoxia
  - Reduced oxygen days

Reduced ROP

Key Messages

- Optimal management of RD reduces ROP
- Use pulse oximeter for infants on Oxygen
- Careful use of Hood Oxygen
- Optimize the use of CPAP and Surfactant

What did you learn from this webinar?

1. .....
2. .....
3. .....

What are the queries which come to your mind?

1. .....
2. .....
3. .....

1.5:Script

Managing respiratory distress for prevention of retinopathy of prematurity (ROP)

This script shall help you to understand the concept of managing respiratory distress optimally helps to prevent ROP.

The potential areas where inappropriate management of a neonate with respiratory distress places the neonate at a higher risk for developing ROP

- At birth, during resuscitation if the baby receives oxygen which is not monitored using a pulse oximeter or if the baby is given unblended 100% oxygen, he is exposed to more oxygen than required and hence is at risk of retinopathy of prematurity
- During transport of the baby to a centre different from the place of birth, if the baby becomes hypothermic or he is hypoxic or fluctuates between hypoxia and hyperoxia, this affects the retinal vascularity, predisposing the infant to reperfusion injury and places him at a higher risk of developing ROP
- In the neonatal care unit, if the baby receives oxygen which is unmonitored or the baby remains hyperoxic while on oxygen therapy, he is at risk to develop ROP
- It needs to be understood that babies who remain hypoxic and then become hyperoxic tend to have severe damage to the vulnerable retinal vasculature
- If surfactant or respiratory support in the form of CPAP or mechanical ventilation is suboptimal or instituted late then the baby continues to be exposed to higher oxygen and is more liable to develop ROP

How to mitigate the ill effects of issues

At birth, if the baby requires oxygen then it has to be blended oxygen and the neonate must be monitored using a pulse oximeter to ensure that minute specific saturation targets are not exceeded in the initial few minutes. Thereafter, if the neonate requires oxygen, it should be ensured that the baby is neither hypoxic nor hypersaturating with the oxygen saturation being maintained in the normal range of 90% to 95%

- For the neonates requiring surfactant and respiratory support, it must be ensured that total duration of ventilation, days on oxygen as well as episodes of hyperoxia and hypoxia are minimized
- It is very important that while the neonate is being managed for his respiratory ailment, he should not get infected during his stay in the unit which really means that the asepsis should be meticulously maintained
- Any neonate with infection should be appropriately and adequately treated. All these measures together will certainly help to reduce the incidence and severity of ROP, if not completely prevent it

1.6:Key messages

- Optimal management of respiratory distress using CPAP
- Use surfactant early and appropriately
- Meticulous oxygen therapy using blended oxygen
- Monitoring of oxygenation by pulse oximeter helps to reduce ROP

1.7:Self-check MCQ's

1. Which of following is not a physiological effect of CPAP?

    a. Prevention of alveolar collapse
    b. Decrease pulmonary compliance
    c. Increase in the FRC
    d. Decreases airway resistance

2. CPAP refers to application of positive pressure to the airway of a spontaneously breathing infant

    a. During the expiratory phase only
    b. During the inspiratory phase only
    c. Throughout the respiratory cycle
    d. In between the inspiration and expiration

3. What are the opportune moments wherein targeted management can help prevent ROP?

    a. At birth, during resuscitation if the baby receives unmonitored oxygen
    b. During transport of the baby to a centre different from the place of birth, if the baby becomes hypothermic or he is hypoxic or fluctuates between hypoxia and hyperoxia,
    c. In the neonatal care unit, if the baby receives unmonitored oxygen
    d. All of the above

4. What is the main component of surfactant?
    a. DPPC (dipalmitoylphosphatidylcholine)
    b. Phosphatidylglycerol
    c. Phosphatidylinositol
    d. Neutral lipid

5. State if **true** or **false**, Optimal CPAP keeps the lung at its functional residual capacity.

Learning objective 2

Promoting the timely and rational use of antenatal corticosteroid therapy in preterm newborn infants

This objective covers the concept of promoting the use of antenatal corticosteroid therapy timely and rationally in preterm newborn infants and is delivered as

- Webinars
- Script
- Key messages
- Poster
- Self-check MCQ's

After viewing the videos, posters, role play and reading the script and the key messages you shall undergo a self-evaluation based on what have you already learnt.

2.1:Webinar

You will view and listen to webinar on the concept of antenatal corticosteroid therapy along with your facilitator. You are free to interrupt your facilitator anytime for any clarifications or suggestions. The power point slides of the webinar are given here.

Rational Use of Antenatal Corticosteroids (ANS)

DR. Sushma Nangia
MD, DM (Neonatology)
Director Professor & Head,
LHMC & Kalawati Saran Children's Hospital, New Delhi

Problems of preterm infants

- Respiratory Distress Syndrome (RDS)
- Increased susceptibility to infections
- Intraventricular hemorrhage
- Necrotizing enterocolitis
- Patent ductus arteriosus
- Bronchopulmonary dysplasia

Role of ANS in Preterm

- 45% reduction in Respiratory Distress Syndrome (RDS)
- 46% reduction in Intra Ventricular Haemorrhage (IVH)
- 54% reduction in Necrotising Enterocolitis (NEC)
- 31% reduction in mortality

Current Recommendation

Single course of injection of Dexamethasone to be administered to women with preterm labour (between 24 and 34 weeks of gestation) at all levels of health facilities in the public as well as the private sector.

Current Recommendations

- Administration of Antenatal Corticosteroid (Dexamethasone) constitutes an integral part of standard treatment in preterm labour
- Oral Preparations of steroids are not to be used
- Repeated courses/more frequent doses are not useful
- Multiple courses in fact could have harmful neuro-developmental effects in the baby
- ANCs have a role even if surfactant replacement is available

Preparation

Injection Dexamethasone Sodium Phosphate is available in 4 mg per ml strength

Route and Dose

Dose and Route of Administration of Injection Dexamethasone	
Dose	6 mg each
No. of Injections	4
Interval between injections	12 hours
Route of administration	Deep intramuscular
Site of administration	Preferably antero lateral aspect of thigh
Complete course	4 doses (equivalent to 24 mg total)
Logistics	2 ml disposable syringes 22/23 gauge needles
Storage	No need to refrigerate

Indications for ANS

1. True preterm labour
2. Following conditions that lead to imminent delivery:
   - Antepartum haemorrhage
   - Preterm premature rupture of membrane
   - Severe pre-eclampsia

Contraindication for ANS

- Frank chorioamnionitis is an absolute contraindication for using antenatal corticosteroids. Following signs and symptoms in the mother suggests Frank amnionitis:

1. History of fever and lower abdominal pain
2. On examination: Foul smelling vaginal discharge, tachychardia and uterine tenderness
3. Fetal tachycardia

Maternal diabetes, pre-eclampsia and hypertension are NOT contraindications for using injection corticosteroid in pregnant women. Dexamethasone can be administered if otherwise indicated with a careful watch on blood sugar and blood pressure

What to expect?

- ANS therapy - Maximal effect if fetus is delivered 24 hours after the last dose and up to 7 days thereafter

Summary

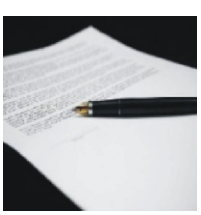
- Antenatal steroids induce lung maturity in preterm fetus.
- A single course of ANS can reduce neonatal morbidities including mortality to a significant extent.
- Dexamethasone is the drug of choice for administration to women with preterm labour between 24-34 weeks of gestation.

What did you learn from this webinar?

1. .....
2. .....
3. .....

What are the queries which come to your mind?

1. .....
2. .....
3. .....



2.2:Script

Rational use of antenatal corticosteroids (ACS)

This script shall help you to understand the concept of antenatal corticosteroid therapy (ACS).

There is almost 45% reduction in respiratory distress syndrome, 46% reduction in intra ventricular haemorrhage, 54% reduction in necrotising enterocolitis and 31% reduction in mortality

The current recommendation for our country is to give a single course of injection of Dexamethasone to women with preterm labour (between 24 and 34 weeks of gestation) at all levels of health facilities in the public as well as the private sector

- As per the current recommendations, administration of antenatal corticosteroid (Dexamethasone) constitutes an integral part of standard treatment in preterm labour irrespective of place of delivery
- Oral preparations of steroids are not to be used
- Repeat courses/more frequent doses are not useful
- Multiple courses could have harmful neuro-developmental effects in the baby
- ACS have a role even if surfactant replacement is available
- The preparation made available by the Government of India is Injection dexamethasone sodium phosphate, available in the strength as 4mg/mL as a 5 mL vial

Indications of ANS are:

- All women at high risk of preterm delivery between 24 and 34 weeks of gestation who are in true preterm labour. In addition, in the following conditions that lead to imminent delivery, antenatal steroids should be administered
    - Antepartum haemorrhage
    - Preterm premature rupture of membrane
    - Severe pre-eclampsia
- We also need to know which women should not receive ANS as it may be detrimental to the women or her fetus. Women with clinical chorioamnionitis as evidenced by:
    - History of fever and lower abdominal pain and on examination, foul smelling vaginal discharge, tachychardia and uterine tenderness along with fetal tachycardia is a contraindication to use of ANS
- Premature rupture of the membranes, pre-eclampsia, hypertension and diabetes are NOT contraindications to ANS use. In all these situations the obstetrician needs to monitor the pregnant woman's blood sugar and blood pressure more meticulously after administration of ANS
- Antenatal corticosteroid therapy has maximal effect if the fetus is delivered 24 hours after the last dose and up to 7 days thereafter

2.3:Key messages

- A single course of ANS can reduce neonatal morbidities including mortality to a significant extent
- Dexamethasone is the drug of choice for administration to women with preterm labour between 24-34 weeks of gestation

2.4:Poster

Antenatal corticosteroid therapy

The facilitator shall conduct a demonstration session on Antenatal corticosteroid therapy

Flow Chart for Antenatal Corticosteroid (ANCS) Administration {24-34 Weeks Gestational Age}

Assess the gestational age of pregnant woman reporting with the complaints of labour pain. If between 24-34 weeks then

Check whether the pregnant woman is in true preterm labour using the table* given below:

- If the pregnant woman is in true labour
  - Delivery imminent → Give one dose of Injection Dexamethasone as described in the box** and prepare for delivery and neonatal resuscitation
  - Delivery NOT imminent → Give one pre-referraldose of Injection Dexametasone if the patient is to be referred, othersie complete the course. Tocolysis (delay of uterine contractions) is to be done under medical supervision.
    - Before referral
      1. Check vitals, BP
      2. Do Hb, Blood Sugar, Urine Examination (Ex)
      3. Give ANCS first dose - Refer to higher facility
      4. Arrange transport
      5. Referral slip
    - Referral refused or not possible
      1. Check vitals, BP
      2. Do Hb, Blood Sugar, Urine Ex
      3. Give ANCS first dose, then 3 additional doses 12 hourly
      4. Arrange for delivery, resuscitation and care of preterm baby
- If the pregnant woman is not in true labour → Observe for the symptoms, discharge if the symptoms resolve with advice to report immediately if danger signs appear. If symptoms do not resolve, treat her as in true preterm labour and follow the chart.

**Dexamethasone protocol	
Dose/injection	6 mg
Route	Intramuscular
Interval	12 hours
No. of Injections	4

Contraindication for use of ANCS is Frank Chorioamnionitis

*Symptoms of True and False Labour Pain	
TRUE Labour Pain	FALSE Labour Pain
1. Begins irregularly but becomes regular and predictable 2. Felt first in the lower back and sweeps around to the abdomen in a wave pattern 3. Continues no matter what the woman's level of activity 4. Increases in duration, frequency and intensity with the passage of time 5. Accompanied by 'show' (blood-stained mucus discharge) 6. Associated with cervical effacement and cervical dilatation	1. Begins irregularly but remains irregular 2. Felt first abdominally and remains confined to the abdomen and groin 3. Often disappears with ambulation or sleep 4. Does not increase in duration, frequency or intensity with the passage of time 5. Show absent 6. Does not associate cervical effacement and cervical dilatation

2.6:Self-check MCQ's

1. Government of India recommends 4 doses of Inj Dexamethasone 6 mg each at 12 hr interval for pregnant women between 24-34 weeks gestation with

    a. Threatened preterm labour
    b. Imminent eclampsia
    c. PPROM
    d. Antepartum hemorrhage
    e. All of the above

2. Antenatal steroids protects the newborn from all except
    a. RDS
    b. NEC
    c. Congenital malformations
    d. IVH

3. Which is the preferred route for administration of antenatal steroids?
    a. Oral
    b. Intravenous
    c. Intramuscular
    d. Subcutaneous

4. What is the dose of dexamethasone when used as antenatal steroids for lung maturity?
    a. 6 mg q 12 hourly
    b. 12 mg q 24hourly
    c. 6 mg q 6 hourly
    d. 12 mg q 6 hourly

5. Which of the following is not an effect of antenatal corticosteroid therapy?
    a. Reduction in intraventricular hemmorhage
    b. Reduction in respiratory distress syndrome
    c. Reduction in neonatal death
    d. Reduction in chronic lung disease

Learning objective 3

Use of CPAP equipment safely and effectively

This objective covers the concept of use of CPAP equipment safely and effectively and is delivered as

- Webinars
- Script
- Key messages
- Videos
- Posters
- Checklist
- Self-check MCQ's

After viewing and listening to the videos, posters, and reading the script and the key messages you shall undergo a self- evaluation based on what you have already learnt.

3.1:Webinar

You will view and listen to webinar on the concept of initiation of bubble CPAP along with your facilitator. You are free to interrupt your facilitator anytime for any clarifications or suggestions. The power point slides of the webinar are given here.

Application of CPAP

DR. Srinivas Murki
MD, DM (Neonatology)
Consultatnt Neonatologist
Fernandez Hospital, Hyderabad

Essentials

- Oxygen : Fractional Inspired Oxygen
- Pressure : Continuous positive airway pressure
- Warming and Humidification of Gases

Indications

- Spontaneous Breathing
- Preterm neonate
  - Respiratory distress (Silverman Score ≥ 3)
  - Recurrent Apneas
  - Post extubation

Tracheomalacia / Phrenic N palsy

Indications

- Term Neonate
  - Respiratory Distress with Silverman Score ≥ 5
  - Post Extubation

Tracheomalacia / Phrenic N palsy

Contraindications

- Poor respiratory efforts
- Congenital diaphragmatic hernia
- Tracheo-esophagial fistula
- Choanal atresia, cleft palate
- Cardiovascular instability

Initiation

- Connect to a Pulsoximeter
- Fix the CAP (size)
- Right size prongs (interface)
  - Fisher and Paykel or Hudson
- Check the circuit
- Connect CPAP circuit to Interface

Fisher and Paykel

Hudson Interface

Orogastric Tube

CPAP, FiO_2 & flow for bubble CPAP

CPAP	5 cms
FiO_2	50%
Flow	5 liters/min

Rule of 5

What did you learn from this webinar?

1. .....
2. .....
3. .....

What are the queries which come to your mind?

1. .....
2. .....
3. .....

3.2:Script

Initiation of bubble CPAP

This script shall help you to understand the concept of initiation of bubble CPAP.

Delivery of CPAP to a newborn includes delivery of continuous positive airway pressure to the airway and lungs, delivery of air and oxygen mixture at the preset fractional oxygen concentration and delivery of air oxygen mixture at body temperature and at relative humidity of 100% to the newborn nares

The 3 common indications of CPAP in a preterm newborn are:

- Respiratory distress with silverman anderson score >=3,
- Post extubation from a mechanical ventilation and
- Recurrent apneas or apnea requiring positive pressure ventilation

However presence of spontaneous breathing efforts is a prime requirement of CPAP delivery
CPAP is also indicated for airway malformations such as tracheomalacia and for phrenic nerve palsy
The indications for CPAP in a term newborn are respiratory distress with silverman anderson score (SAS) more than equal to five and also for post extubation from mechanical ventilation. Poor respiratory efforts, malformations such as congenital diaphragmatic hernia, tracheo-esophagial fistula, and cleft palate are contraindications for CPAP. CPAP is not the choice of respiratory support if the newborn with respiratory distress also has severe cardiovascular instability

The steps of CPAP application to a newborn would include

- Connecting the newborn to a pulse oximeter
- Fixing the CAP of right size and fixing the appropriate type and size CPAP interface
- Checking the CPAP circuits for leaks and then connecting the CPAP circuit to the nasal interface
- Immediately after connecting the newborn to a CPAP machine one should insert an orogastric tube and fix it the side wall of the warmer or incubator
- If a newborn is supported on CPAP for respiratory distress, remember the rule of 5. At initiation one may support such a newborn with a CPAP pressure of 5cm, an FiO_2 of 50% and flow of 5 L/ min

3.3:Key messages

- CPAP is initiated in a preterm infants with respiratory distress and having a silverman anderson score >3
- CPAP is initiated in a term infants with respiratory distress and having a silverman anderson score >5
- Remember the rule of 5 when initiating CPAP for respiratory distress in any infant

3.4:Webinar

You will view and listen to webinar on the components and types of CPAP machine along with your facilitator. You are free to interrupt your facilitator anytime for any clarifications or suggestions. The power point slides of the webinar are given here.

CPAP Machine

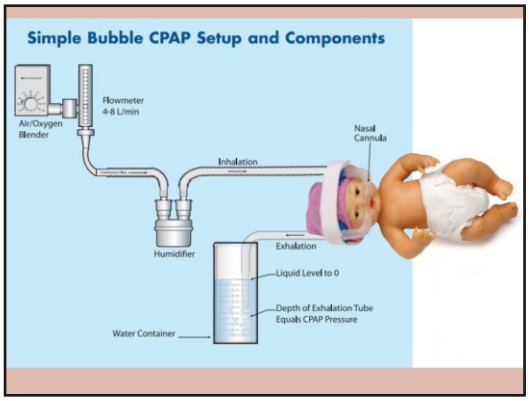
DR. Srinivas Murki
MD, DM (Neonatology)
Consultatnt Neonatologist
Fernandez Hospital, Hyderabad

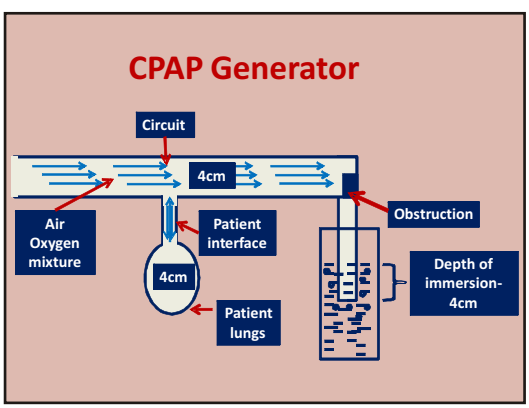
Requirements for CPAP

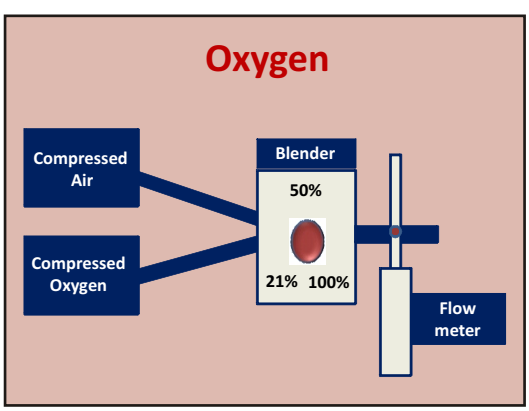
▪ Oxygen	FiO_2	21% to 100%
▪ Pressure	CPAP	4 to 7 cms
▪ Flow		2 to 7 L/min
▪ Temperature		37° C
▪ Humidity		100% RH

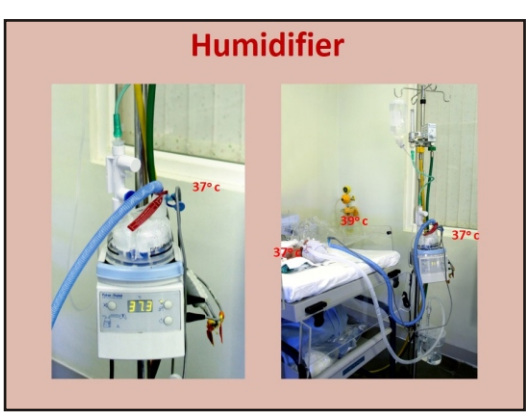
Requirements for CPAP

- Oxygen — **Compressed Air**, Compressed Oxygen, Blender
- Pressure — **Flow of gas and CPAP Generator**
- Temperature — Humidifier
- Humidity


Simple Bubble CPAP Setup and Components
Flowmeter
4-8 L/min
Air/Oxygen
Blender
Nasal
Cannula
Inhalation
Humidifier
Exhalation
Liquid Level to 0
Depth of Exhalation Tube
Equals CPAP Pressure
Water Container


CPAP Generator
Circuit
4cm
Air
Oxygen
mixture
Patient
interface
Obstruction
4cm
Depth of
immersion-
4cm
Patient
lungs


Oxygen
Compressed
Air
Compressed
Oxygen
Blender
50%
21%
100%
Flow
meter


Humidifier
37° c
37° c
37° c

Types of CPAP machines

- Bubble CPAP Machine
- Flow Driver CPAP Machine
- Ventilator CPAP

Cleaning and Disinfection

- Always use disposable circuits
- No need to replace circuit routinely
- Fill the Humidifier chamber with Distilled water
- Use Auto-fill option for filling the chamber
- Clean the equipment with a soft cloth
- Humidification to avoid water logging

Troubleshoot

- Alarm from the blender
- Malfunctioning of Blender
- Leaks in the circuit
- Condensation in the inspiratory limb
- No condensation in the expiratory limb
- Inadvertent delivery of high pressures

Troubleshoot

Blender

Leaks

Condensation and Water

Summary

Basic requirements	▪ Pressure generator ▪ Graded oxygen ▪ Warmidification
Pressure	Bubble generator
Oxygen	▪ Blender ▪ Oxygen ▪ Compressed air
Warmidificaiton	Servo controlled humidifier

What did you learn from this webinar?

1. .....
2. .....
3. .....

What are the queries which come to your mind?

1. .....
2. .....
3. .....

3.5:Script

Components and types of CPAP machine

This script shall help you to understand the concept of components and types of CPAP machine.

- Delivering CPAP to a newborn involves giving oxygen ranging from 21% to 100%, CPAP pressures 4 to 7 cm of water, flow of air oxygen mixture at 2 to 7 L/ min and the required air oxygen mixture at a temperature of 37ºC and a relative humidity of 100% to the newborn nares
- For delivering oxygen 21% to 100% one would need a compressed air source such as an air compressor or a centralized gas source, compressed oxygen source such as an oxygen cylinder or a centralized gas source and a blender to mix the pressurized air and oxygen to the desired fractional oxygen concentration
- For delivering warm and humdified air oxygen to the nares, there is also a need for servo controlled humidifier
- As the gas flows in the T piece, air from the lung will be sucked into the tube due to bernoullui's principle. When an obstruction is built in the T piece as the gas is flowing in the tube, pressure builds in the T piece and gas will flow into the lungs till the pressure in the lungs equals the pressure that is built in the T piece
- The obstruction to gas flow in the T piece can also be achieved by immersing one end of the T piece in a chamber of water. The pressure generated in the T piece and in the lung is equal to the depth of immersion of the end of T piece. The greater the depth of immersion, greater is the pressure built in the T piece. The depth of immersion of the T piece inside water from the water level is the pressure generated in the T piece provided the gas mixture is bubbling out from the pressure generator or the water chamber
- A blender mixes the compressed air and compressed oxygen to desired fractional oxygen concentration from 21% to 100% depending on the desired FiO_2 one sets on the blender. The amount of gas coming out of the blender is to be set by the flow meter that is fixed at the outlet of the blender. So the blender is used to titrate the FiO_2 of the gas mixture and flow meter is used to titrate the amount of gas mixture that is allowed to flow in the T piece.
- A servo humidifier delivers the gas mixture to the new born nares to 37ºC and at a relative humidity of 100%. To do this function, servo humidifiers are autoset for the exit of gas form the humidifier chamber at 37ºC and reach a temperature 39ºC inside the inspiratory of the CPAP circuit. This happens by a heating element present in the inspiratory limb. As the length of the heating element is restricted in the inspiratory limb upto a few cms away from the nares, there is drop in gas temperature from 39ºC to approximately 37ºC in the inspiratory limb and just before reaching the nares of the newborn. To ensure this estimated drop of gas temperature in the inspiratory limb, the last segment of the inspiratory limb should be inside the radiant warmer
- The gas that exits from the water chamber is at a relative humidity of 100% and as the gas gets heated in the inspiratory limb, there is a drop in relative humidity. Again in the last segment of inspiratory as gas temperature comes back to 37ºC and relative humidity is 100%

- In a bubble CPAP, pressure is generated by a bubble or water chamber, in a ventilator CPAP is generated by a valve/obturator in the expiratory limb of the expiratory circuit and CPAP is generated at the peculiar nasal interface by degree of gas flow and fixed obstructive mechanism fitted in the nasal interface

3.6 Key messages

- A CPAP machine is a combination of pressure generator
- Delivery of fractional oxygen can vary from 21% to 100%
- CPAP ensures delivery of warm and humidified gases to the newborn nares
- In a bubble CPAP machine the pressure generator is the bubble chamber, fractional oxygen to the desired level is achieved with compressed air and oxygen, and a blender
- Warming and humidification of gases is achieved with a servo humidifier

3.7:Webinar

You will view and listen to webinar on the concept of common trouble shoots on bubble CPAP along with your facilitator. You are free to interrupt your facilitator anytime for any clarifications or suggestions. The power point slides of the webinar are given here.

Troubleshoot : Bubble CPAP

DR. Srinivas Murki
MD, DM (Neonatology)
Consultatnt Neonatologist
Fernandez Hospital, Hyderabad

1. De-saturating Baby

- **D** isplaced-distorted prongs
- **O** bstructed nares
- **P** neumothorax
- **E** quipment failure

2. Why Won't It Bubble?

- Complete or partial circuit leak
- Complete or partial prong disconnect
- Displaced prongs
- Inadequate flow through the circuit
- Prongs are too small for the baby
- Baby's mouth is open

3. Agitated Baby

- Minimal handling
- Careful interface application
- Effective airway clearance
- Clustering of care
- Feeding
- "Hands off"
- ? Sedative

Trouble Shoot

SpO_2	Retractions	Air entry	Bubbling	Diagnosis
Low	++/+++	Poor	Yes	Lung disease
Low	+/nil	Good	Yes	PPHN/CHD/ blender malfunction
Normal	++/++++	Good	Yes	Metabolic acidosis
Low	++/+++	Poor	Yes	Obstruction
Low	++/+++	Poor	Nil	Leaks

What did you learn from this webinar?

1. .....
2. .....
3. .....

What are the queries which come to your mind?

1. .....
2. .....
3. .....

3.8:Script

Common trouble shoots on bubble CPAP

This script shall help you to understand the concept of common trouble shoots on bubble CPAP.

- When a newborn on CPAP has saturations less than 90%, remember the concept of DOPE; displaced or distorted prongs, obstructed nares or nostrils, pneumothorax or other air leaks and equipment failure
- If bubbles are intermittent or absent in the bubble chamber this could occur due to complete or partial circuit leak, complete or partial nasal prong disconnect, displaced prongs, inadequate flow gases in the circuit, prongs are too small for the baby and or patient's mouth is open
- If a baby on CPAP is agitated, watch for nasal injury and secretions. Minimal handling, careful assessment of interface applications, clearing of the nose and throat, clustering of care and feeding would help in comforting the baby. Sedation is never recommended for a struggling baby
- Assessment of saturations, retractions, air entry, bubbling are useful in understanding the problems and finding appropriate solutions
- If saturations are low, retractions are moderate to severe, air entry is poor and bubbling in the bubble chamber are present the problem is related to lung disease or air way obstruction
- If saturations are low, no retractions, air entry is good and bubbling is present the problem is either congenital heart disease or blender malfunction
- If saturations are normal, retractions are moderate or severe, air entry is good and bubbling is present, the problem is probably metabolic acidosis. Also one need to look at the water level in the bubble chamber
- If saturations are low, retractions are moderate or severe, air entry is poor and there is no bubbles in bubble chamber, suspect leaks in the circuit or at the nostril or the baby's mouth is open

3.9:Key messages

- Assessment of saturations, retractions, air entry, bubbling are useful in understanding the problems
- If bubbles are intermittent or absent in the bubble chamber this could occur due to complete or partial circuit leak
- If a baby on CPAP is agitated watch for nasal injury and secretions
- Minimal handling, careful assessment of interface applications, clearing of the nose and throat, clustering of care and feeding would help in comforting the baby

3.10:Video

There will be five video demonstrations by your facilitator on

1. How to set up bubble CPAP machine?
2. How a newborn is connected to ventilator CPAP?
3. How to fix binasal prongs?
4. How to fix ram's cannula?
5. How to fix heated humidified high flow nasal cannula?

The video demonstration will be followed by discussion.

1. The following aspects of how to set up bubble CPAP machine were shown:
   - i. .....
   - ii. .....
   - iii. .....
2. The following aspects of how a newborn is connected to ventilator CPAP care were shown:
   - i. .....
   - ii. .....
   - iii. .....
3. The following aspects of how to fix binasal prongs were shown:
   - i. .....
   - ii. .....
   - iii. .....
4. The following aspects of hudson prongs were shown:
   - i. .....
   - ii. .....
   - iii. .....
5. The following aspects of ram's cannula were shown:
   - i. .....
   - ii. .....
   - iii. .....
6. The following aspects of H3FNC were shown:
   - i. .....
   - ii. .....
   - iii. .....

Comments on video:

Good aspect	Need improvement
.....	.....
.....	.....
.....	.....

3.11:Poster

There will be a poster demonstration on

- CPAP Mega code poster
- Fixation of nasal prongs poster
- Circuit and machine preparation chart

CPAP MEGA CODE POSTER

The facilitator shall conduct a demonstration session on CPAP Mega code

APPLICATION OF BUBBLE **CPAP** FOR NEWBORN

INDICATIONS :
Respiratory Distress :
- Preterm Infants (Gestation<35 weeks) : SAS Score>3
- Term Infants (Gestation>=35 weeks) : SAS Score>5
- Recurrent Apneas in a preterm infant
- Post extubation in VLBW infant

CONTRAINDICATIONS :
- Poor Respiratory efforts
- Nasal seal poor (Cleft Palate)
- Tracheo-esophageal fistula and Congenital diaphragmatic hernia
- Pnuemothorax and other air leaks

PREPARATION OF MACHINE AND INTERFACE :
- Assemble the sterile circuit
- Fill distilled water in humidifier and clean water in bubble chamber
- Connect air and oxygen to blender, switch on the humidifier
- Fix the cap to the baby and appropriated size prongs to the cap
- Connect interface to the sterile circuit

Initiation of CPAP

	Preterm infants with RD	Recurrent Apnea	Post-extubation
Initial Settings	CPAP : 5cms FiO_2 : 50% Flow : 5liter/min	CPAP : 4 to 5cms FiO_2 : <25 % Flow : 5liter/min	CPAP : 5cms FiO_2 : As on MV Flow : 5liter/min

Adjustment of FiO_2 and CPAP pressure

Increase CPAP in steps of 1cm :
- If retractions ++ & SpO_2 <90% and Chest x ray (1/2 hour after starting) < 6 spaces

Increase FiO_2 in steps of 5%
- If mild or no retractions and SpO_2 <90%
- For every 10% increase in FiO_2 assess the need for increase in CPAP pressure by 1cm

No change in CPAP or FiO_2 is required if baby is comfortable, minimal or no retractions, CFT and BP are normal, SpO_2 between 90 to 95%, bubbling is good and breath sounds are heard

Nursing Care & Monitoring

- Ensure correct size and fixation of nasal prongs
- Ensure gap between columella and nasal prongs
- Fix the prongs to cap and cover ears with cap
- Remove prongs, inspect nostrils, use saline drops if needed and do gentle massage in each shift
- Ensure water level in bubble chamber and Humidifier
- Record depth of immersion of expiratory limb
- Maintain monitoring sheet

Weaning of CPAP

CPAP and FiO_2 :
- Reduce FiO_2 if SpO_2 >95% in steps of 5%
- If FiO_2 reduced by 10% and retractions are mild or absent, reduce CPAP pressure by 1cm till CPAP is 5cm and FiO_2 is 50%
- Subsequently reduce FiO_2 in steps of 5% till FiO_2 <30% before reducing CPAP pressure from 5cm to 4cm of water
- Remove CPAP if FiO_2 is <25% and CPAP is 4cm

Failure of CPAP or Need for MV

- SpO_2 <90% on FiO_2 >70% and CPAP >7cm
- Moderate to severe retractions on CPAP >7cm
- Recurrent Apneas
- Shock or multiorgan dysfunction
- Poor respiratory efforts or $PaCO_2$ >60mm of Hg

SILVERMAN ANDERSON SCORING

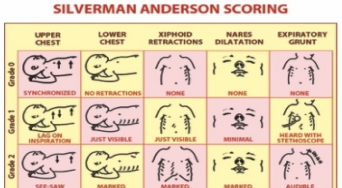
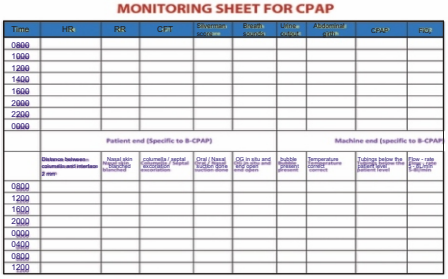


Figure : The Silverman score for assessing the magnitude of respiratory distress. (From Avery, M.E., And Fletcher, B.D. : The Lung and Its Disorders in the Newborn. Philadelohia, W.B.Saunders Company, 1974) (Courtesy of W.A.Silverman)

Note: Upper Chest is the chest above the mid-axillary line

MONITORING SHEET FOR CPAP



TROUBLE SHOOT ON CPAP

SpO2	Retractions	Air Entry	Bubbling	Diagnosis
<90%	++/+++	Poor	Yes	Lung Disease or Nasal Block
<90%	+/nil	Good	Yes	PPHN/CHD/Blender Malfunction
<90%	++/+++	Poor	No	Leaks in the Circuit or inadequate flow
Condensation in Inspiratory limb			• Heater Wire is not working • Room Temperature is too low • Distal Circuit is not under warmer	
No condensation in Expiratory Limb			• Humidifier is not-working • Room temperature is High	

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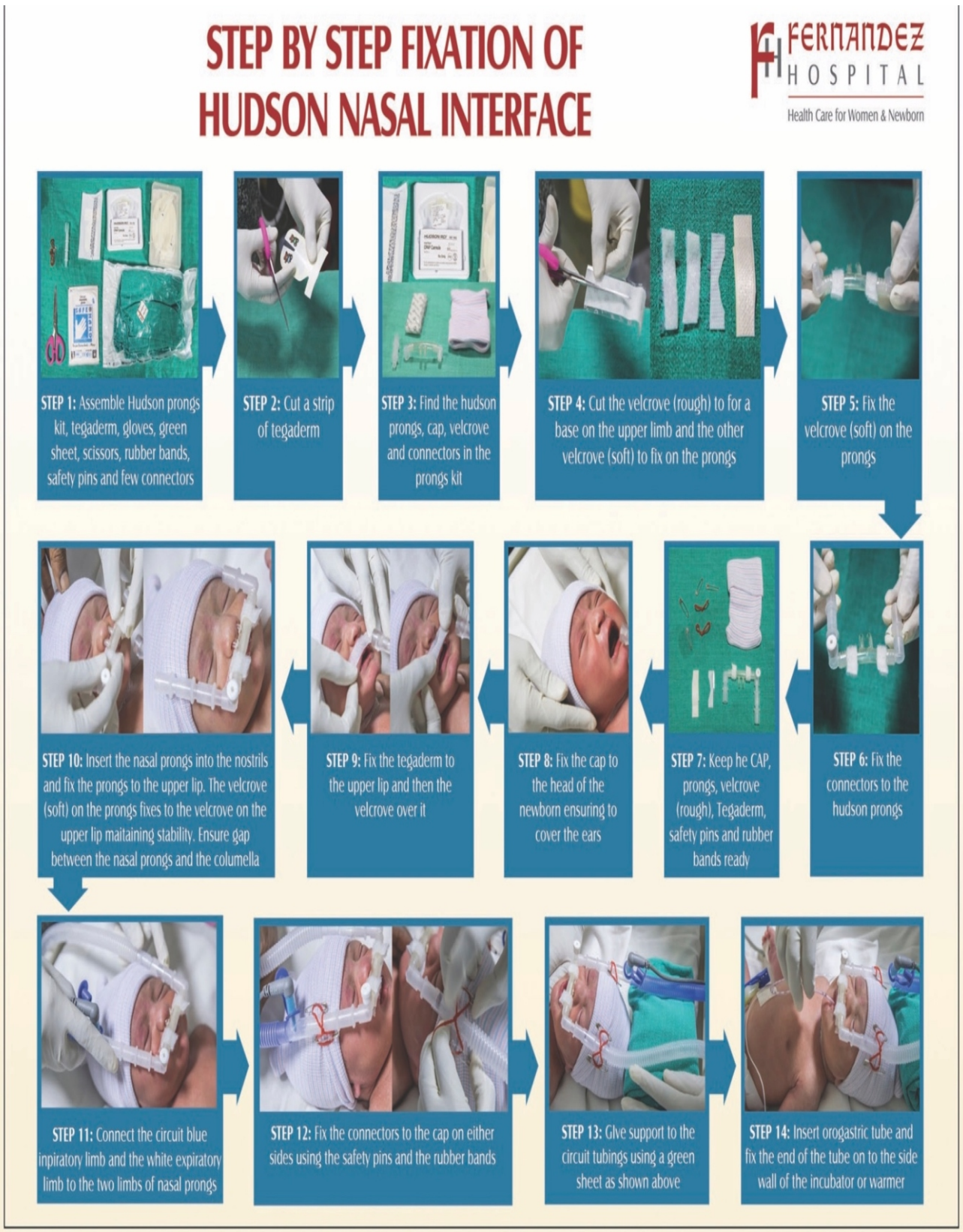
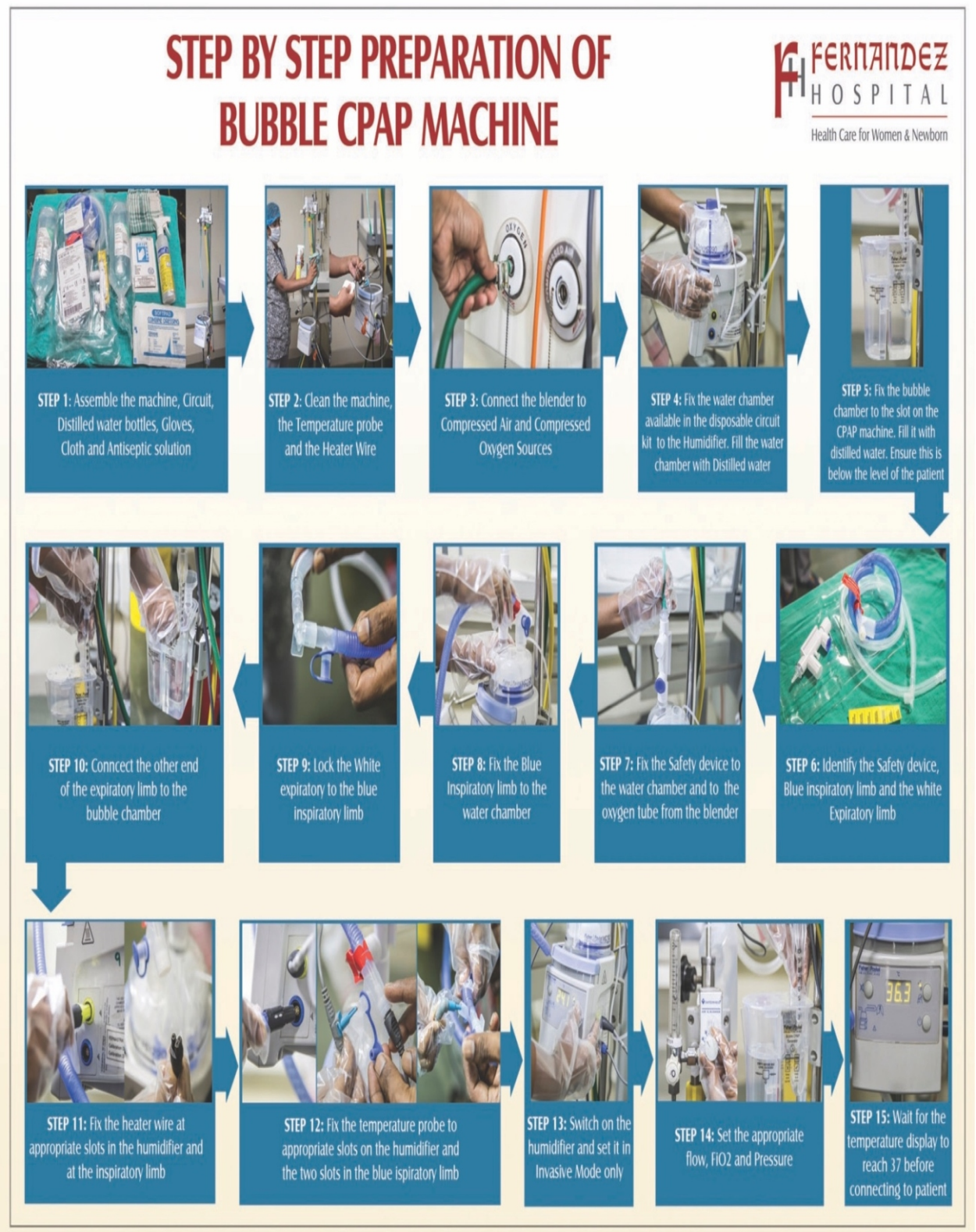
FIXATION OF NASAL PRONGS POSTER

The facilitator shall conduct a demonstration session on fixation of nasal prongs



CIRCUIT AND MACHINE PREPARATION CHART

The facilitator shall conduct a demonstration session on Circuit and machine preparation chart



3.12:Checklist

CPAP MACHINE

The facilitator shall explain the checklist step by step according to procedure on CPAP machine

S. No		Yes	No
1.	Heater wire fixed at appropriate slot and the correct connection used for disposable circuit		
2.	The temperature probe is fixed at appropriate slots in the humidifier and the inspiratory limb. The terminal end of the temperature probe is placed outside of the incubator or radiant warmer. If inside, it is covered with an insulating material		
3.	Water level in the humidifier chamber is appropriate		
4.	The water filled in the humidifier chamber is distilled water		
5.	Distilled water bottle is connected to the humidifier		
6.	The water column in the bubble chamber is appropriate		
7.	The bubble chamber is fixed at a level below that of the new born		
8.	There is adequate bubbling in the bubble chamber		
9.	The humidifier is set in the invasive mode		
10.	The temperature display on the humidifier is 37° C (at least 36°C and above)		
11.	FiO_2, Flow of gas and CPAP pressure are monitored		

Module VII - Optimal Use of CPAP

3.13:Audit sheet

USE OF CPAP

The facilitator shall explain the audit sheet step by step according to procedure of use of CPAP

AUDIT OF CPAP SERVICES AT SNCU

Name of the Hospital : _____ Unit No.: _____

Date pf the Audit : _____ Time of the Audit : _____ Done by : _____

Does the unit have facility for giving CPAP : ☐ YES ☐ NO Central Oxygen : ☐ YES ☐ NO

Compressed Air Source: ☐ YES ☐ NO If yes compressor or central source _____

Blenders : ☐ YES ☐ No CPAP Circuits : _____ Disposable or Reusable : _____

If disposable how they are procured by _____

Type of Prongs Used : ☐ Fisher and Paykel ☐ Hudson ☐ Others Humidifiers : ☐ Servo ☐ Partial

No. of babies in the unit at the time of the audit : _____

No. of newborns in the unit with respiratory distress : _____

No. of newborn with RD on Oxygen : _____ No. of newborns with RD on ventilator : _____

No. of newborns with RD on CPAP : _____

No. of newborns with RD on Oxygen but eligible for CPAP : _____

If Eligible baby for CPAP is on oxygen reason for not instituting CPAP : _____

The table below should be filled in at the time of the audit for each individual baby receiving CPAP :

Sr. No.	1	2	3	4	5	6	7	8
IP No.								
Gender (M/F)								
Birth Weight (In grams)								
Gestation (in weeks)								
Inborn (I)/ Outborn (O)								
Date of birth								
Day of life on day of audit								
Appropriate use of CPAP pressure								
FiO_2 adjusted to monitoring with Pulsoximeter with target SpO_2 (90 to 95%)								
Appropriate use of flow (fixed flow) or adequateto cause bubbling)								
Monitoring with portable X ray done								
Monitoring chart for CPAP use								
Adequacy of water in the humidifier								
Circuit used is appropriate								
No condensate in inspiratory limb								
Prongs are fixed appropriately								
Cap fixed well and covering Ears								
Bubbles in water chamber								
NG tube insitu and kept open above the level of prongs								

3.14:Self-check MCQ's

1. CPAP Pressure, FiO_2 and Flow are the 3 parameters to be set in all the methods of CPAP delivery except
   a. Bubble CPAP
   b. Ventilator CPAP
   c. Flow Driver CPAP
   d. Indigenous CPAP

2. Which of the following is not a recommended nasal interface in the delivery of CPAP to a newborn?
   a. Hudson bi-nasal prongs
   b. Argyli prongs
   c. Endotracheal tube placed in nasopharynx
   d. Fisher and paykel nasal mask

3. Match the following

a. Condensation in the inspiratory limb	1. Leak in the circuit
b. No bubbles in the bubble chamber	2. Heater wire not working
c. No mist seen in the expiratory limb	3. Humidifier chamber not working
d. Good bubbling, increased recessions	4. Nose block

4. Which of the following is a contraindication for use of CPAP in newborns
   a. Apnea of prematurity
   b. Severe respiratory distress syndrom (RDS) with SAS Score 8/10
   c. Meconium Aspiration syndrome
   d. Congenital Diaphragmatic Hernia

5. Following are the indications for CPAP, **'Except'**?
   a. Respiratory distress syndrome (RDS)
   b. Apnea of prematurity
   c. Transient tachypnea of newborn (TTN)
   d. Severe cardiovascular instability

Module VII - Optimal Use of CPAP

Learning objective 4

Use of CPAP therapy rationally in various clinical situations in preterm newborn infants

This objective covers the concept of use of CPAP therapy rationally in various clinical situations in preterm newborn infants and is delivered as:

- Webinars
- Script
- Key messages
- Posters
- Self-check MCQ's

After viewing the videos, webinars, posters and reading the script and the key messages you shall undergo a self- evaluation based on what you have already learnt.

4.1:Webinar

You will view and listen to webinar on concept of monitoring, maintenance and weaning of CPAP along with your facilitator. You are free to interrupt your facilitator anytime for any clarifications or suggestions. The power point slides of the webinar are given here.

Monitoring and Weaning of CPAP

DR. Srinivas Murki
MD, DM (Neonatology)
Consultatnt Neonatologist
Fernandez Hospital, Hyderabad

Maintenance and Monitoring

- Flow
  - Bubble minimal bubbling (2 to 7 L/min)
  - Ventilator 6 to 8 cms of water
- FiO_2 (21% to 60 %) : SpO_2 90% - 95s%
- CPAP (4 to 7 cms) : Recessions / CXR and SpO_2

CPAP and FiO_2: Proportionality

CPAP	5 cms	FiO_2	50%
CPAP	6 cms	FiO_2	60%
CPAP	7 cms	FiO_2	70 to 100%
CPAP	4 cms	FiO_2	25 to 40%

CPAP

- CPAP of < 4 cm H_2O never given!
- CPAP of 4-7 cm H_2O is a good range
  - Advantages many, disadvantages few!
- CPAP of > 7 cm H_2O is a bad range
  - Advantages some, disadvantages galore!

Warming and Humidification

- Temperature of inspiratory gases at 37 ° C
- Relative humidity of 100%
- No condensation in the inspiratory circuit
- Some condensation in the expiratory limb

Humidifier

Monitoring

- Patient
  - HR, RR, SAS Score, SpO_2, Air entry and bubbling
  - CFT, Blood pressure, AF, Urine output, Abd girth
- Machine
  - CPAP pressure, FiO_2 and Flow
  - Water in humidifier, Bubble chamber
  - Condensation in circuit
- Interface
  - Nasal injury, Cap size, Prong size, Secretions

CXR

Adequacy of CPAP

Satisfactory cardiorespiratory status

- Comfortable baby
- Minimal retraction, no grunt
- Normal capillary refill, BP
- Normal saturations: 90% - 94%
- Normal ABG

(PaO_2 60-80, $PaCO_2$ 40-60, pH 7.35-7.45, BE ± 2)

Bubbling Breath sounds

Weaning

- Decrease FiO_2 and then CPAP
- Every 1 cm decrease in CPAP, aim 10% in FiO_2
- CPAP : 5cm & FiO_2 50%, maintain CPAP till FiO_2 is 30%
- Decrease CPAP to 4 cm
- The disease process has improved
- If CPAP 4 cm & FiO_2 < 30% & clinically well (no RD, SpO_2 > 90% & Normal ABG) : Remove CPAP

Procedure after the CPAP

- Oral and Nasal suction / Saline nebulization if secretions
- Watch for apneas, tachypnea, retractions and bradycardia
- Frequent change in positions

Failure of CPAP

- Continuing retractions, grunt
- Recurrent apneas
- SpO_2 <90 %/ PaO_2 < 50 : PEEP > 7 & FiO_2 >60%
- $PaCO_2$ > 55, Poor respiratory efforts
- Baby not tolerating CPAP

Reasons for Failure

- Failure of the CPAP system
- Worsening of baby
  - Respiratory
  - Cardiovascular
  - Neurological

Summary

- Titration
  - Flow — Bubbling
  - FiO_2 — SpO_2
  - CPAP — Recessions/Chest X-ray
- Proportionality of FiO_2 and CPAP
- Systematic evaluation: Failure of CPAP

What did you learn from this webinar?

1. .....
2. .....
3. .....

What are the queries which come to your mind?

1. .....
2. .....
3. .....

4.2:Script

Monitoring, maintenance and weaning of CPAP

This script shall help you to understand the concept of monitoring, maintenance and weaning of CPAP.

After the initiation of CPAP, subsequent titration of pressure, flow and FiO_2 involves mostly clinical assessment. Flow is immediately adjusted to obtain continuous bubbling in the bubble chamber. A flow requirement greater than 7 L /min is an indication for leaks in the CPAP circuit. The FiO_2 is adjusted from a range of 21% to 60% for a target newborn saturation between 90% to 95% and CPAP Pressure is adjusted based on the recessions, chest expansion on the X-ray and the saturations. Increasing recessions mandate increasing CPAP pressure provided there are no leaks in the circuit and there is no airway or nasal block. In most clinical situations when a newborn with RD is supported with CPAP, one expects a proportionality of CPAP pressure with FiO_2 needed to maintain target saturations

- For a FiO_2 requirement of 50% the maximum CPAP pressure expected is about 5cm
- Like wise for 60%, CPAP pressure of 6cm, for 70% to 100% FiO_2 a pressure requirement greater than 7 or more cm of H_2O
- When the newborn maintains target saturations with FiO_2 less than 30%, the CPAP pressure may be dropped to 4cm of water
- CPAP pressure of less than 4cm is not indicated and a pressure greater than 7cm is associated with complications such as air leaks and CPAP belly

- A newborn supported on CPAP needs 3 phased monitoring: (i) Monitoring of the patient for the adequacy of CPAP settings and for assessing the complications,(ii) monitoring of CPAP machine for leaks, water condensation, water level in the bubble chamber and the humidifier and the (iii) interface for nasal injury, nasal block and appropriateness of CPAP and interface size and fixation

Indications of chest X-ray in a neonate on CPAP:

- Chest X-ray is indicated immediately after starting the newborn on CPAP to assess for lung inflation and also evaluating the etiology of respiratory distress. A lung expansion of 6 anterior or 8 posterior intercostal space is considered appropriate. Low volume lung requires increase in CPAP pressure and vice versa. Chest X-ray is also indicated when a newborn on CPAP has a sudden unexplained deterioration or when there is a discrepancy between the CPAP pressure and FiO_2 requirements

A newborn on bubble CPAP is considered to have adequacy of settings and does not require any change in flow, FiO_2 or CPAP pressure if

- He/she is hemodynamically stable
- Is comfortable and not fighting
- There are no recessions and no grunt
- Saturations are between 90% and 95%
- If blood gas is done it has a pH between 7.35 to 7.45, PaO_2 between 60 to 80 mm of Hg and $PaCO_2$ is between 40 and 60 mm of Hg, and
- There is bubbling in bubble chamber and bubble sounds heard in the axilla

Weaning CPAP:

If a newborn on CPAP is well settled and the disease process for which CPAP is started is improving, there is need to wean FiO_2 and CPAP pressure. When the CPAP pressure >5 cm and FiO_2 >50%, always first reduce the FiO_2 in steps of 5% and then the CPAP pressure in steps of 1cm. For every 10% reduction in FiO_2, aim for a reduction in CPAP pressure by 1cm. After reducing the CPAP to 5cm, subsequent reduction in pressure to 4cm is done only when the FiO_2 could be dropped to <30%. When the CPAP pressure is 4cm and FiO_2 <30% and the disease process has improved, remove the newborn from CPAP. After removing the newborn from CPAP, the nose should be cleared of any secretions and a frequent change in baby position is recommended. One should watch for increasing FiO_2 need, increasing recessions and heart rate fluctuations. There is no need for routine chest X-ray after CPAP removal.

Any baby on CPAP who continues to have moderate to severe recessions, grunts, has saturations <90%, has recurrent apneas even on a maximum CPAP pressure of 7cm and FiO_2 of 60% is a candidate for mechanical ventilation. Always assess for appropriate delivery of all components of CPAP before labelling CPAP failure. Those newborns who do not have good respiratory efforts and those not tolerating CPAP machine also may need mechanical ventilation. The commonest reason for CPAP failure or need for mechanical ventilation (MV) are the failure of CPAP delivery system or baby related issues such as worsening respiratory distress, cardio vascular instability or recurrent apneas.

4.3:Key messages

- Titration of flow is based on presence of bubbling in the bubble chamber
- FiO_2 is titrated to maintain SpO_2 between 90% and 95%
- CPAP pressure alteration is based on the presence of recessions, lung expansion on chest X-ray and on the target SpO_2
- When giving pressure and oxygen always remember the proportionality concept
- A systematic evaluation is required before confirming CPAP failure

4.4:Webinar

You will view and listen to webinar on concept of supportive care during CPAP along with your facilitator. You are free to interrupt your facilitator anytime for any clarifications or suggestions. The power point slides of the webinar are given here.

Supportive Care

- **Ongoing Assessment**
  - Infant, Interface, CPAP Machine
- **Feeding Considerations**

DR. Srinivas Murki
MD, DM (Neonatology)
Consultatnt Neonatologist
Fernandez Hospital, Hyderabad

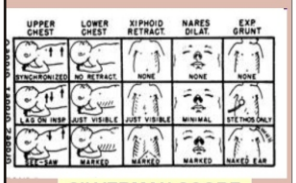
Ongoing Assessment

Complete assessment: 4-6 hr
Vital signs: 2-3 hr

A. Infant Monitoring

- **Appearance:** Comfort, color, posture
- **Vitals** : Temp, HR, RR, SpO_2, BP
- **CVS:** Pulse volume, CRT, U/o, BP
- **CNS:** Activity, tone, responsiveness
- **GIT:** OGT, abdominal distension
- **Settings:** FiO_2, CPAP and Flow

Respiratory Monitoring



SILVERMAN SCORE

Clinical

- RR, Effort, Pattern
- Chest Movement
- Retractions
- Grunt
- Breath sounds
- Air entry

Optimal Positioning

- Reposition q 3 to 6 hr
- Nesting
  - Promote flexion, containment and comfort

Airway Monitoring

- Note the color, consistency, & quantity of nasal secretions
- Suction the mouth, nose and pharynx
- Moisten the nares with normal saline or sterile water

B. Interface

- Prongs should fit snuggly
- Symmetry of Nares?
- Blanching of skin at nares?
- Skin breakdown?
- Gap between columella and Prongs

Assessing the nasal interface

- Is the cap appropriately placed?
- Is the nasal interface component twisted?
- Compress the tip of the nose

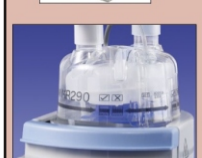
Assessing Skin integrity

- Color
- Quality of perfusion
- Possible areas of pressure or excoriation

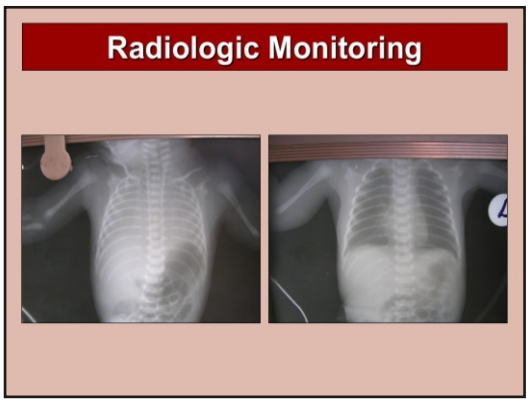
C. Monitoring CPAP System

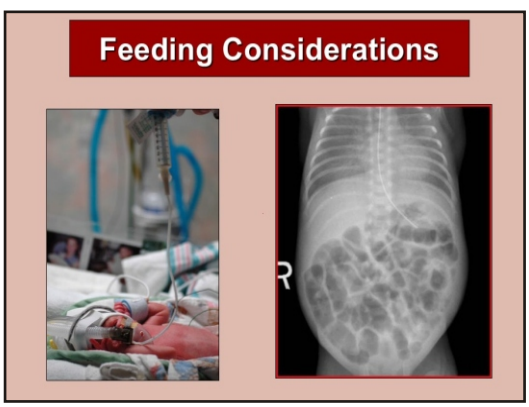
- CPAP pressure?
- FIO_2 reading?
- Flow rate?
- Is there bubbling?
- Water level …cm

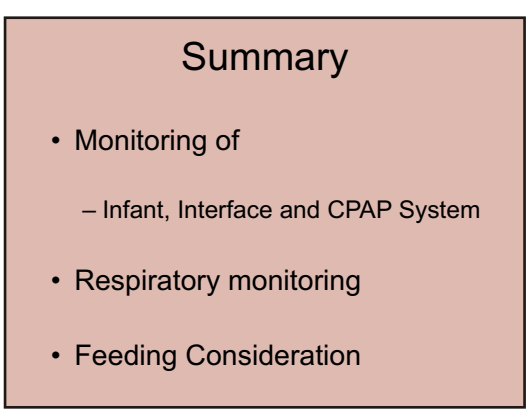
HUMIDIFICATION



- Set the humidifier in invasive mode
- Water level correct
- No condensation in inspiratory limb
- Condensation in expiratory limb







What did you learn from this webinar?

1. .....
2. .....
3. .....

What are the queries which come to your mind?

1. .....
2. .....
3. .....

4.5:Script

Supportive care during CPAP

This script shall help you to understand the concept of supportive care (including enteral feeding) during CPAP.

Supportive care of a newborn on CPAP includes ongoing assessment of the newborn, nasal interface and CPAP machine and finally ensuring early and aggressive enteral feeding. Assessment is ongoing, systematic, thorough and meticulous. Vitals need to be assessed every 2 to 3 hours and complete assessment of infant, interface and CPAP system should be done every shift or every 4 to 6 hours

- Infant monitoring should include vitals, assessment of all the organ settings. Also one needs to assess the adequacy of FiO_2, CPAP and flow in each shift
- Respiratory monitoring should include assessment of respiratory rate, recessions, chest movements, breath sounds and bubble sounds. An objective assessment of silverman anderson score is also essential at least twice in each shift
- Infants in any position need to be properly supported by rolls. Repositioning should be done every 3 to 6 hours. Promote nesting and avoid excess flexion, extension, rotation of the head and neck.
- Airway monitoring includes assessment of secretions in the nose and mouth. Suctioning is recommended only when required. When the secretions are thick, moisten the nares with normal saline or sterile water.
- Ensure the prongs are fit snuggly into the nares. Watch for symmetry of nose, blanching of the skin and any skin break down. Ensure distance between columella and nasal prongs
- The cap should cover the ears and fit snugly. Watch for twisting of the nasal interface, blanch the tip of nose and assess for perfusion integrity
- Watch for color, perfusion, areas of pressure points and areas of skin excoriations
- Monitoring of the CPAP system includes recording the CPAP pressure, FiO_2 and flow rate. Bubble chamber should be monitored for bubbling and the level of water
- Set temperature of 37°C on the humidifier, adequate water in the chamber, no condensation in the inspiratory limb and some condensation in the expiratory limb are proof of good and adequate humidification. The humidification chamber should be set at invasive mode in automatic humidification
- Radiological monitoring is required at starting of CPAP and during any acute deterioration

All newborns on CPAP should be fed provided there is no obvious contraindication such as necrotizing enterocolitis (NEC) or hemodynamic instability. To prevent CPAP belly, ensure insertion of a OG tube immediately of initiating CPAP and keeping the OG tube above the level of stomach and keeping it open after about 1 hr of feeding

Monitoring of the infants, interface and CPAP system are essential components of monitoring of a newborn on CPAP. Respiratory monitoring is needed to assess efficacy of CPAP and also for early identification of possible complications. Initiate use of colostrum within the first few hours of birth. Encourage mother to express milk. Increase feed volume by 20 to 30 mL/kg/day as tolerated by the infants. Whenever feasible, provide skin to skin contact once the infant is stable even though on CPAP. Stop use of parenteral nutrition once the infant is on enteral feeds of 100 ml/kg/day and supplement mother's milk with human milk fortifier when the infant is on enteral feeds of 150 mL/kg/day

4.6:Key messages

- Monitoring of the infants, interface and CPAP system are essential components of monitoring of a newborn on CPAP
- Respiratory monitoring is needed to assess efficacy of CPAP and also for early identification of possible complications
- Feeding a newborn on CPAP with orogastric tube and prevention of CPAP belly improve the overall success of CPAP

4.7:Webinar

You will view and listen to webinar on complications and necessary interventions while on CPAP along with your facilitator. You are free to interrupt your facilitator anytime for any clarifications or suggestions. The power point slides of the webinar are given here.

Complications of CPAP

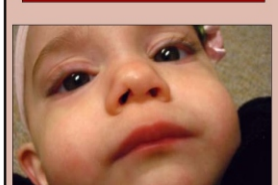
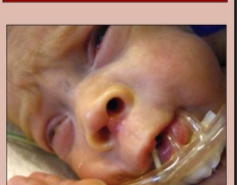
DR. Srinivas Murki
MD, DM (Neonatology)
Consultatnt Neonatologist
Fernandez Hospital, Hyderabad

CPAP Complications

- Respiratory
- Cardiac
- GI tract

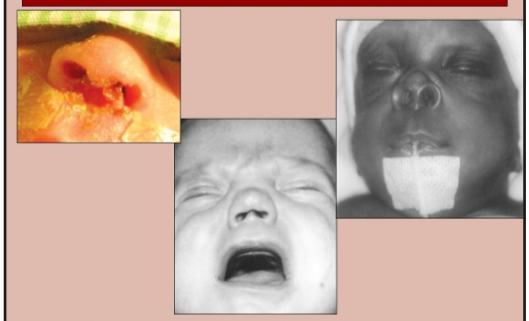
Do not take CPAP lightly!

Columellar Notch | Columellar transection

Distance between Prong and the Columella

Nasal septum damage



Size and softness of the Nasal Prongs

Snubbing while on NCPAP

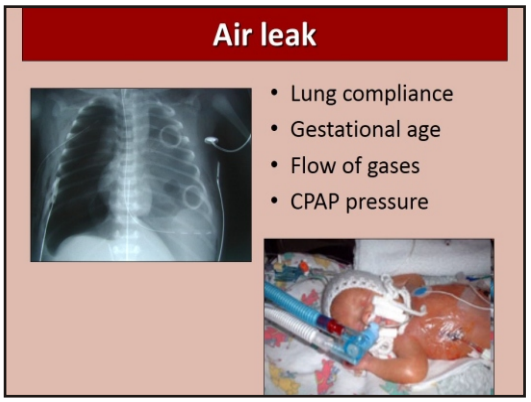
Nasal septal injury is Preventable

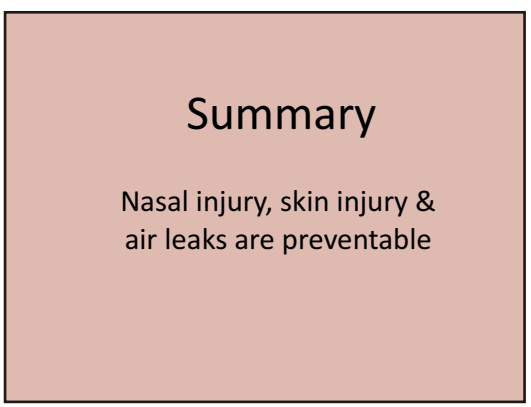
- Careful observation
- Correct prong size
- Correct prong position
- Gap between prongs and columella
- Effective attachment

Monitor/view the infant and the device every hour

Maintain skin integrity

- Frequent observation
- Minimize points of contact
- Keep dry and clean
- Avoid topical applications





What did you learn from this webinar?

1. .....
2. .....
3. .....

What are the queries which come to your mind?

1. .....
2. .....
3. .....

4.8: Script

Complications and necessary interventions while on CPAP

This script shall help you to understand the concept of complications and necessary interventions while on CPAP.

- Any newborn on CPAP requires extensive monitoring for complications. The complications are related to nasal injury, air-leaks, CPAP belly and hemodynamic instability
- Injuries such as columellar notch and columellar transaction are prevented by maintaining the distance between the nasal prongs and the columella and preventing the weight of CPAP circuit to fall on the nose. Injuries such as septal damage and flaring of nostrils are preventing by using appropriate size of the prongs and also by ensuring the correct softness of the prongs
- Prevention of snubbing is needed to prevent pressure sores and skin injury
- Overall nasal and nasal septal injury is preventable by careful observation, using correct prong size, appropriate prong fixation and attachment of prongs to cap and CPAP tubings
- Injury to the skin over the upper limb, chin and nose is prevented by frequent observation, minimizing the points of contact, keeping the area clean and dry and by avoiding topical paints or ointments
- Air leaks sometime occur in a baby on CPAP. Although poor compliance and gestation are non-modifiable risk factors, flow and pressures are modifiable risk factors
- Nasal injury, skin injury and air leaks are preventable complications of CPAP

4.9 :Key messages

- Prevention of snubbing is needed to prevent pressure sores and skin injury
- Injury to the skin over the upper limb, chin and nose is prevented by frequent observation
- Air leaks sometime occur in a baby on CPAP
- Nasal injury, skin injury and air leaks are preventable complications of CPAP

4.10: Podcast

You will view and listen to podcast on concept of Identifying neonates at high risk of CPAP failure along with your facilitator. You are free to interrupt your facilitator anytime for any clarifications or suggestions. The power point slides of the webinar are given here.

Identifying Newborns at risk of CPAP Failure

DR. Srinivas Murki
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Fernandez Hospital, Hyderabad

Determinents of CPAP Failure

- Criteria used to define failure
- Infant charecteristics : Gestation, Birth weight, Disease severity
- Maternal factors: Antenatal steroid usage
- Setting
  - Experience of using CPAP
  - Supportive Care
  - Nursing Care
- Type of equipment-CPAP generator and nasal interface
- Timing of initiation of CPAP
- Concomitant treatment: inSurE (early vs. late rescue)

CPAP Failure Criteria

- Overall Failure rate
  - 15-35% in VLBW Infants
  - 30-55% in ELBW infants
- Common Criteria
  - Maximium CPAP Settings: CPAP Pressure 7 or 8cm, FiO_2 >0.60
  - SpO2 <90%
  - Increase in respiratory distress (increase in SAS by 2)
  - Recurrent apneas
  - Shock requiring inotropic support
  - pH <7.20, PaO2<50 mm of Hg and $PaCO_2$ >60 mm of Hg

High risk of CPAP Failure

- Infant Characteristics
  - Weight <1000 grams
  - Gestation <28 weeks
  - Male Sex
- Maternal Factors
  - Poor antenatal steroid coverage
  - PPROM
- Disease Severity
  - SAS > 5 or Downe Score >7
  - FiO_2 >0..40 in the first 4 hours
  - Moderate or Severe RDS on CXR
  - Delayed onset of treatment

Co-morbid Conditions

Shock
PDA
Sepsis
Air leaks

Improving CPAP success…

S No.	Factors	Interventions
1.	Antenatal	Ensuring complete antenatal steroid course
2.	CPAP initiation	Practice 'Delivery Room CPAP'
3.	Infant characteristics	Mild to moderate RDS, Avoid with severe asphyxia or sepsis
4.	Early InSurE	Practice 'early rescue' surfactant
5.	CPAP settings	CPAP up to 8 cm H_2O and FiO_2 up to 0.7
6.	CPAP Interface	Use short binasal prongs instead of uni-nasal or nasopharyngeal prongs

How to improving CPAP success rates?

S No.	Factors	Interventions
5.	Diligent nursing care	Ensure proper application of CPAP interface
		Ensure adequate pressure delivery ▪ Avoid leaks/inadequate gas flows in the circuits ▪ Ensuring adequate water level in the bubble chamber
		Prevent airway obstruction ▪ Ensure neutral neck position ▪ Clear nasal secretions at regular interval ▪ Ensure proper humidification of gases
		Good supportive care ▪ Holistic monitoring including respiratory monitoring ▪ Regular inspection for any sign of nasal trauma ▪ Ensuring homeostasis (temp., perfusion, sugar, feeds/fluids, preventing gastric distension) ▪ Ensuring asepsis measures
		▪ Having trained/experienced nursing personnel

What did you learn from this webinar?

1. .....
2. .....
3. .....

What are the queries which come to your mind?

1. .....
2. .....
3. .....

4.11: Script
Identifying neonates at high risk of CPAP failure

This script shall help you to understand the concept of Identifying neonates at high risk of CPAP failure.

CPAP failure rate is dependent on the criteria used to define it:

- Infant and maternal characteristics: The setting in which CPAP is being applied, type of equipment and nasal interface and time of initiation of CPAP are the most important determinants of CPAP success or failure
- Appropriate use of adjuvant therapies such as surfactant would also affect success/failure
- The average failure rate for CPAP when used in VLBW infants varies from 15% to 35% and that in ELBW infants from 30% to 55%

The most commonly used criteria to define CPAP failure include:

- Hypoxia i.e. SpO_2<90% even with maximum CPAP pressure of 7cm or 8cm and FiO_2 requirement >0.60 or
- Increased in work of breathing as suggested by an increase in SAS score by 2 after initiation of CPAP or
- Recurrent apneas requiring PPV while on CPAP or
- Presence of cardiovascular instability requiring significant inotropic support or
- A blood gas criteria such as as PaO_2 <50 mm of Hg and $PaCO_2$ >60 mm of Hg with a pH < 7.20

From the existing literature CPAP failure is higher in infants with weight <1000 grams, gestation <28 weeks and in male infant. Additional risk factors include

- Maternal PPROM and inadequate antenatal steroid coverage
- Severe underlying respiratory problem such as high FiO_2, higher distress in the first few hours, and moderate and severe RDS on the chest X- ray
- Co-morbid conditions such as shock, PDA, sepsis and air leak
- Appropriate care from antenatal to perinatal, all contribute to successful CPAP usage

Antenatal steroid coverage, choosing the right infant, early initiation of CPAP in the delivery room, early and aggressive use of surfactant, diligent use of high CPAP settings such as CPAP pressure upto 8cms, FiO_2 upto 70% increase the success rates of CPAP

Appropriate use, experience and fixation of CPAP interface also contribute significantly to CPAP success. The factors that contribute to CPAP success nursing care takes the priority. The nurses play a significant role in interface fixation, monitoring, providing supportive care and above a gentle and human care. Proper application of CPAP interface, preventing air leaks in the circuit, using distilled water in the humidifier chamber and maintaining water column in the bubble chamber in case of bubble CPAP, would ensure appropriate pressure delivery to patient lungs. Improving humidification of gases, maintaining air patent with proper positioning and clearing of nasal secretions would contribute to nurses role in CPAP success. Monitoring for complications, providing temperature regulation, feeding and fluid balance and overall developmental supportive care would lead to not only CPAP success but also in holistic care.

4.12:Key messages

- A systematic evaluation is required before confirming CPAP failure
- The average failure rate for CPAP when used in very low birth weight (VLBW) infants varies from 15% to 35% and that in extremely low birth weight (ELBW) infants from 30% to 55%
- Hypoxia i.e SpO_2 <90% even with maximum CPAP pressure of 7cm or 8cm and FiO_2 requirement >0.60
- Recurrent apneas requiring PPV while on CPAP
- Different criteria have been used in literature for defining CPAP failure

4.13:Posters

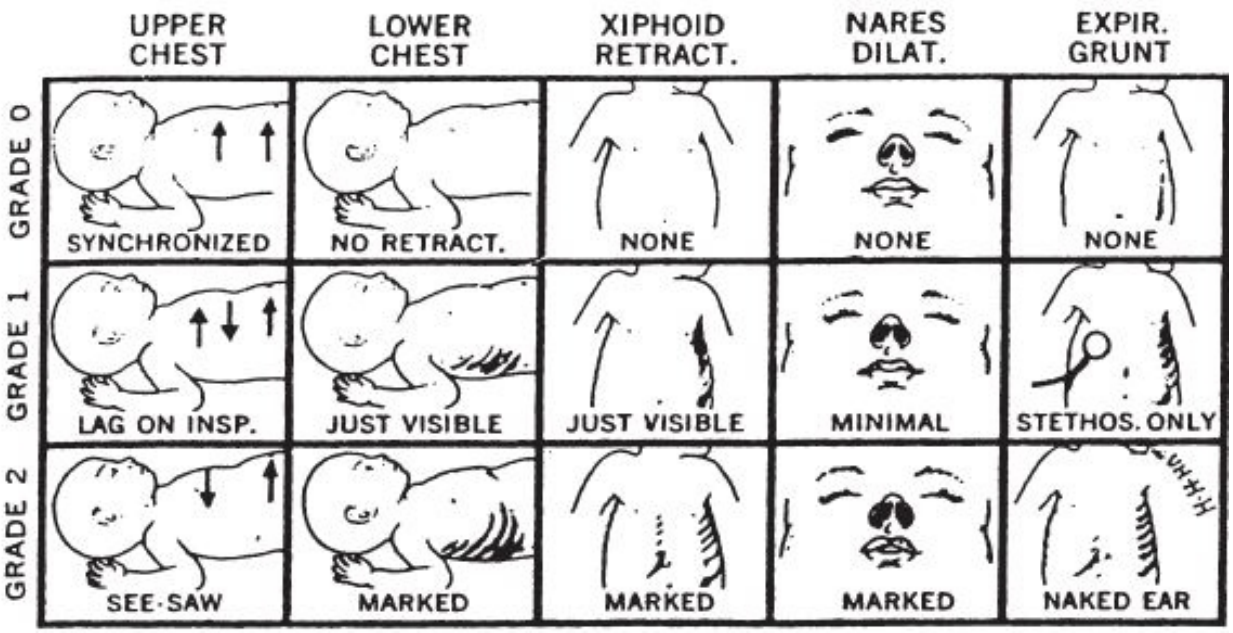
There will be a poster demonstration on:

- Respiratory distress scoring chart: silverman score, downe's score
- Standard treatment protocol (STP) on management of baby with respiratory distress
- CPAP monitoring charts

RESPIRATORY DISTRESS SCORING CHART

The facilitator shall conduct a demonstration session on respiratory distress scoring chart

Silverman scoring for respiratory distress



Downe's score for respiratory distress

Score	0	1	2
Respiratory rate	<60	60-80	>80
Central cyanosis	None	None of FiO_2 of 40%	Needs >40% FiO_2
Retractions	None	Mild	Severe
Grunt	None	Minimal	Obvious
Air entry	Good	Fair	Poor

STP ON MANAGEMENT OF BABY WITH RESPIRATORY DISTRESS

The facilitator shall conduct a demonstration session on STP on management of baby with respiratory distress

Breathing difficulty in the Newborn

Breathing difficulty
Chest indrawing
Grunting

↓

Check * $
Respiratory Rate
Cyanosis
Oxygen saturation (SpO_2) #

↓

Severe respiratory distress	Moderate respiratory distress	Mild respiratory distress
○ RR>90/minute with grunting/ retractions OR ○ RR<30/minute OR ○ Cyanotic on > 1 L/min on nasal prongs or catheter or > 5L/min O_2 on oxygen by hood ** or SpO_2 <90%	○ RR 60-90/minute AND retractions/ grunting OR ○ RR>90/minute OR ○ Oxygen 0.5 to 1 L/min on nasal prongs or catheter or 3-5 L/min on oxygen by hood & pink or SpO_2 >90%	○ RR 60-90/minute OR ○ Oxygen < 0.5 L/min on nasal prongs or catheter or < 3L/min on oxygen by hood & pink or SpO_2 >90%

Specific Management

○ Start CPAP, if not available **REFER***** ○ Maintain IV line, ○ Treat for sepsis ○ Chest x-ray, if needed ○ if no improvement **REFER** (for assisted ventilation)	○ Chest x-ray ○ Maintain O_2 and IV line ○ Treat for sepsis ○ May require CPAP , if not available **REFER***	○ Consider chest x-ray ○ Continue care (feeding, temperature control) ○ Deteriorates or increasing oxygen requirement: Give antibiotics

↓

Watch for signs of improvement
a. Decreasing oxygen requirement
b. No grunting or indrawing or cyanosis
c. Decreasing respiratory rate

Remove oxygen, observe every 15 minutes for next one hour to see for pink tongue & lips, consider alternative methods or direct breast feeding once off oxygen. No difficulty in breathing, feeding well, pink for at least 2 days without oxygen: discharge.

*Refer to scores for assessment of respiratory distress
$ Signs of surgical conditions - scaphoid abdomen (diaphragmatic hernia), drooling of saliva (esophageal atresia)
# If Pulse oximeter is available
** Congenital heart disease should be ruled out if cyanosis but no distress at > 5 L/ min
*** Aminophylline may be required in preterm infant to manage apnoea

CPAP MONITORING CHARTS

The facilitator shall conduct a demonstration session on CPAP monitoring charts

Name: CR No: Date:

Patient end (specific to B-CPAP) **Machine end (specific to B-CPAP)**

Time	Distance between columella and interface 2 mm	Nasal skin blanched	Columella / septal excoriation	Oral/ nasal suction done	OG in situ and open end	Bubble Present	Temperature correct	Tubings below the patient level	Flow rate 5-8L /min	Water level in the Container and Humidifier upto the mark
0800										
1000										
1200										
1400										
1600										
1800										
2000										
0000										
0200										
0400										
0600										

Time	HR	RR	CFT	SM score	Breath sounds	Urine output	Abdominal girth	CPAP	FiO_2	SpO_2
0800										
1000										
1200										
1400										
1600										
1800										
2000										
0000										
0200										
0400										
0600										

4.14:Self-check MCQ's

1. A newborn (28 weeks, 1.1kg) on CPAP is having moderate recessions on a CPAP pressure of 6cm, FiO_2 of 45% and flow of 5 L/min at 1 hour of life. Chest X-ray is suggestive of RDS. There is good bubbling and breath sounds are heard. What is the best option for this newborn?
    a. Intubation surfactant and extubation (INSURE)
    b. Increased CPAP pressure to 7 cm
    c. Surfactant and ventilation
    d. Keep the same settings in SpO_2 is between 90% to 95%

2. Match the CPAP settings for the clinical condition

a.	RDS	FiO_2 50%, Flow 5 L, CPAP 5 cm of H_2O
b.	Post extubation	FiO_2 25%, Flow 5 L, CPAP 4 cm of H_2O
c.	Apneas	FiO_2 25%, Flow 5 L, CPAP 5 cm of H_2O

3. Which of the following is a not recommended procedure to prevent nasal injury?
    a. Maintain a gap between columella and nasal prongs
    b. Ears are covered by the cap and tubings well-fixed to the cap
    c. Supporting the nasal tubing and the circuit to prevent weight falling on the nose
    d. Removing the prongs every hour to look for nasal injury

4. See Saw respiration, with marked lower chest and xiphoid retractions, no audible or grunt on auscultation and miminal nasal flaring in a preterm baby indicates a silverman score of :
    a. 5
    b. 6
    c. 7
    d. 8

5. Which of the following is not a component of downe's Score?
    a. Nasal flaring
    b. Grunting
    c. Respiratory rate
    d. Cyanosis

Learning objective 5

Identifying neonates who can benefit from surfactant administration and to be able to administer surfactant by INSURE approach.

This objective covers the concept of Identifying neonates who can benefit from surfactant administration and to be able to administer surfactant by INSURE approach and is delivered as:

- Webinars
- Script
- Key messages
- Checklist
- Self-check MCQs

After seeing the videos, posters, and reading the script and the key messages you shall undergo a self- evaluation based on what you have already learnt.

5.1:Webinar

You will view and listen to webinar on concept of identifying neonates who need surfactant therapy along with your facilitator. You are free to interrupt your facilitator anytime for any clarifications or suggestions. The power point slides of the webinar are given here.

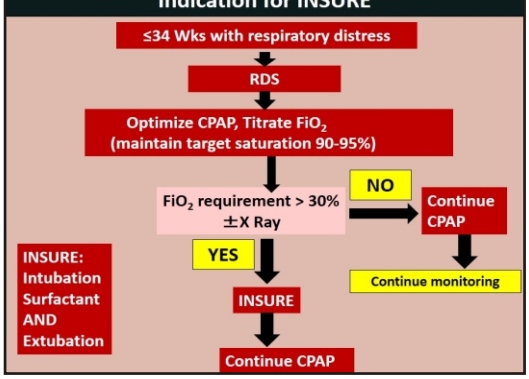
Indication of surfactant for RDS

DR. Jagjit Dalal
MD, DM (Neonatology)
Department of Pediatrics, PGIMS
Rohtak, Haryana

Objective

- To identify neonates who need surfactant therapy

Indication for INSURE



Key message

- **Identification of neonate for need of surfactant is important and should be done early in neonates with respiratory distress**

What did you learn from this webinar?

1. .....
2. .....
3. .....

What are the queries which come to your mind?

1. .....
2. .....
3. .....

5.2:Script

Identifying neonates who need surfactant therapy

This script shall help you to understand the concept of identifying neonates who need surfactant therapy

- When a baby is born with less than or equal to 34 weeks of gestation with respiratory distress (with silverman score of 4 or more) one should start on CPAP, which should be adjusted as per distress of baby and FiO_2 titrated to maintain the oxygen saturation of 90% to 95%
- If FiO_2 requirement is more than 30 percent, even if X ray facility is not available,one should give surfactant as soon as possible after birth or early rescue surfactant (i.e with in 2 hrs of life). Post surfactant, if baby is maintaining the saturation, the baby should be extubated to nasal CPAP
- If the baby, on CPAP is maintaining saturation between target ranges of 90% to 95% with FiO_2 of less or equal to 30, there is no need to give surfactant and keep the baby under monitoring and continue CPAP
- Identification of neonate for need of surfactant is important and should be done early in neonates with respiratory distress. One should have in house facility of back up ventilation or an identified higher centre to refer in case baby needs mechanical ventilation

5.3:Key messages

- Neonates less than equal to 34 weeks of gestation with respiratory distress (with silverman score of 4 or more); should be stared on CPAP
- FiO_2 requirement more than 30 percent while the infant is on CPAP is an indication of surfactant therapy
- Surfactant is an important therapy and should be given early in neonates with respiratory distress

5.4:Webinar

You will view and listen to webinar on concept of interpretation of chest X-ray: HMD versus other disorders along with your facilitator. You are free to interrupt your facilitator anytime for any clarifications or suggestions. The power point slides of the webinar are given here.

Chest X-ray HMD versus other disorders

DR. Shiv Sajan Saini
MD, DM (Neonatology)
Assistant Professor
PGIMER, Chandigarh

Learning objectives

- Understand the characteristics of the normal X-ray
- X-ray pictures of common neonatal respiratory morbidities

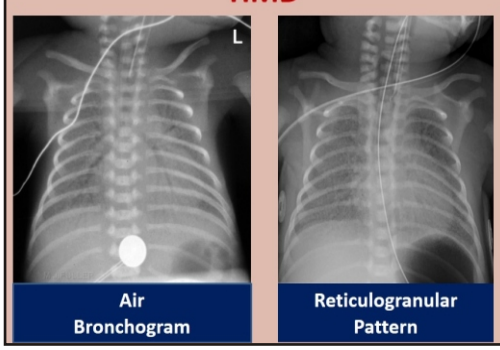
Normal neonatal X-ray

- Neonatal CXRs are all AP films taken in supine position
- The chest is more cylindrical and translucent
- Ribs more horizontal compared to children and adults
- Thymus is prominent and CT ratio can be up to 0.6
- Diaphragm is upto 6th rib anteriorly & 8th rib posteriorly
- More is hyperinflation and less is underaeration

Indications for X-ray

- For diagnosis of respiratory distress
- To check position of endotracheal tube, umbilical arterial and venous lines, and chest tubes
- To prove clinical suspicion of air leak

HMD



HMD

X-ray of HMD

Typical X-ray finding of RDS/ HMD

- Decreased lung volume
- Reticulogranular pattern
- Ground glass opacification
- Air bronchograms
- White out lungs

Pneumonia

- Patchy alveolar or interstitial infiltrates
- Consolidation is rarely seen in newborn
- Normal to increased lung volumes with areas of air trapping

MAS

Fluffy nodular opacity and air leaks

TTNB

- Prominent hilum with streaky shadows
- Prominent interlobar fissures
- Small pleural effusion
- Mild cardiomegaly
- Normal to increased lung volume

Pneumothorax

- Pleural air with no or decreased lung markings (hyperlucent)
- Collapsed lung
- Shift of Mediastinum to opposite side

Congenital Diaphragmatic Hernia

- Left hemithorax filled with cyst like loops of bowel
- Mediastinal shift to right side

Key messages

- Identification of RDS on x-ray will help us in correctly identifying newborn who needs surfactant
- Other respiratory disorders can be identified with the help of x-rays

What did you learn from this webinar?

1. .....
2. .....
3. .....

What are the queries which come to your mind?

1. .....
2. .....
3. .....

5.5:Script

Interpretation of chest X-ray: HMD versus other disorders

This script shall help you to understand the concept of interpretation of chest X-ray: HMD versus other disorders

- Normal neonatal chest X-rays are shot antero-posteriorly while the baby is lying in a supine position. The anteroposterior orientation of X-ray is recognised by the prominence of posterior ribs as compared to anterior and comparatively oblique orientation of clavicle as compared to PA views. The neonatal ribs more horizontal compared to children and adults Thymus is often prominent in neonatal chest X-rays. Normal cardiothoracic (CT) ratio can be up to 0.65 on day 1 and 0.6 for rest of the neonatal period
- To check for the inflation we should observe the level of the diaphragm. Diaphragm is normally up to 8th rib posteriorly and 6^{th} rib anteriorly such that we see 7-8 posterior intercostal spaces. Posterior intercostal spaces more than 8 qualify for hyperinflation and less than 7 as under-inflation

The common indications of chest X-rays in a neonate include

- To investigate the cause of respiratory distress
- To check the position of endotracheal tube, umbilical arterial and venous lines, and chest tubes
- To prove a clinical suspicion of air leak. It is important to remember that in the spectrum of air leak, non-invasive tests like transillumnination should be immediately performed to take urgent decisions and one shouldn't wait for X-ray diagnosis in a clinically deteriorating baby

Hyaline membrane disease

In a neonate with surfactant deficiency the alveoli tends to collapse and thus we see under inflation (i.e.<7 posterior intercostal spaces). Additionally due to the patchy atelectasis we observe the reticulogranularity pattern on chest X-ray.As more and more alveoli collapse, the X-ray displays ground glass opacity and appears white-out

One should always interpret findings of X-rays in light of clinical details. e.g. similar findings can be expected in a case of hemorrhagic pulmonary edema, very severe pneumonia leading to ARDS, pulmonary hypoplasia etc. A relevant clinical antenatal history and course of illness will give vital clues for identification of the clinical condition. The typical findings include:

- Decreased lung volume
- Reticulo-granular pattern
- Ground glass opacification
- Air bronchograms
- White-out lungs

Pneumonia

The typical findings of pneumonia are patchy alveolar or interstitial infiltrates, which leads to non homogenous involvement of the lungs. The typical features of consolidation as seen in children and adults with pneumonia are not generally seen in neonates. In the initial stages of pneumonia, there is no effect on surfactant metabolism. Therefore usually the chest X-ray appears to retain normal lung volumes. However in the advanced stages the surfactant is destroyed by infective process and the X-ray may show bilateral more dense involvement of lungs and in extreme cases even white-out appearance

Meconium aspiration syndrome

The typical x ray of meconium aspiration syndrome shows hyper-inflated lung due to ongoing ball-valve phenomenon secondary to presence of meconium in airways. Due to patchy atelectasis and hyperinflation, the X-ray shows fluffy or nodular opacities and hyperlucent areas

Transient tachypnea of newborn (TTNB)

TTNB manifests due to delayed clearance of amniotic fluid from the lungs after birth. Therefore the x-ray chest suggests:

- Prominent hilum with streaky shadows
- Prominent interlobar fissure visible on right side
- There may also be small pleural effusion. You will see blunting of the costophrenic angle
- Mild cardiomegaly
- Normal to increased lung volume

The pneumothorax is diagnosed by the presence of free air in the pleural cavity. Pleural air can be easily differentiated as it is

- Hyper-lucent i.e. appears more dark
- Doesn't have peri-hilar markings
- Shift of mediastinum to opposite side
- One can also appreciate the collapsed lung

In congenital diaphragmatic hernia (CDH), the X- ray shows the presence of bowel in the left hemithorax, which have cystic appearance. Due to the presence of bowel in thoracic cavity, the mediastinum is shifted to opposite side as seen in the X-ray

5.6:Key messages

- Common pulmonary morbidities have a characteristic X-ray findings
- This can help in early diagnosis and timely management

5.7:Webinar

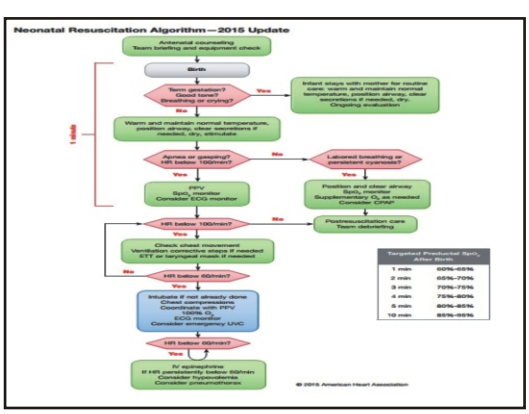
You will view and listen to webinar on concept of intubation and fixation of endotracheal tube along with your facilitator. You are free to interrupt your facilitator anytime for any clarifications or suggestions. The power point slides of the webinar are given here.

Endotracheal Intubation

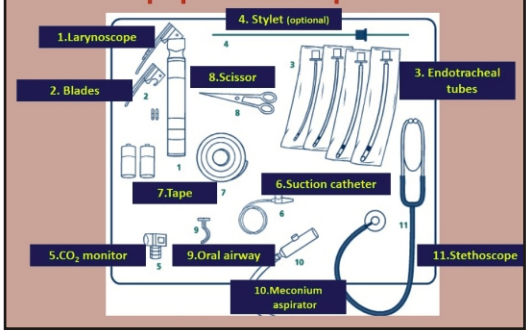
DR. Jagjit Dalal
MD, DM (Neonatology)
Department of pediatrics, PGIMS
Rohtak, Haryana

Indications for intubation

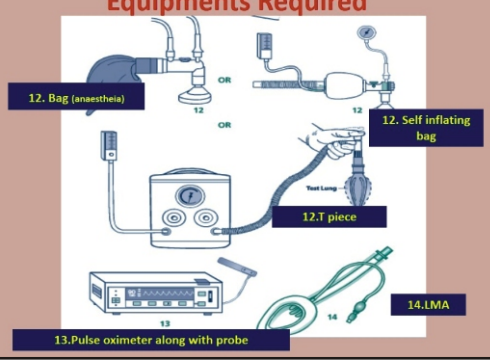
- Ineffective BMV - not resulting in adequate clinical improvement
- Prolonged PPV
- Along with chest compressions
- Surfactant administration (INSURE)
- Special situation
  - *Diaphragmatic hernia*



Equipments Required



Equipments Required



Laryngoscope Blades Selection

- No. 1 for full term
- No. 0 for preterm / LBW
- No. 00 for extremely preterm (optional)

Selecting Endotracheal Tube

Weight	Gest. Age	Tube Size ID
<1000 gm	< 28 wks	2.5 mm
1000-2000 gm	28-34 wks	3.0 mm
>2000 gm	>34 wks	3.5 mm

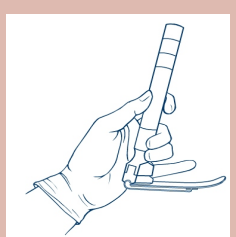
ID = Internal Diameter *NRP 2016*

Additional items

Tape	▪ For securing the tube
Suction equipment	▪ Mechanical suction ▪ Manual (mucus sucker)
Resuscitation Bag and Mask	▪ To ventilate the infant in between intubation ▪ To check tube placement

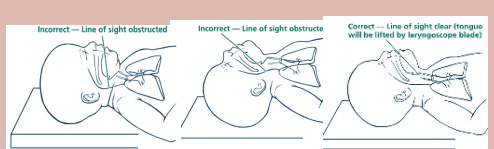
Endotracheal Tube size	Catheter Size
2.5	5F or 6F
3.0	6F or 8F
3.5	8F
4.0	8F or 10F

How to use the laryngoscope to insert an Endotracheal tube

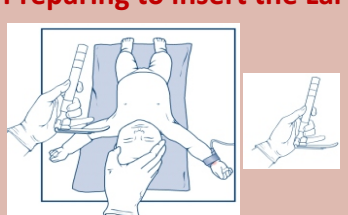


Positioning the infant

- **On a flat surface, head in midline and neck slightly extended**
- **Optimal viewing of glottis**

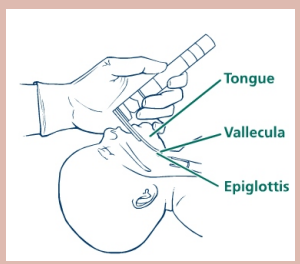


Preparing to insert the Laryngoscope

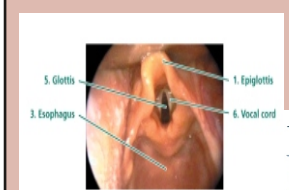


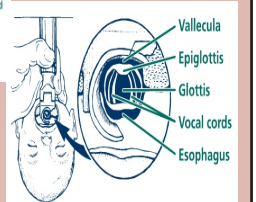
1. **Stand at the head end of the infant**
2. **Hold the laryngoscope in your left hand**
3. **Stabilize the infant's head with right hand**

Landmarks for placing Endotracheal tube



Landmarks for intubation





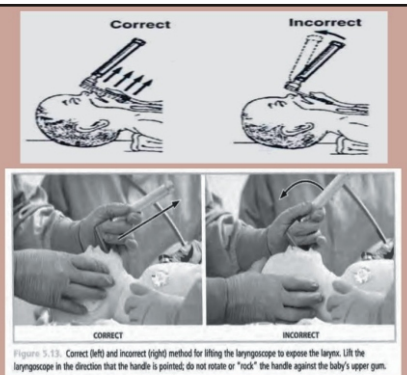
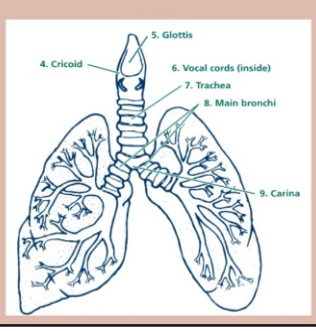
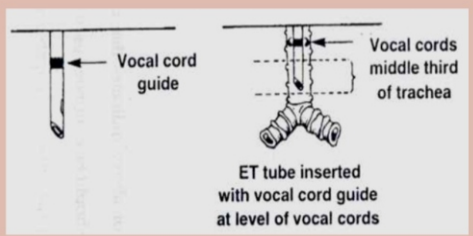


Figure 5.13. Correct (left) and incorrect (right) method for lifting the laryngoscope to expose the larynx. Lift the laryngoscope in the direction that the handle is pointed; do not rotate or "rock" the handle against the baby's upper gum.

Anatomy - Beyond Glottis



Vocal Cord Guide

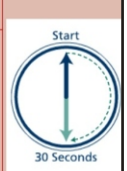


Tip to lip distance (6+wt.in kg)

Weight	Distance
1 kg	7 cm
2 kg	8 cm
3 kg	9 cm
4 kg	10 cm

Confirming ET Tube Placement

Correct placement	▪ *$ETCO_2$ - the recommended method*
Signs	▪ *Bilateral breath sounds* ▪ *Equal breath sounds, Mist in ET tube* ▪ *Rise of the chest with each ventilation* ▪ *No air heard entering stomach* ▪ *No gastric distention*
Confirmation of tip position in trachea	▪ *Chest X-ray: tip at T_2*



Fixation of Endotracheal Tube (ET)

- Use your right hand to hold the tube securely against the baby's hard palate
- *Carefully remove the laryngoscope* without displacing the tube
- Continue PPV
- Fixation as shown

Tube in Rt. Main bronchus

- Breath sounds only on right chest
- No air heard entering stomach
- No gastric distention

Action:

1. Withdraw the tube
2. Recheck

Correct Placement of Tube

Correct placement Of endotracheal tube with tip adjacent to the second thoracic vertebra

Incorrect placement. The tip of the endotracheal tube is in too far. It is touching the carina. approaching the right main stem bronchus, and the left lung is collapsed.

Tube in Esophagus

- No breath sounds heard
- Air heard entering stomach
- Gastric distention may be seen
- No mist in tube
- No CO_2 in exhaled air

Action :

1. Remove the tube
2. Bag and mask ventilation
3. Reintroduce ET tube

Complications During Intubation

Complication	Possible cause	Prevention or corrective steps
Hypoxia	▪ Taking too long to intubate ▪ Incorrect tube placement	▪ Ventilate with mask if possible ▪ Halt intubation attempt after 30 seconds ▪ Reposition tube
Bradycardia/ apnea	▪ Hypoxia ▪ Vagal response from laryngoscope or suction catheter	▪ Ventilate with mask if possible ▪ Oxygenate after intubation ▪ Limit duration of intubation attempts
Pneumothorax	▪ Over ventilate of one lung because of tube in right main bronchus ▪ Excessive pressure	▪ Place tube correctly ▪ Use appropriate pressures
Contusions or lacerations of tongue	▪ Rough handling of the laryngoscope ▪ Laryngoscope blade too long	▪ Be gentle while manipulating the laryngoscope ▪ Have proper equipment
Infection	▪ Introduction of infection from hands or instruments	▪ Pay careful attention to clean technique

5.8:Script

Intubation and fixation of endotracheal tube

This script shall help you to understand the concept of intubation and fixation of endotracheal tube

The common indications of intubation are:

1. Ineffective bag and mask ventilation
2. Requirement of prolonged positive pressure ventilation and when chest compressions are required during resuscitation
3. Administration of surfactant
4. Diaphragmatic hernia

- The equipments required for intubation are laryngoscope, extra blade, endotracheal tube, stylet (optional), CO_2 monitor, suction catheter, tape, scissors, oral airway, meconium aspirator, stethoscope, self inflating bag or flow inflating bag or T piece resuscitator, pulse oximeter, laryngeal mask airway, and gloves. Pulse oximeter is required for monitoring during intubation. One should always ensure selection of appropriate equipment and ensure their optimal functioning of equipments before intubation. The appropriate size blade should be selected for intubation. Blade size 1 is to be used for full term neonates, No. 0 for preterm and low birth weight babies and blade No.00 is to be used for extremely preterm neonates. One should always ensure that it is working with adequate light and one extra blade is always there.

The different sizes are:

- Size 2.5 is appropriate for less than 1000 gm or <28 weeks gestation newborn
- Size 3.0 should be selected for 1000 to 2000 gm newborn or 28 weeks to 34 weeks newborn
- Size 3.5 is used for newborn > 2000 gm or >34 weeks newborn

- Any additional item like tape or dynaplast for securing the tube must be prepared a priori and suction equipment must be set at 80-100 mm of mercury suction pressure before the procedure. For ET tube of size 2.5, catheter size of 5F or 6F is appropriate. A simple formula for calculating the actual size of suction catheter is approximately double the endotracheal tube size. Resuscitation bag will help in ventilating the baby as well as to confirm the tube placement by auscultation for equal bilateral air entry
- Endotracheal tube is fixed at the tip to lip distance of weight in kg plus 6. For example, in a one kg baby endotracheal tube it is to be fixed at 7 cm tip to lip distance and for 2 kg baby it should be fixed at 8 cm, for 3 kg should be fixed at 9 cm and so on. A recent method for estimating the depth of insertion is estimation using nasotragus length that is the NTL plus 1 cm (where in the NTL=distance from nasal septum to ear tragus). The depth of estimation should be confirmed by equal breath sounds on auscultation post intubation

5.9:Key messages

- One should always remember that endotracheal intubation should be a well planned procedure and ensure that all required accessories are available before intubation
- Intubation should be done under monitoring with pulse oximeter
- The size and depth of insertion should be determined before intubation

5.10:Webinar

You will view and listen to webinar on trouble shoots during endotracheal intubation with your facilitator. You are free to interrupt your facilitator anytime for any clarifications or suggestions. The power point slides of the webinar are given here.

Endotracheal Intubation: trouble shoot and complication

DR. Jagjit Dalal
MD, DM (Neonatology)
Department of pediatrics, PGIMS
Rohtak, Haryana

Objective

- Endotracheal tube in the right main bronchus
- Endotracheal tube in esophagus
- Associated complications during intubation and their prevention

Tube in Rt. Main bronchus

- Breath sounds only on right chest
- No air heard entering stomach
- No gastric distention

Action:

1. Withdraw the tube
2. Recheck

Correct Placement of Tube

Correct placement of endotracheal tube with tip adjacent to the second thoracic vertebra

Incorrect placement. The tip of the endotracheal tube is in too far. It is touching the carina. approaching the right mainstem bronchus, and the left lung is collapsed.

Tube in Esophagus

- No breath sounds heard
- Air heard entering stomach
- Gastric distention may be seen
- No mist in tube
- No CO_2 in exhaled air

Action :

1. Remove the tube
2. Bag and mask ventilation
3. Reintroduce ET tube

Complications During Intubation

Complication	Possible cause	Prevention or corrective steps
Hypoxia	▪ Taking too long to intubate ▪ Incorrect tube placement	▪ Ventilate with mask if possible ▪ Halt intubation attempt after 30 seconds ▪ Reposition tube
Bradycardia/ apnea	▪ Hypoxia ▪ Vagal response from laryngoscope or suction catheter	▪ Ventilate with mask if possible ▪ Oxygenate after intubation ▪ Limit duration of intubation attempts ▪ Monitor with pulse oximeter
Pneumothorax	▪ Over ventilate of one lung because of tube in right main bronchus ▪ Excessive pressure	▪ Place tube correctly ▪ Use appropriate pressures
Contusions or lacerations of tongue	▪ Rough handling of the laryngoscope ▪ Laryngoscope blade too long	▪ Be gentle while manipulating the laryngoscope ▪ Have proper equipment
Infection	▪ Introduction of infection from hands or instruments	▪ Pay careful attention to clean technique

What we learnt

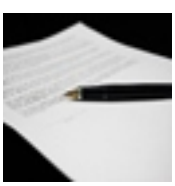
- How to manage complications during intubation .
- We should also note that intubation should be done under monitoring with pulse oximeter.
- Size of endotracheal tube and depth of insertion should be determined before procedure, so that complication are prevented or detected on time.

What did you learn from this webinar?

1. .....
2. .....
3. .....

What are the queries which come to your mind?

1. .....
2. .....
3. .....



5.11:Script

Intubation and fixation of endotracheal tube

This script shall help you to understand trouble shoot and complications during endotracheal intubation.

- On some occasions, the endotracheal tube may go in the right main bronchus and this is suggested by the breath sounds being heard mainly on the right side of the chest. In such a scenario, withdrawing the endotracheal tube and rechecking for equal air entry on both sides will confirm accurate position of the endotracheal tube
- The tip of endotracheal tube on chest X ray should lie at body of T2 vertebra. The correct position of ET tube should be confirmed on X-ray
- Incorrect placement of the endotracheal tube in the esophagus can be confirmed by absence of the breath sounds heard over chest, air is being heard entering stomach on auscultation with visible gastric distention, absence of mist in tube and no carbon dioxide detected in exhaled air
- One should remove the tube and do bag and mask ventilation and then reintroduce the endotracheal tube

Possible complications and their management:

- Hypoxia, that means a baby is showing low saturations or becoming cyanosed. The possible cause may be we are taking too long time to intubate or tube is not at correct position. In this scenario, we should halt intubation, attempt ventilation of the baby with bag and mask and try to reposition tube
- Baby may develop bradycardia or apnea after hypoxia or a vagal response from laryngoscope or suction catheter. Here again, one has to follow the same principles of ventilation with bag and mask, limiting the duration of intubation attempts and oxygenation after intubation. We should also ensure that the baby is being monitored during the process of intubation

- If baby develops pneumothorax, it may be because of one lung ventilation or inadvertent excessive pressure. Once it happens, immediate measure may be required to drain it. One can prevent pneumothorax by using appropriate pressure and by ensuring correct positioning of the tube
- Baby may develop contusions and laceration of tongue due to rough handling or if the laryngoscope blade is too long. This complication can be prevented by proper application of laryngoscope and gentle handling during procedure
- Baby may develop infection possibly from caregivers' hands, so we should try and prevent this by paying attention to aseptic techniques during intubation

5.12:Key messages

- Intubation should be done under monitoring with pulse oximeter.
- The size of endotracheal tube and depth of insertion should be determined before procedure
- One has to follow the same principles of ventilation with bag and mask, limiting the duration of intubation attempts and oxygenation after intubation

5.13:Webinar

You will view and listen to webinar on concept of administration of surfactant using INSURE approach along with your facilitator. You are free to interrupt your facilitator anytime for any clarifications or suggestions. The power point slides of the webinar are given here.

Indication of Surfactant for RDS

DR. Jagjit Dalal
MD, DM (Neonatology)
Department of pediatrics, PGIMS
Rohtak, Haryana

Overview of Presentation

- What are different preparations ?
- What is the dose?
- When (time) to give surfactant ?

What are different preparations ?

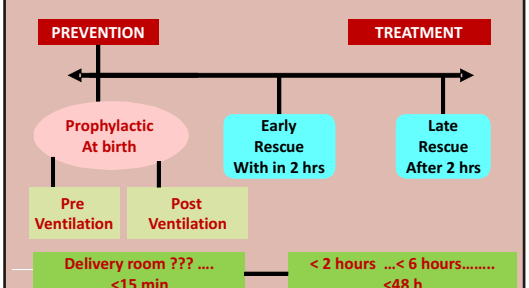
Surfactant Preparations

- Bovine (*Survanta, Neosurf* Infasurf, Alveofact)
- Porcine (*Curosurf*)

Surfactant Available : Dosing

Surfactant	Dose	Available
Survanta	4mL/kg	4mL, 8mL
Curosurf	2.5mL/kg	1.5mL
Neosurf	5mL/kg	3mL 5mL

Timing of surfactant Administration



Surfactant Administration

- INSURE stands for Intubate - Surfactant - Extubate to CPAP

Key Messages

- Natural surfactant are preferred choice
- Optimal dose, type and time of surfactant should be used

What did you learn from this webinar?

1. .....
2. .....
3. .....

What are the queries which come to your mind?

1. .....
2. .....
3. .....

5.14:Script

Administration of surfactant using insure approach

This script shall help you to understand the concept of administration of surfactant using INSURE approach.

There are two types of surfactant available; natural and synthetic. Natural ones are the preferred choice. The commonly available natural or animal derived surfactant are either bovine or porcine derived. Those derived from bovine are survanta, neosurf, infasurf, and alveofact and those derived from porcine is curosurf. The dosage amount varies for each surfactant preparation.

The dose of survanta is 4mL/kg and it is available as 4 mL and 8 mL vial. The dose of curosurf dose is 2.5mL/kg, and it is available as 1.5 mL and 3.0 mL vial. Neosurf is given as 5 mL/kg available as 3 mL and 5mL vials.
Timing of surfactant administration is important. If indicated after birth it should be given as soon as possible or preferably be given within the initial 2 hr of life when it is commonly known as early rescue. The fluid in lungs helps in better distribution of surfactant when given early rescue. Late rescue surfactant is administrated beyond 2 hr of life. The word INSURE stands for, intubate, surfactant and finally extubate to CPAP.

5.15:Key messages

- Natural surfactant is the preferred choice
- Timing of surfactant administration is very important. If indicated after birth it should be given as soon as possible or preferably be given within the initial 2 hr

5.16:Checklist

SURFACTANT ADMINISTRATION

The facilitator shall explain the checklist step by step according to procedure on surfactant administration

S.No.	Steps	Yes	No
1.	List of equipment and Accessories required for surfactant delivery by INSURE approach		
2.	Surfactant taken out from refrigerator / freezer and kept at room temperature		
3.	Dressing set and plain sterile seats are available		
4	Scissor available		
5.	Dose calculation done		
6.	Et tube is well fixed and air entry is bilateral equal		
7.	Pulse oximeter is well attached and monitor is displaying saturation and heart rate		
8.	Cut length of orogastric tube equal to length of endotracheal tube		
9.	Hub of the surfactant vial is cleaned with spirit -betadine and again with spirit		
10.	Baby is maintaining saturation and no bradycardia before insertion of next aliquot		
11.	Surfactant dose and time documented in babies file records		
12.	Baby is being monitored for any complication		
13.	There was no breach in asepsis during procedure		

5.17:Self-check MCQ's

1. The pressure limit for endotracheal tube suction is
   a. 50mm of Hg
   b. 100mm of Hg
   c. 150 mm of Hg
   d. 200 mm of Hg

2. What size of suction catheter should be used for suction from endotracheal tube of size 3 mm?
   a. 5F
   b. 6F
   c. 7F
   d. 8F

3. Internal diameter (mm) of endotracheal tube for a newborn weighing 2.5 kg should be:
   a. 2.0
   b. 2.5
   c. 3.0
   d. 3.5

4. The best effects of surfactant are seen when it is given
   a. At birth before the first breath
   b. Early rescue
   c. Delayed rescue
   d. In utero

5. Which one of the following is not a natural surfactant?
   a. Poractant alfa (Curosurf)
   b. Beractant (Survanta)
   c. Calfactant (Infasurf)
   d. Exosurf

Skill Check

After you have read through the scripts, seen the videos and the webinars, you shall be asked to undergo a skill check on task trainers. The facilitator shall assess you and provide feedback. This shall include assessment of skills :

S.No	OSCE
1.	Silverman Scoring
2.	Interpreting X-ray for diagnosis
3.	CPAP circuit assembly
4.	Readying humidifier for use
5.	Assessing adequacy of CPAP Settings
6.	Intubation and tube fixation
7.	Interpreting X ray for adequacy of CPAP usage and complications
8.	Surfactant administration

1. Silverman anderson scoring

You have received a preterm baby from the labour room, The baby is born to a mother with preterm labour at 28 weeks of gestation and a birth weight of 1.2kg. Assess the respiratory distress of this newborn and write the plan of action

S.No.	Correct Action	Yes	No
1.	Tells the upper chest recessions score		
2.	Tells the lower chest recessions score		
3.	Tells the grunt score		
4.	Tells the sternal recessions score		
5.	Tells the nasal flaring score		
6.	Tells the total SAS Score		
7.	Identifies correctly the required respiratory support for this baby (CPAP/ventilation/oxygen/none)		
	Total Score:		

Score: (Maximum Score 7): _____

2. Interpreting X-ray for diagnosis

This is the anteroposterior view of x-ray of a preterm newborn with respiratory distress. The baby born to a mother with preterm rupture of membranes at 30 weeks and has a birth weight of 1.4 kg

S.No.	Correct Action	Yes	No
1.	Identifies and comments on the lung inflation		
2.	Identifies and comments on zone wise infiltrates (homogenous/heterogeneous)		
3.	Identifies and comments on costophrenic angles		
4.	Identifies and comments on cardiophrenic angles		
5.	Identifies and comments on cardiac size		
6.	Identifies and comments on air bronchograms or peri-hilar flaring		
7.	Identifies and comments on special features (reticulo -nodularity, reticulogranularity, transverse fissure)		
	Total Score:		

Score: (Maximum Score 7): _____

3. CPAP Circuit Assembly

You received a call from the labour room that a preterm baby is born and is having severe respiratory distress. The baby is being transported on T piece resuscitation. You need to prepare the CPAP machine and circuit

S. No.	Correct Action	Yes	No
1.	Washes hands with soap and water		
2.	Assembles the CPAP circuit, distilled water at one place		
3.	Cleans the blender, humidifier and the probes in an appropriate manner		
4.	Connects the machine to air and oxygen ports		
5.	Washes hands again		
6.	Fixes the water chamber		
7.	Fist the safety device between the flow meter and the water chamber of humidifier using a gas tubing		
8.	Now connects the blue inspiratory limb to the other port of the water chamber. To the other end of the blue inspiratory limb lock the white expiratory limb of the bubble CPAP circuit		
9.	The second end of the expiratory limb is connected to the bubble chamber		
10.	Fill the bubble chamber with clean or distilled water and fix it to the slot available on the CPAP machine stand		
11.	Fix the temperature probe and heater wire at appropriate slots		
12.	Watch for bubbling in the bubble chamber		
13.	Set the flow, FiO_2 and the pressure to appropriate level		
	Total Score:		

Score: (Maximum Score 13): _____

4. Readying humidifier for use

You received a call from the labour room that a preterm baby is born and is having severe respiratory distress. The baby is being transported on T piece resuscitation. You need to prepare the CPAP humidifier.

S. No.	Correct Action	Yes	No
1.	Fix the water chamber on the servo humidifier and fill it with Distilled water		
2.	Use the auto-fill option of fixing the distilled water bottle to a stand for filling the water chamber		
3.	Fill the bubble chamber with clean or distilled water and fix it to the slot available on the CPAP machine stand		
4.	Fix the heater wire and the temperature probe to the appropriate slots available in the humidifier and the inspiratory limb of bubble CPAP circuit		
5.	Switch on the humidifier and set it in invasive mode		
6.	Watch for bubbling in the bubble chamber		
7.	Wait for the humidifier to display a temperature near 37^0 C before connecting the circuit to the patient		
	Total Score:		

Score: (Maximum Score 7): _____

5. Adequacy of CPAP settings

What are the criteria to assess adequacy of settings when using bubble CPAP in the management of a newborn with respiratory distress?

S.No.	Settings	Adequacy of setting	Yes	No
1.	**FiO_2**	• SpO_2 between 90% to 95% • PaO_2 between 50 to 70 mm of Hg		
2.	**CPAP pressure**	• Minimal or no recessions • No hyperinflation • X-ray chest 6 to 8 intercostal space • SpO_2 between 90% to 95%		
3.	**Flow**	• 4 to 5 L/min • Bubbling in the bubble chamber		
4.	**Temperature**	• Invasive mode • Temperature display 37° C • Inspiratory limb warm to touch		
5.	**Humidification**	• No condensation in the inspiratory limb • Some condensation in the expiratory limb		

Score: (Maximum Score 13): _____

6. Endotracheal intubation and fixation

You were informed regarding a 1.5 kg newborn who is in need of intubation in view of respiratory failure . Demonstrate the necessary steps of endotracheal intubation and fixation

S. No	Correct Action	YES	NO
1.	Cleans hands with hand rub/hand wash under elbow operating tap		
2.	Checks list of required equipment needed for intubation		
3.	Selects of appropriate size endotracheal tube		
4.	Selects appropriate size laryngoscope		
5.	Prepare tegaderm and dynaplast		
6.	Select appropriate suction catheter		
7.	Ensures availability of free flow oxygen		
8.	Sets suction pressure to 80-100mm of Hg		
9.	Stands at head end of the baby		
10.	Done gloves		
11.	Holds laryngoscope in left hand		
12.	Duration of intubation lasts less than 20 sec		
13.	Confirms endotracheal tube in trachea		
14.	Fixes endotracheal tube at appropriate depth		
15.	Monitors vitals with pulse oximeter during procedure		
	Total Score:		

Score: (Maximum Score 15): _____

7. Interpretation X-ray for adequacy of CPAP

A 30 weeker infant with respiratory distress is on CPAP, X-ray was called to look for adequacy of CPAP. How do you interpret this?

S. No.	Correct Action	YES	NO
1.	Looked for projection AP or PA view		
2.	Exposure mentioned whether hard versus soft films		
3.	Looked about rotation of X-ray		
4.	Mentioned soft tissues /bones		
5.	Looked for lung expansion bilateral and counted spaces		
6.	Looked for lung parenchyma for underlying disease		
7.	Flattening of diaphragm noticed		
8.	Any air under heart looked for		
9.	Ribs positioned looked horizontal or not		
10.	Decision on the basis of X-ray taken on the settings of CPAP Machine		
	Total Score:		

Score: (Maximum Score 10): _____

8. Surfactant administration

You have just received sick 28 weeker preterm infant in the SNCU. Demonstrate the steps of surfactant administration

S.No.	Correct Action	YES	NO
1.	Cleans the hands with hand rub		
2.	Assembles all the equipment and accessories required		
3.	Calculation of the dose of surfactant as per availablepreparation done		
4.	Warming surfactant ensured not by shaking but by holding within hands or keeping at room temperature		
5.	Intubation with appropriate size tube done		
6.	Infant connected to pulse oximeter		
7.	Aseptic precautions; wearing cap and mask, doing hand washing again		
8.	Clean the hub of surfactant vial before taking in syringe done		
9.	Surfactant drawn under all aseptic precautions		
10.	Orogastric tube length for insertion in endotracheal tube measured		
11.	Surfactant administrated in aliquots of 3 to 4 under all aseptic precautions		
12.	Says will monitor heart rate, saturation during surfactant administration		
13.	Post surfactant says will continue ongoing monitoring		
	Total Score:		

Score: (Maximum Score 13): _____

Simulation

An essential pre-requisite before reaching this stage in each module is that the learner should have undergone the entire module, seen the videos and webinars facilitated by the facilitator, attempted the evaluation questionnaire, and demonstrated the skill check.
This session brings out learning and practice in a realistic environment for continuous positive airway pressure (CPAP). The emphasis is on working together as a team and not on individual skills.

You shall be asked by the facilitator to participate as a team for the management of the following conditions:

1. Baby with respiratory distress started on CPAP
2. Baby with respiratory distress needing surfactant therapy
3. Baby having CPAP failure

This shall be followed by feedback and debriefing.