Delivery Room Management

A newborn baby's survival is dependent on the mother/caregiver(s). It is important to provide appropriate care at birth to reduce the risk of morbidity and mortality

Importance of care at birth:

The **four basic needs** of all newborns at the time of birth and afterwards are:

1. **To be kept warm**
2. **To breathe normally**
3. **To be protected (prevent infection)**
4. **To be breastfed**

It is very important to understand the needs of the baby and meet all those needs. Unmet needs will lead to health problems very quickly.

Preparation for delivery:

- Identify helper and review the emergency plan
- Select an area for delivery
- Select an area for resuscitation/ventilation which is clean, warm, well-lighted, flat & firm
- Hand wash
- Wearing a sterile gloves
- Identify nine equipments with 7.1% chlorohexidine
- Check suction device and resuscitation device

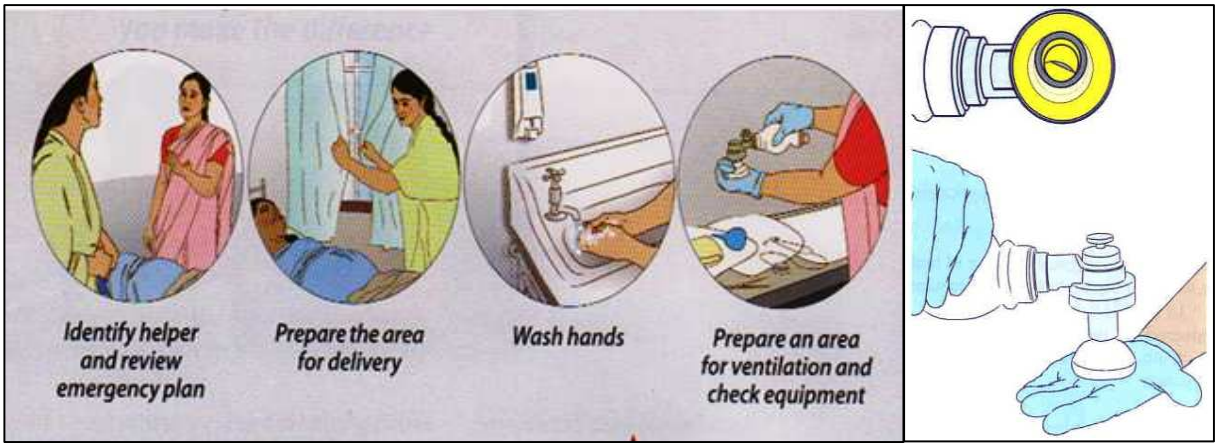


Figure: Preparation for delivery and assessment of function of resuscitation device

List of equipments/supplies:

- Gloves
-Two pieces of clean, sterile and warm clothes
-Cap
-Sterile ties/ cord clamps
-Sterile scissors/ cutting instrument
-Suction device
-Resuscitation device
-Stethoscope
-Timer
-7.1% chlorohexidine

Hand washing

Norms for hand washing

- Roll-up sleeves above the elbow—bare bellow elbow
- Remove wrist watch, bangles, shakha, rings and any other jewellery
- Wet hand with water
- Apply enough soap and make adequate foam to cover all hand surface
- Hand wash should be done in six steps and every step must be done for six times

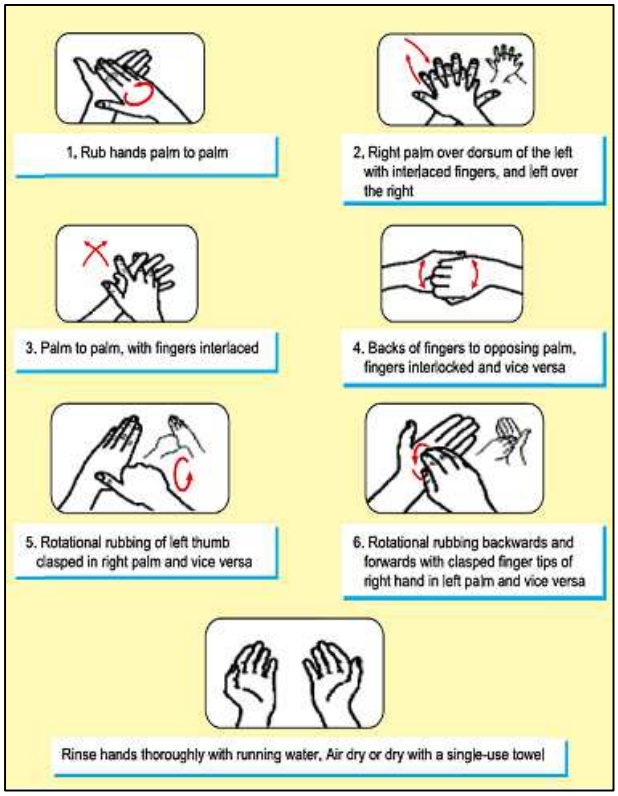


Figure: Steps of hand wash

- Rinse hands with water and keep elbows always below the level of hands to avoid water running from elbows to hands.
- Dry thoroughly with a single use sterile towel/ in air
- Once dry your hands are safe
- Before entering NICU hand wash should be done for 2 minutes
- Before and after touching the each baby hand rub should be done for 20 sec with alcohol based chlorhexidine solution (Hexisol)

Immediate new born Care:

- A baby should be placed onto its mother's abdomen, if this is not possible keep the baby next to the mother on a clean surface.
- Immediately dry the baby with a warm clean towel or piece of cloth. Wipe the mouth and nose with the clean cloth. Do not wipe off the white greasy substance covering the baby's body. This helps to protect the baby's skin and gets reabsorbed very quickly.
- Assess breathing. If not breathing well, follow Resuscitation protocol. If yes, provide Routine care as given below
- Clamp and cut the umbilical cord after 1-3 minutes with sterile scissors. Tie the cord with three sterile ties (clean thread, rubber bands or sterile cord clamps) and cut the cord following the method described below.
- Apply 7.1% Chlorhexidine on the stump after cutting and thereafter follow dry cord care
- Examine the baby quickly for malformations/birth injury. If there is a major malformation/severe birth injury refer the baby to a newborn unit.
- Ensure warmth during examination and transportation.
- Leave the baby between the mother's breasts to start skin-to-skin care.
- Cover the baby's head with a cloth. Cover the mother and baby with a warm cloth.
- Place an identity label on the baby.
- Give Inj Vit K 1 mg IM.
- Encourage the initiation of breastfeeding.

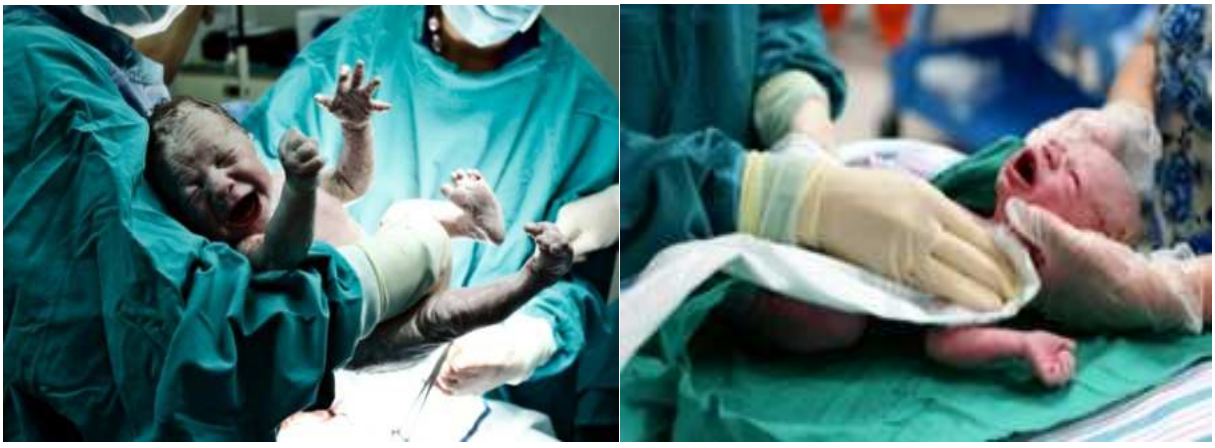


Figure: Immediate care of the newborn in the delivery room

Follow up after immediate newborn care (30-60 minutes interval for at least 6 hrs)

- Color
- Respiratory rate-count for 1 full minute
- Heart rate
- Temperature
- Bleeding from umbilicus or any other sites
- Breast feeding-position and attachment

The baby's need to breathe normally

- To 'breathe normally' was identified as one of the baby's immediate and basic 'need'. A baby can die or suffer from hypoxic injury very quickly if breathing does not start soon after birth.
- Oxygen is needed to keep the baby's brain and other vital organs normally functioning. When the umbilical cord is cut the placenta is no longer a source of oxygen and the baby needs to support his oxygenation through the lungs.
- Once a baby is born, and while it is being dried, assess baby's breathing. If a baby is breathing normally the air entry on both sides of the chest shall be equal and the respiratory rate would be 30-60 per minute.

Decide: Does the baby need any help with its breathing?

The majority of babies do not have any problem in initiating breathing after birth, but it is vital to recognize those babies who need immediate help to support respiration and follow the protocol for resuscitation of these babies.

Keeping the baby warm

After having ensured that the baby has established effective breathing, it is essential that all efforts are made to prevent hypothermia. Hypothermia should be prevented by paying special attention to temperature maintenance in the baby.

- The delivery room should be warm (26 - 30^0 C) and free from draft of air.
- The infant should be received in a pre-warmed sterile linen sheet.
- The infant should be dried thoroughly including the head and face areas.
- The wet linen should not be allowed to remain in contact with the infant.
- The infant should be placed in skin-to-skin (STS) contact with the mother immediately after birth.
- In addition to maintaining normal temperature of the infant, STS promotes early breastfeeding and decreases the pain and bleeding from the mother.
- The infant should be made to wear the caps and socks.

Cord Care

- Umbilical cord must be clamped within 1 to 3 minutes of birth
- Clamp and cut cord with a sterile instrument.
- Use three sterile ties ; Ist tie 2 fingers from the abdomen, 2nd tie 1 finger from the Ist tie & 3rd tie 4 fingers from 2nd tie
- Cut the cord with sterile instrument 1 finger distal to the 2nd tie
- Apply 7.1% chlorhexidine to the cut surface and all over the stump once soon after cord cutting and then follow dry cord care
- Observe for oozing of blood. If blood oozes, place a second tie between the abdominal skin and first tie.

Initiation of Breast feeding within 1 hour

- Help the mother to initiate breastfeeding within the first hour.
- Check position and attachment are correct at the first feed.
- The baby's first feed of colostrum is very important because it helps to protect against infections.
- The baby can feed from its mother whether she is lying down or sitting; baby and mother must be comfortable
- Do not give artificial teats or pre-lacteal feeds to the newborn e.g. sugar water or local foods or even water.
- Continue demand feeding
- There is no need to routinely separate babies born by Caesarean Section or Instrumental delivery from mother

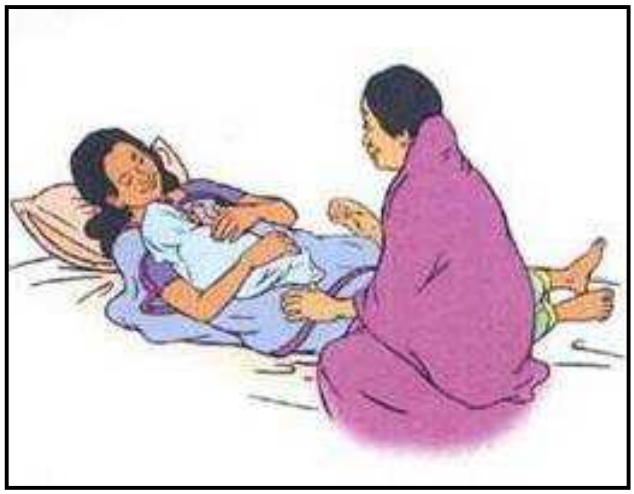


Figure: Breast feeding counseling of the mother

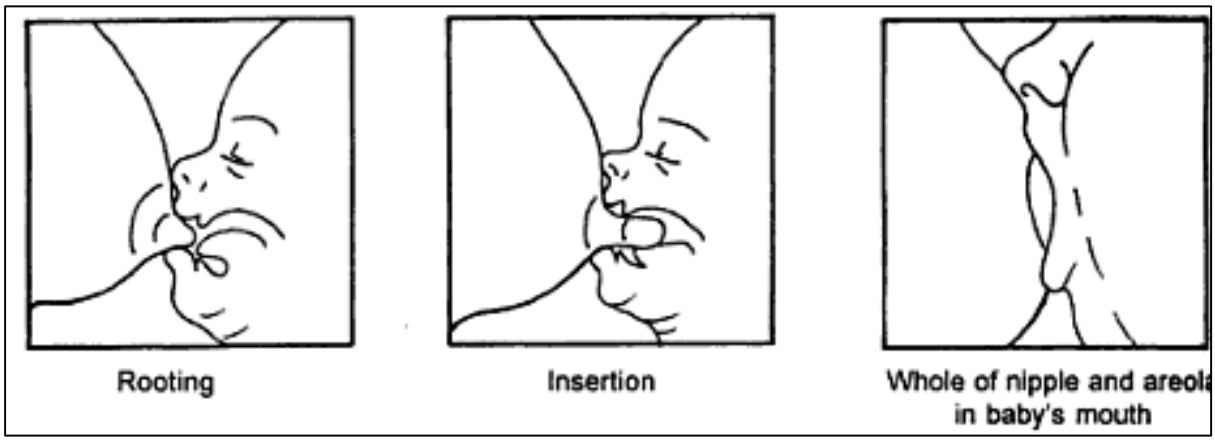


Figure: Correct attachment of breast feeding

Baby identification marking

- A method of identification should be followed as per local guidelines.
- The identification should contain name of the mother, hospital registration number, gender and birth weight of the infant.

Recording growth measurements

- All the infants should be weighed once the baby is stabilized on a scale with at least 5 gm sensitivity.
- A single-use paper towel or a sterile cloth should be placed on the weighing scale beneath the infant.
- The weighing scale must be periodically (at least weekly) calibrated.

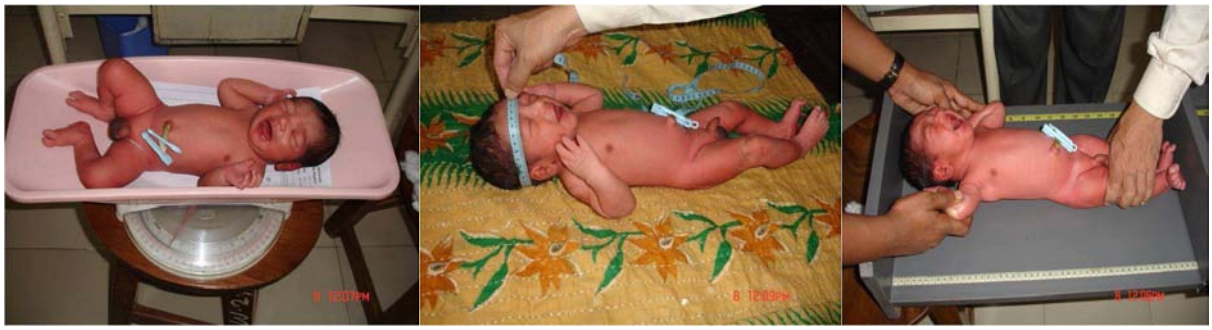


Figure: Steps of taking growth parameter at birth

Administration of Vitamin K:

- Vitamin K should be administered intramuscularly on the antero-lateral aspect of the thigh using a 26 gauze needle and one ml syringe.
- Dose to be used is 0.5 mg for babies weighing less than 1000 g and 1 mg for those weighing above 1000 gm at birth.

Examine the baby quickly for malformations/birth injury

Clinical screening should be quick but thorough to identify any life threatening congenital anomalies and birth injuries

- Inspect the cut end of the cord for number of vessels - two umbilical arteries and one umbilical vein.
- The infant should be examined for esophageal patency by passing an orogastric tube if mother has history of polyhydramnios or there is frothing or excessive salivation.
- Rule out anal atresia by inspecting the anal opening at the normal site.
- The oral cavity must be examined to exclude cleft palate.
- Displacement of the heart towards the right side in association with respiratory difficulty and difficult resuscitation is suggestive of either diaphragmatic hernia or pneumothorax on the left side.
- Examine the back for any swelling or anomaly.

Communication with the family

- The health provider must communicate the time, birth weight, gender and condition of the infant to the mother and other family members.
- The infant should be shown to the family with particular attention given to the fact that family members get to know the gender and about the identity tag on the infant.

Admission Criteria to the NICU:

- Babies with birth weight < 1800 gms
- Babies with gestation < 34 weeks
- Babies with major congenital malformations
- Babies with asphyxia (needing bag musk ventilation)
- Babies with breathing difficulty
- Suspected early onset neonatal sepsis
- Neonatal jaundice requiring phototherapy or exchange transfusion
- Infant of diabetic mother who need IV glucose infusion
- Post-operative newborn requiring intensive care
- Newborn referred from other centre

Neonatal Resuscitation

Which babies require resuscitation?

Community-level: No respiration, no cry; gasping respirations with long pauses in between, blue babies.

Facility-level: No respiration, no cry, gasping respirations with long pauses in between; blue or pale color; heart rate absent or < 100 beats/min; flaccid or reduced muscle tone; low APGAR score

Management of perinatal asphyxia

Approximately 10% of newborns require some assistance to begin breathing at birth; about 1% needs extensive resuscitative measures to survive.

ABC of resuscitation

- Ensure that the **'Airway'** is open and clear.
- Be sure that there is **'Breathing'**, whether spontaneous or assisted.
- Make certain that there is adequate **'Circulation'** of oxygenated blood

Newly born babies are wet following birth and heat loss is significant. Therefore, it also is important to maintain body temperature during resuscitation.

Preparation:
As mentioned in preparation for delivery.

Initial steps: Put the baby on mother's abdomen

- Dry thoroughly (if amniotic fluid is clear)
- Remove the wet cloth
- **Keep warm:**
  - ✓ Provide **skin to skin contact** with mother's chest
  - ✓ **Cover whole body** with dry cloth and head with cap

* The baby can be placed under a **radiant warmer**, or near a heating device if available

Assess Crying/Breathing while drying:

- Breathing Well: Crying or breathing quietly & regularly
- Not breathing well: Not breathing at all or gasping

If baby is not breathing well after initial steps:

Open airway: The baby should be **positioned** on the back, with the neck slightly extended in the **"neutral"** position.

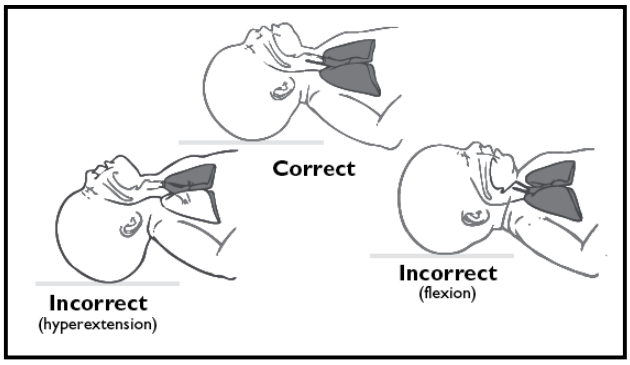


Figure: Correct and incorrect head positions for resuscitation

Clear airway (if necessary)

- Routine suctioning is not recommended.
- If required give suction first in the oral cavity and then nose if indicated. Introduce the catheter about 5 cm into the mouth and 3 cm into the nostrils.
- If liquor is meconium stained and baby is non-vigorous /depressed give suctioning of oral cavity, and tracheal suction after intubation (if possible) before drying.
- A nonvigorous or depressed baby is one who has
  - No or Poor respiration
  - Poor tone
  - Heart rate <100/min

While clearing airway if liquor is meconium stained

- Set negative pressure of the suction machine at 100mm Hg
- Do not suction >10 seconds at a time

Once the airway is clear, stimulate breathing:

- Turn the baby in lateral position on mother's skin
- Keep warm by covering
- Stimulate by rubbing along the spine with hypothenar eminence of hand once or twice.

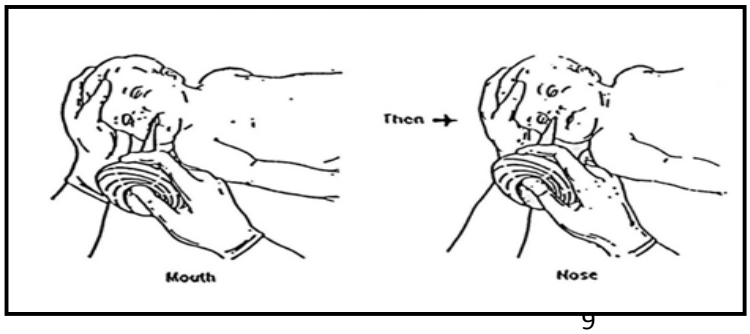


Figure: Suctioning Procedure

Certain actions of physical stimulation can harm the baby and should not be used.

Harmful Actions		Consequences
Slapping the back	→	Bruising
Squeezing the rib cage	→	Fractures, pneumothorax, death
Holding upside down and shaking	→	Intraventricular bleeding, brain damage.

Evaluation of the baby after the initial steps

Evaluate the baby and decide the appropriate action:

- ✓ **Breathing well**
- ✓ **Not breathing well**

Bag musk ventilation (BMV):

If the baby is not breathing well after suction & stimulation

- Cut the umbilical cord to separate from mother
- Shift the baby to the area for ventilation
- Start bag and mask ventilation within one minute of birth

Ventilation of the lungs is the single most important and most effective step in cardiopulmonary resuscitation of the compromised newly born baby.

Use of Self Inflating bag to ensure bag musk ventilation (BMV) to newborns

The self-inflating bag inflates automatically after squeezing. It remains inflated at all times, unless being resqueezed.

Selection of appropriate size masks

The mask should cover the chin, mouth, and nose, but not the eyes, while will create a tight seal on the face.

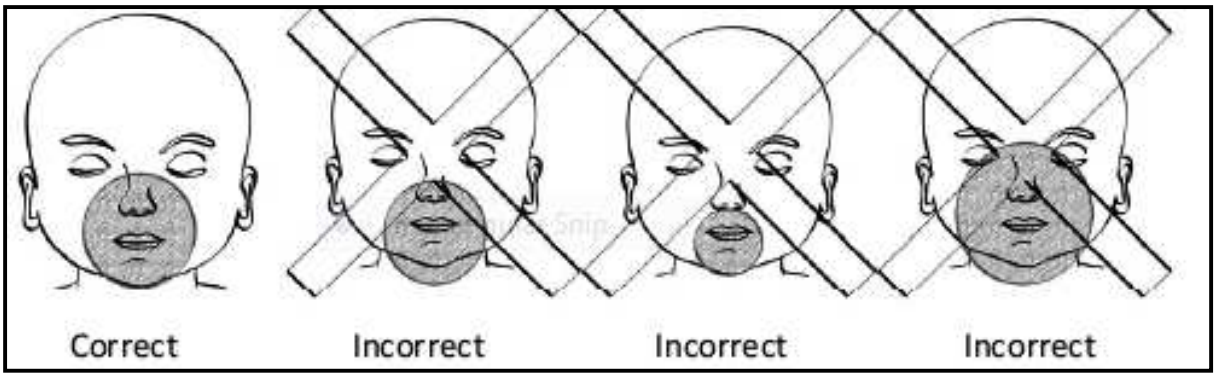


Figure: Correct placement of bag and musk for effective resuscitation

Steps to follow before beginning bag musk ventilation (BMV):

Position yourself at the bedside

- Position yourself preferably at the baby's head or at the baby's side to use a resuscitation device effectively.
- Both positions leave the chest and abdomen unobstructed for visual monitoring of the baby, for chest compressions, and for vascular access via umbilical cord.

Position the baby's head

The baby's neck should be slightly extended (but not overextended nor flexed) into the "sniffing position" to maintain an open airway.

Applying and sealing mask on the face

- Place the mask on the face so that it covers the nose and mouth, and the chin rests within the rim of the mask.
- Use four fingers to ensure sealing: Thumb and ring finger to encircle the upper stiff part of the mask to keep the mask firmly apposed on face, middle finger resting on the rim at chin and little and ring finger at the jaw to maintain neutral position

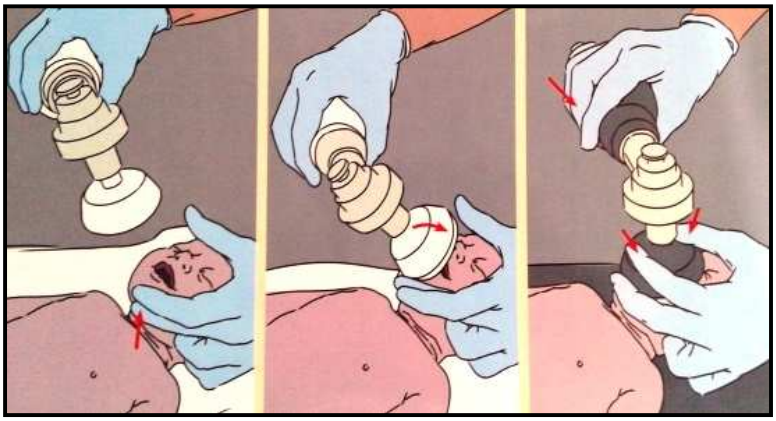


Figure: Applying and sealing mask on the face

Starting Bag musk ventilation (BMV):

- Once positioning and sealing are done start bagging and observe whether chest rises with each squeeze. Continue BMV at a rate of 40/min (40 - 60/min)
- ***Be sure that chest rises with each squeezing.***
- Take ventilation corrective measures for effective ventilation at any time if chest does not rise with squeezing:
    - ✓ Repositioning

- ✓ Check the mouth, oropharynx, and nose for secretions; suction the mouth and nose (if necessary)
- ✓ Reapplying mask with mouth open and ensuring better seal
- ✓ Providing harder squeeze (Lock pop-off valve if necessary)

- Continue effective ventilation for 30 seconds at a rate of 40 (40 - 60) breaths/min
- To help maintain a rate of 40 breaths per minute, try saying to yourself as you ventilate the newborn:

One thousand….. one…….. One thousand…….. two……..
(squeeze) (release……..) (squeeze) (release……..)

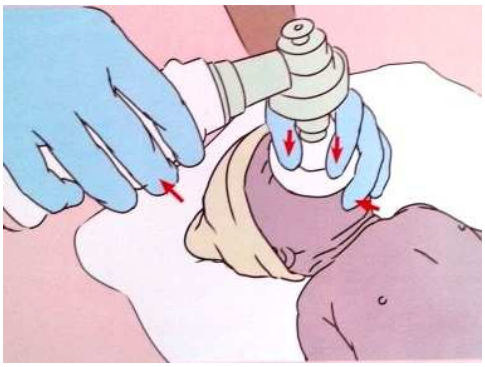


Figure: Starting Bag mask ventilation

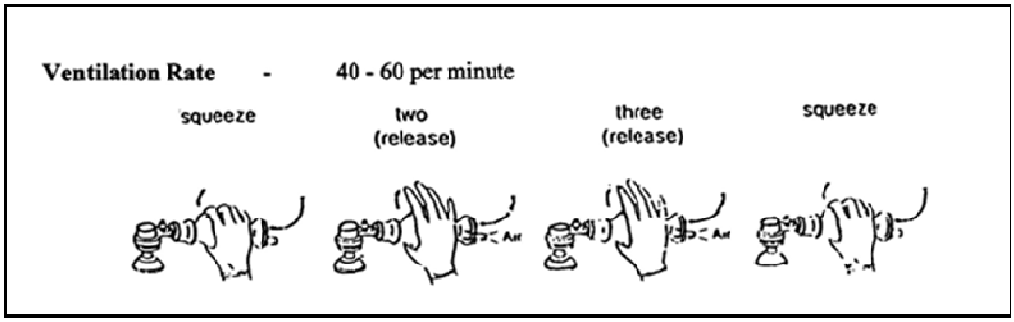


Figure: Maintaining bag mask ventilation

Assessment for signs of improvement after 30 seconds of effective ventilation:

- Improvement is indicated by the signs:
  - o Improving color
  - o Breathing well: Spontaneous regular breathing
  - o Improving muscle tone

- If spontaneous regular breathing established reduce rate of BMV and discontinue.

Check Heart rate if not breathing well after 30 second of effective BMV:

- If heart rate is >60 continue effective BMV till spontaneous regular breathing is established along with assessment for signs of improvement every 30 seconds.
- When the heart rate stabilizes above 100/min, and no spontaneous regular respiration, reduce the rate and pressure of assisted ventilation until effective spontaneous respirations.
- If the heart rate remains below 60/min despite 30 seconds of effective ventilation, proceed to the next step of chest compressions.

If physiologic improvements still cannot be achieved, endotracheal intubation may be done if possible.

If bag mask ventilation is to be continued for more than several minutes, following measures have to be taken

- Insert an orogastric tube and keep in place.
- The problems related to gastric/abdominal distention and aspiration of gastric contents can be reduced by inserting an orogastric tube, suctioning gastric contents, and leaving the gastric tube in place and uncapped to act as a vent for stomach gas throughout the remainder of the resuscitation.

Chest Compression

- The indications for beginning chest compression-
    - If baby's condition fails to improve, and the heart rate remains below 60/min despite 30 seconds of effective bag-mask ventilation.
- The person performing chest compressions must have access to the chest and be able to position his or her hands correctly.
- The person assisting ventilation will need to be positioned at the baby's head to achieve an effective mask-face seal (or to stabilize the endotracheal tube) and watch for effective chest movement

There are two techniques for performing chest compression

The 2 thumb- encircling hand technique:

- Two thumbs are used to depress the sternum, while the hands encircle the torso and the fingers support the spine.
- Thumb should be positioned on the lower third of the sternum in the midline.
- The thumbs can be placed side by side or, on a small baby, one over the other.

- The thumbs should be flexed at the first joint and pressure applied vertically to compress the heart between the sternum and the spine

The 2-finger technique:

- The tips of the middle finger and either the index finger or ring finger of one hand are used to compress the sternum, while the other hand is used to support the baby's back (unless the baby is on a very firm surface).
- In the 2-finger technique, the tips of the middle finger and either the index or ring finger of one hand are used for compressions.
- Position the 2-fingers perpendicular to the chest, and press with the fingertips.
- As with the thumb technique, apply pressure vertically to compress the heart between the sternum and the spine.

The 2 thumb-encircling hands technique is recommended for performing chest compression in newborn as it generates higher peak systolic and coronary perfusion pressure than 2-finger technique.

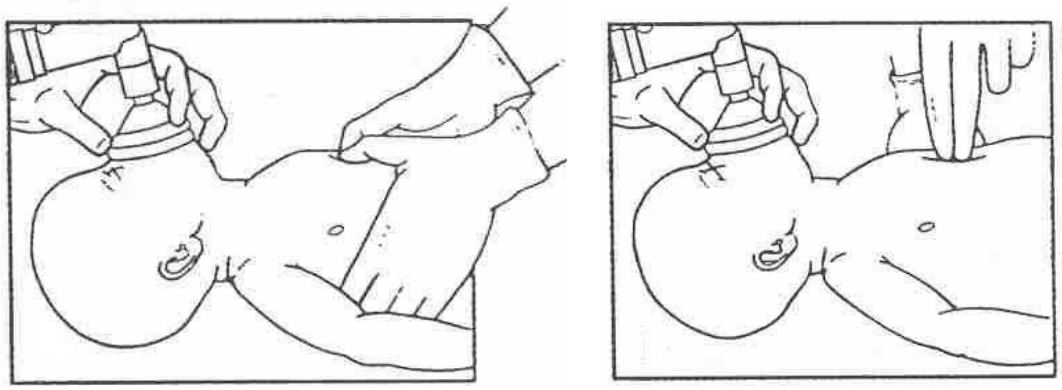


Figure: Techniques of performing chest compression

The required pressure to compress the chest:

Use enough pressure to depress the sternum ***to a depth of approximately one third of the anterior posterior diameter of the chest*** and then release the pressure to allow the heart to refill. One compression consists of the downward stroke plus the release. The actual distance compressed will depend on the size of the baby.

Coordinate chest compressions with ventilation:

During cardiopulmonary resuscitation, chest compressions must always be accompanied by positive-pressure ventilation, with one ventilation interposed after every third compression, for a total of 30 breaths and 90 compressions per minute

***One cycle of events (CPR cycle)* will consist of 3 compressions plus 1ventilation (these 4 events should be administered in 2 seconds)**

Practicing the rhythm of chest compressions with ventilation

Practice saying the words and compressing the chest.

One-and-Two-and-Three-and-one……**One-and-Two-and-Three-and**-two……..
One-and-Two-and-Three-and three……**One-and-Two-and-Three-and-four……**
One-and-Two-and-Three-and-five…..….
If the heart rate is <60 bpm despite CPR given for 30 seconds, then consider the use of drugs

Drugs used in neonatal resuscitation:

- Before initiating drug treatment, check the following:
    - Whether the airway is open?
    - Whether the chest inflates with each ventilation?
    - Whether chest compression is given properly?
- If the newborn does not respond even after the airway is open, the chest moves easily with ventilations, and effective chest compression has been given, only then the drugs may help.
- Intravenous adrenaline 1: 1000: 1ml mixed with 9ml of distilled water to make a 1:10,000 dilution. Give 0.1-0.3 ml/kg IV
- Umbilical venous access should be obtained with advanced resuscitative efforts for quick administration of adrenaline.
- **Volume Expansion**: When blood loss is known and or shock (pale skin, poor perfusion, week pulse and rapid heart rate) an isotonic crystalloid solution or blood 10ml/kg is recommended which may need to be repeated. Give volume expanders very slowly in premature babies.
- **Additional Drugs:**
    - Intravenous glucose administration should be considered as soon as after resuscitation with the goal of avoiding hypoglycemia.
    - Naloxone (0.1mg/kg) can be administered to an infant with respiratory depression unresponsive to ventilatory assistance whose mother has received narcotics within 4 hours before delivery.

When to stop resuscitation?

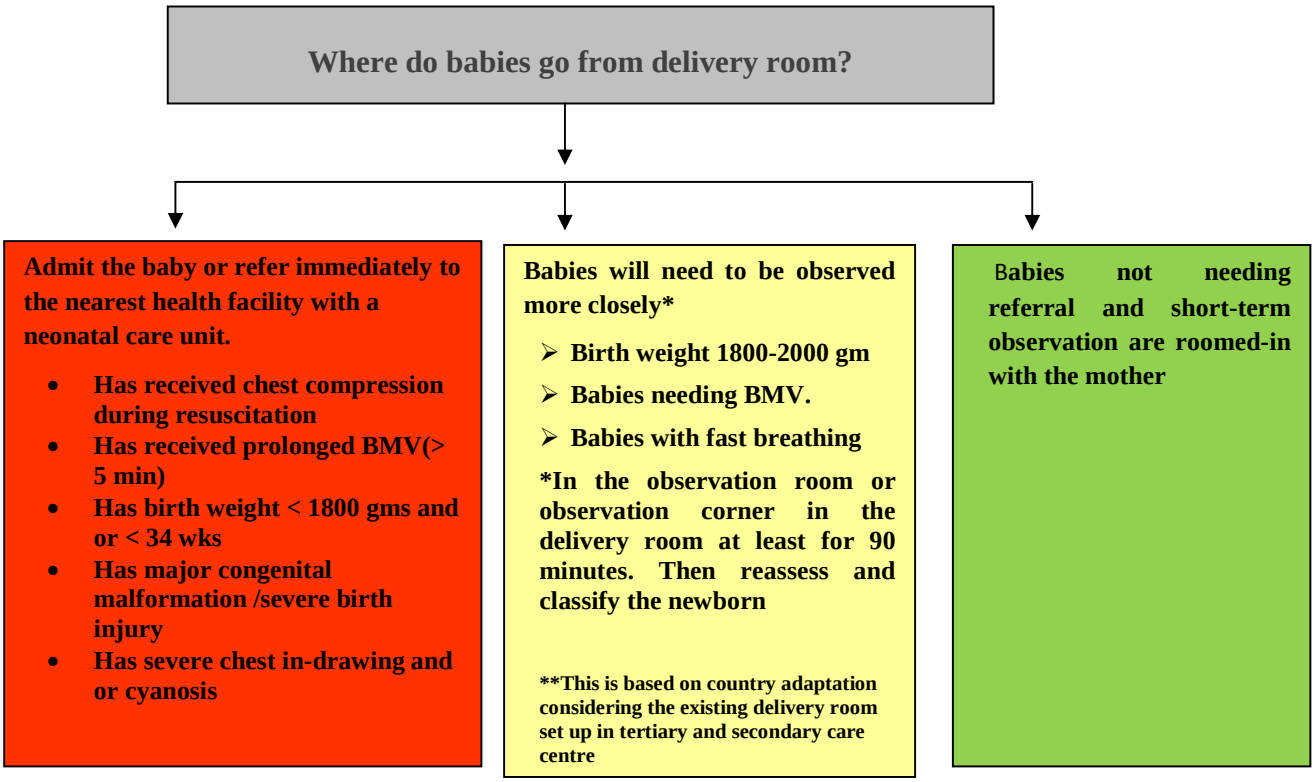
After 20 minutes of continuous and adequate efforts if there are no signs of life (no heart rate and no respiratory effort), discontinue resuscitative efforts.

Post-resuscitation care:

The resuscitation is successful if the baby is breathing 30 – 59 breaths per minute, there is no chest in drawing and grunting and the baby's color is pink.

- **Criteria for admission/referral- in case of babies:**
  - Requiring chest compressions
  - Requiring prolonged bag mask ventilation
  - Babies resuscitated in the community should be referred to the facility for post resuscitation assessment/care.
- **Counseling /Advice**
  - Talk with the mother and family about the resuscitation. Answer any question they may have
  - Counsel the parent about hospital admission for post resuscitation care
  - Encourage mother to keep the baby warm
  - Explain that there are some risks of infection, feeding problem or convulsions advise them to come promptly if any problem arises
- **Manage the baby accordingly**
- **Monitor the baby at least 6 hours for:**
  - Color
  - Breathing problems (RR $\geq$ 60/ min, grunting, severe chest in drawing)
  - Temperature
  - Bleeding from umbilicus
  - Feeding
- Give other care as necessary
- **Record keeping**
  - Condition at birth
  - What resuscitation procedure needed
  - How long the resuscitation took
  - Outcome of resuscitation
  - After care given
- **Follow up of the patient**

Delivery Room Management: Decision Matrix:



- If separate newborn care area is not available it is advisable to keep the baby with the mother with close follow up and monitoring
- A Complete physical examination is performed after baby's clinical condition is stable or anytime if needed

Thermal Care

Provision of warmth to prevent hypothermia is one of the cardinal principles of newborn care. Hypothermia can lead to hypoglycemia, bleeding diathesis, pulmonary hemorrhage, acidosis, apnea, respiratory failure, shock and even death. Neonatal hypothermia continues to be a very important cause of neonatal deaths due to lack of attention by health care providers.

A newborn is more prone to develop hypothermia because of a large surface area per unit of body weight. A low birth weight baby defined as one with birth weight < 2500gms (LBW) has decreased thermal insulation due to less subcutaneous fat and reduced amount of brown fat.

Normal axillary temperature in newborn infant 36.5^{0}C to 37.5^{0}C (97.5^{0}F to 99.5^{0}F)

Temperature recording:

Newborn infant's temperature can be recorded in the axilla with a low reading thermometer. Axillary temperature is as good as rectal temperature and it is safer. But the bulb of the thermometer is to be kept three minutes while recording infant's temperature and nothing is to be added or deducted from this recorded value.

Hypothermia:

If axillary temperature of a newborn infant drops down below 36.5^{0}C is called hypothermia. Hypothermia continues to be an important cause of neonatal morbidity and mortality and may be a sign of underlying serious illness.

Types:

- Mild hypothermia/cold stress
  (36.0^{0}C to 36.4^{0}C or 96.8^{0}F to 97.5^{0}F)
- Moderate hypothermia
  (32.0^{0}C to 35.9^{0}C or 89.6^{0}F to 96.6^{0}F)
- Severe hypothermia
  (<32.0^{0}C or <89.6^{0}F)

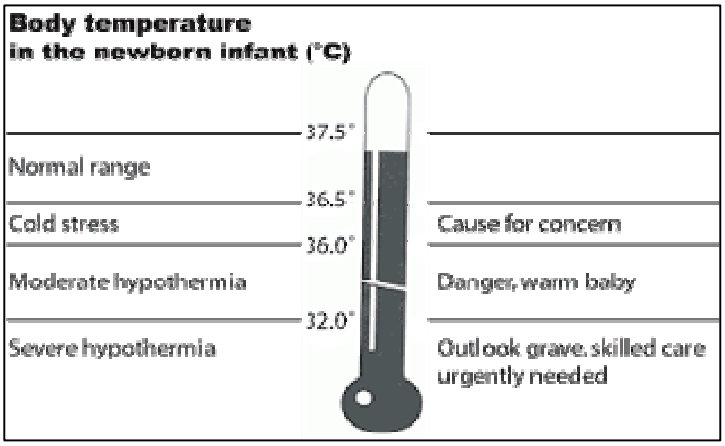


Figure: Types of hypothermia

Warm chain and prevention of hypothermia:

The "warm chain" is a set of interlinked procedures carried out at birth and later which will minimize the likelihood of hypothermia in all newborns. Baby must be kept warm at the place of birth (home or hospital) and during transportation from home to hospital or within the hospital. Satisfactory control of baby's temperature demands both prevention of heat loss and providing extra heat using an appropriate source.

Steps to prevent heat loss in labor room

- Keep delivery room warm (26°-30°C)
- Newborn care corner temperature to be maintained at 30°C
- Drying immediately. Dry with one towel. Remove the wet towel and cover with another pre-warmed towel
- Skin-to-skin contact between mother and baby
- Warm transportation

Steps to prevent heat loss in postnatal ward

- Promote breast feeding
- Appropriate clothing, cover head and extremities
- Keep mother and baby together and skin to skin contact.
- Keep the room warm
- Use radiant warmer in nursery
- Postpone bathing till 72 hours of age
- Use a wall-mounted thermometer to ensure that room temperature is maintained between 26°-30°C

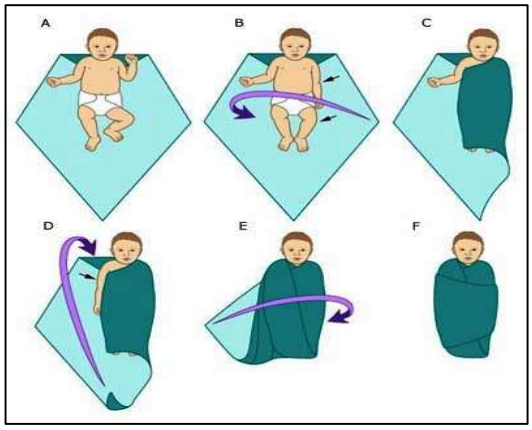


Figure: Drying and wrapping of the newborn

How to keep baby warm?

- Use dry, warm towel to hold the baby at birth. Remove wet towel after cleaning
- Adequate and appropriate clothing
- Skin-to-skin contact soon after birth for at least 2 hour or more followed by bedding in as and when required
- Radiant warmer in nursery
- Keep the room temperature of baby care area between 26°-30°C

Figure: Skin to skin contact

How to keep room warm?

- Don't use ceiling fan especially at high speed
- Keep windows and doors closed in winter
- Warm the room by convector/heater

Ways of heat loss and measures to be taken:

Method of heat loss	Prevention
Evaporation: Wet baby	o Dry the baby immediately after birth and remove the wet cloth o Change the wet napkin o Avoid bath in upto 72 hour
Conduction: Cold surface e.g weighing scale	o Use prewarmed sheets o Do not place the baby on cold object o Use warm sheets when taking weight or X-ray
Convection: Cold draught/air	o Keep environment warm o Avoid air currents o Provide warm humidified oxygen
Radiation: Cold metallic surroundings	o Keep the environment warm o Keep the baby away from cold object o Keep baby covered

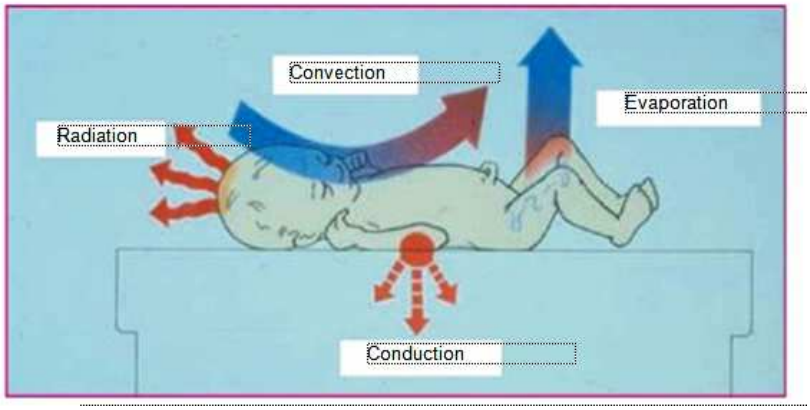


Figure: Four ways of heat loss in the newborn

Consequences of hypothermia:

- Peripheral vasoconstriction leading to cold extremities
- Hypoxia, acidosis
- Hypoglycaemia
- Lethargy
- Tachypnea
- DIC, shock
- Poor weight gain
- Multiorgan failure

Set temperature for Incubator:

32^0 C (range 31.c -34.c)-for a 3kg infant
32^0C (range33.c-35.c)-for a 2kg infant
35^0 C (range34.c-36.c)-for a1kg infant

Set temperature for Radiant:

<1kg	set temperature	36.9^0 C
1-1.5kg	set temperature	36.7^0 C
1.5-2 kg	set temperature	36.5^0 C
2- 2.5 kg	set temperature	36.3^0 C
>2.5kg	set temperature	36.0^0 C

Both hypothermia and hyperthermia can be the signs of infection

The assessment, clinical features and management of hypothermia

Category	Temp. range	Feel by touch	Clinical features	Action
Normal	36.5 to 37.5°C	Warm trunk Warm extremities	Normal baby	o Keep the room warm o KMC o Cover adequately with pre-warmed cloth o Keep the baby next to mother o Encourage breast feeding
Mild hypothermia (Cold stress)	36 to 36.4°C	Warm trunk Cold extremities	Extremities bluish and cold, Lethargy, Poor weight gain if chronic cold stress	o Keep the room warm o Skin-to-skin contact o Cover adequately o Ensure room is warm o Encourage breast feeding o Record temperature ½ hrly till it normalizes then Every 4-6 hrly
Moderate hypothermia	32 to 35.9°C	Cold trunk Cold extremities	Poor sucking, Lethargy, Weak cry, Fast breathing	o Cover mother and baby together using pre-warmed clothes o Cover adequately o Provide warmth with warmer or incubator o Breast feeding o Treat the cause
Severe hypothermia	Less than 32°C	Cold trunk & Cold extremities	Lethargic, Poor perfusion/mottling, Fast or slow breathing, Slow HR, Hardening of skin with redness and oedema, Bleeding, Low blood sugar	o Rapid re-warming @ 1°C/hour upto 34°C followed by 0.5°C/hour till 36.5°C o Oxygen o IV fluids- Dextrose (warm) o Inj-vitamin K o Reassess every 15 minutes; if temperature doesn't improved provide additional heat o Look for sepsis and treat the cause

Hyperthermia

What is a high temperature?

High temperature, fever or hyperthermia, occurs when the body temperature rises above 37.5°C. It is not as common as hypothermia, but it is equally dangerous. The causes of high temperature may be:

- The room/ environment is too hot
- The baby has too many layers of clothes
- The baby has an infection

How to manage newborn with high temperature?

- Keep the baby away from sources of heat(warmer, heater, etc.), direct sunlight
- If the baby feels hot, remove a layer of clothing
- If the baby has been under a radiant warmer
  - Measure the baby's body temperature every hour until it is in normal range.
  - Measure the temperature under the radiant warmer every hour and adjust the temperature setting accordingly. If there is no obvious reason to suspect overheating, then evaluate.
  - Ensure the temperature probe is properly secured.

  -Find out the cause and treat accordingly

Care in the postnatal ward

After birth a vast majority of newborns expected to be in the post-natal wards for bedding-in with their mothers. These babies might face difficulties during the first few days of life. The mother-infant pair would need breast feeding support and counseling.

Ideal Postnatal Environment

A postnatal room should be kept warm with no draughts. Postnatal room temperature should be 26^0 - 30^0C. A mother and her baby should be kept together in the same bed right from birth and whenever possible skin to skin care can be provided. This helps make an early close loving relationship (bonding). Mother can also respond quickly when her baby wants to feed. It is important to greet the mother appropriately before starting the examination of the baby. Using good communication skills helps to reassure the mother that her baby will receive good care.

Activities in the postnatal round

- Review the labour and birth record
- Ask for any problem
- Take breast-feeding history
- Ask for any breast feeding problem
- Advise mother not to apply anything in the cord after single use of 7.1% chlorohexidine after the cord cutting and keep it dry. ***Umbilical stump must be inspected after 2-4 hours of clamping to see any bleeding.***
- Advise mother to ***postponed bathing for 72 hours*** to prevent hypothermia and infection
- Don't apply anything in eyes unless required(infection)
- Counsel the mother about breast feeding, home care and danger sign.

Appropriate health messages for newborn care

Before discharge mother is given the appropriate health messages and asked to return to the hospital with her baby or contact with Community health worker (if available in her area) if there is appearance of any danger sign.

Warmth

- The room in which the baby is cared for must be warm (26- 30^0C) and free from drafts
- Use of two or more layers of cloth to prevent hypothermia
- Keep the baby's head covered with a cap or cloth
- Bedding –in with the mother promotes warmth and breastfeeding.
- Use Kangaroo Mother Care (KMC) for low birth weight babies

- If the newborn's feet are cold to touch; the newborn needs extra warmth immediately, use of socks and mitten in hands and feet

Protection from infection

- Advise mother to wash hands with soap and water after using the toilet and after cleaning the bottom of the baby, before handling baby for feeding and caring
- Do not apply anything on the umbilical cord.
- Keep the clothing, bedding, etc. clean
- Keep sick children and adults away from the baby, use mask if necessary.
- Protect the newborn from smoke in the air from cigarettes or a cooking fire, using mosquito coil.
- Breastfeed the newborn exclusively
- Make sure the baby gets all his immunizations on time.

Exclusive Breastfeeding

- Tell mother to feed her baby with colostrum
- Tell mother to breast feed her baby on demand
- To feed from the opposite breast when breast if empty
- To feed from both breasts as long as he wants
- Night feeds will help to increase the flow of breast milk

Figure: Correct position of breast feeding

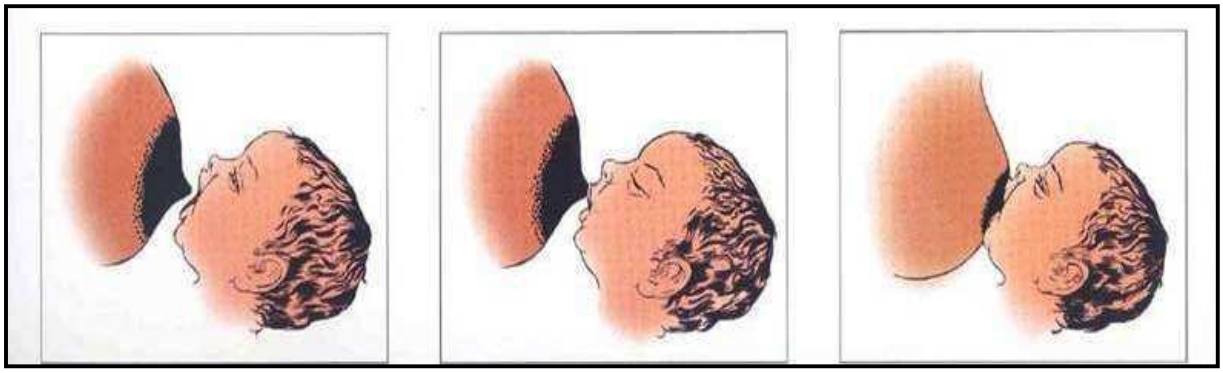


Figure: Correct attachment of breast feeding

Washing and bathing

The newborn's first bath is delayed for first 72 hours by which time his temperature is usually more stable. If the baby is soiled with meconium or blood and only then if the newborn's temperature is normal that is 36.5-37.5^0 C, sponge the baby by warm water and wash the soiled parts quickly.

- Ensure that the room is warm
- Use lukewarm water for bathing
- Thoroughly dry the baby, dress and cover after bath

Sleep

Newborns need sleep. If they are healthy, they sleep most of the times between feedings (up to 18 hours out of 24). They wake up every 2-3 hours to feed.

- Use bed net day and night for a sleeping baby
- Let the baby sleep on his back, or on one side
- Keep the baby away from smoke

Loving care

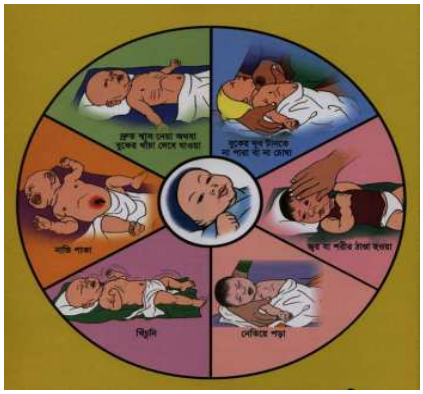
A newborn cannot survive without loving care. At birth, he is unable to meet any of his own basic needs. When a newborn is hungry, wet, cold, uncomfortable, in pain or sick, he can only cry or send out other cues.

Safety and security

Never leave a baby alone on a bed or table from which he can fall. Never hold a newborn by his feet with the head down.

Watching for Danger Signs

- ❖ Convulsion
- ❖ Lethargy
- ❖ Reluctant to feed (stopped feeding well)
- ❖ Hypothermia (< 35.5C or 95.9F)
- ❖ Hyperthermia (> 37.5C or 99.5F)
- ❖ Fast breathing (respiratory rate ≥ 60/min)
- ❖ Chest indrawing (inter-costal, sub-costal, supra-sternal)



Immunization The baby should receive BCG and OPV-0 within 2 weeks of life.

Hospital records

- Birth registration
- Newborn record card
- Immunization card

Plan for Follow-up Visits

Newborn must be follow up at nearby health facility for at least four times in the first month of life. The first 7 days of life are critical times for postnatal care because most newborn deaths occur within the first week, especially the first 24 hours. A suggested schedule for newborn health care visits with special emphasis points are:

- ❖ **Visit1(within 24 hours):** Assess breastfeeding, breathing, colour, stools, urination and temperature
- ❖ **Visit 2(2-3 days):** Assess breastfeeding, signs of infection, skin colour (jaundice)
- ❖ **Visit 3(7 days):** Assess for jaundice, signs of infection, breastfeeding, weight
- ❖ **Visit 4(28 days):** Assess breastfeeding, signs of infection, weight, immunization, family planning

Make a plan for the 6-week immunization visit and counsel or refer the mother for family planning services.

Neonatal Nutrition

Nutritional insufficiency, leading to early growth deficits has long-lasting effects, including short stature and poor neurodevelopmental outcomes. The goal of nutrition management in neonates, especially very low birth weight (VLBW) infants is the achievement of postnatal growth.

Nutrition may be provided to a newborn by

- **Enteral:** Oral or Gavage feedings
- **Parenteral :**
    - **Total parenteral nutrition (TPN):** is intravenous administration of all nutrients (fats, carbohydrates, proteins, vitamins, and minerals) necessary for metabolic requirements and growth.
    - **Parenteral nutrition (PN):** is supplemental intravenous administration of nutrients.

Indications of Total Parenteral nutrition (TPN)

- Infants <28 wk or <1000 gm.
- Infants 28 -32wk or 1000-1500 gm and anticipated to be not on significant feeds for 3 or more days.
- Infants >32 wk or >1500 gm and anticipated to be not on significant feeds for 5 or more days
- Surgical conditions in neonates:necrotizing enterocolitis (NEC), gastroschisis, omphalocele, tracheo-esophageal fistula (TEF), intestinal atresia, mal-rotation, short bowel syndrome,and meconium ileus.
- Babies those are term but hemodynamically unstable

Nutritional requirements in the neonate

To maintain weight, 50-60 kcal/kg/day
To induce weight gain, 100-120 kcal/kg/day to a term infant (***Expected weight gain: 15-30 g/day***) and 110-140 kcal/kg/day to a premature infant

Carbohydrates: 10-30 g/kg/day are needed to provide 40-50% of total calories
Proteins: 2.25-4.0 g/kg/day (7-16% of total calories)
Fats: 5-7 g/kg/day (limit: 40-55% of total calories, or ketosis may result)

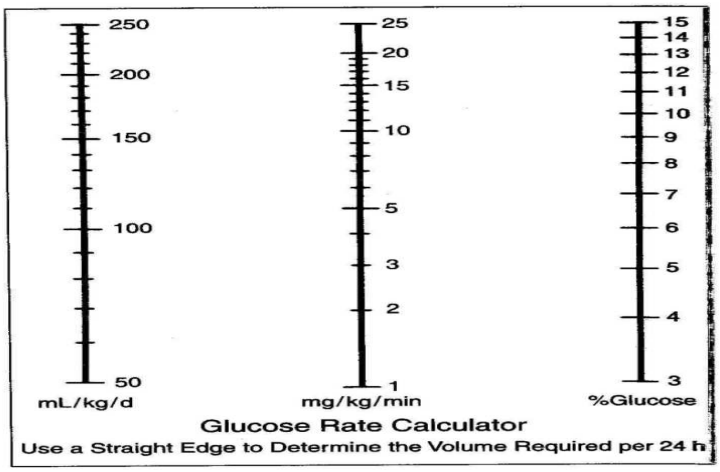
Vitamins and minerals:
Caution is required because toxicity may occur as a result of immature renal and hepatic function.

Osteopenia of prematurity: calcium, phosphorus, and vitamin D may be supplemented.
Iron deficiency: Stable preterm infants should receive iron supplementation (2-4 mg/kg/day) by 6 weeks (4-8 weeks) of age and continued until 6 months

Dextrose

- Caloric value of dextrose is 3.4 kcal /g.
- Prescribe as mg/kg/min, starting at 6 mg/kg/min.
- Increase by daily increments of 2 mg/kg/min if tolerated to a maximum of 12 mg/kg/min.
- Using a peripheral cannula maximum dextrose concentration is 12.5% and up to 25% in central line.

Glucose rate calculator



Amino acids (AA)

- Caloric value of amino acids is 4 kcal/g
- Preterm infants without AA supplement excrete around 0.5 g/ kg / day of protein
- AA can be initiated on day 1 in a dose of 1-1.5 g/kg/day and increase by 0.5 g/kg/day up to 3.5 g/kg/day
- Energy intake should be at least 40-50 kcal/kg/day for optimal amino acids utilization
- Use with caution in babies with renal impairment

Lipids

- Caloric value is 10 kcal/g
- Lipids can be started at 1 g/kg/day and increase by 1 g/kg/day up to 3.5 g/kg/day
- Use of 20% emulsion is preferred
- Use with caution in babies with sepsis, respiratory failure or severe jaundice
- Lipids are potentially vulnerable to photo-oxidation and should be covered with sterile opaque paper

Electrolytes

- Sodium and potassium are added to PN usually from day 2
- Maintenance dose of sodium is 2-4 mmol/kg/day
- Maintenance dose of potassium is 1-2 mmol/kg/ day

Minerals

- Calcium should be added from day 2 or 3
- Dose of calcium 200-800 mg/kg/day in 4 divided doses
- Dose of phosphate is 0.5-1.5 mmol/kg/day. (Not available in Bangladesh)
- Dose of magnesium is 0.25-0.5 mmol/kg/day (Not available in Bangladesh)

Trace elements

- Zinc is recommended from day 1 of PN (Parenteral formulation not available)
- Other trace minerals are generally provided after two weeks' of PN

Sources of parenteral solutions

Constituent	Preparation
Dextrose	Dextrose 5%, 10%, 25%
Amino acid	Amino acid 5%
Lipid	Intralipid 10%, 20%
Sodium	NaCl- 3%, 0.9%, 0.45%, 0.225%
Potassium	KCl
Calcium	Ca gluconate 10%, 10mg/ml
Magnesium	Mg sulphate 50%
Vitamin	Multivitamin infusion

When to stop parenteral nutrition (PN)?

Once the infant has tolerated 100-120 ml/kg/day enterally, PN can be stopped

Routes of parenteral nutrition (PN) administration

A) Central-PICC (Percutaneous peripherally inserted central catheter)
B) Peripheral line
C) Umbilical catheters

- Use of peripheral line is safer when PN is needed for less than 14 days
- Central PN allows the use of more hypertonic solutions but incurs catheter related sepsis

PICC line is inserted when:

- Concentrations of >12.5% glucose are needed
- Osmolarity of solution is >900 mOsm/L
- Prolonged period of PN is anticipated

Monitoring during parenteral nutrition (PN)

- Twice-weekly triglycerides, daily body weight and weekly body length and head circumference
- Initially during grading-up of PN:
  - Strict fluid balance
  - Blood glucose 6-12 hourly
  - Daily sodium, potassium, calcium, creatinine and acid-base

When on full PN:

- Strict fluid balance
- Blood glucose 8 -12 hourly
- Twice-weekly sodium, potassium, calcium, creatinine and acid-base. Plasma magnesium, phosphorus, alkaline phosphatase, albumin, transaminases, triglycerides and bilirubin

Complications

- Sepsis
- Metabolic: azotemia, hyperammonemia, metabolic acidosis
- Cholestasis
- Metabilic bone disease of prematurity
- Related to lipid emulsions: hyperlipidemia, indirect hyperbilirubinemia

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Feeding of Preterm Infants

Feeding of low birth weight (< 2500gms) babies differs from that of normal birth weight babies. These babies (especially those < 1800 grams) often have difficulty in taking milk directly from breast and may require more help and ongoing monitoring.

When to start feeds (within 24 hours of life) -

- Hemodynamically stable (normal CRT, heart rate, blood pressure, temperature, no apnea or respiratory distress,)
- Normal abdominal examination –
  - No distension
  - Normal bowel sounds
  - No bilious gastric aspirates
- No sign of respiratory distress –
  - Signs of respiratory distress are -
    - Cyanosis
    - Tachypnea, intercostal recession, sternal , supraclavicular indrawing
    - Chest in drawing
    - Nasal flaring
- Having no risk factor for NEC -
  - Risk factor for NEC -
    - Severe Intrauterine growth retardation
    - Severe Perinatal Asphyxia
    - Preterm (< 32 weeks, the lower the gestational age, the greater is the risk of NEC)
    - Sepsis
    - Hypotension requiring inotropes
    - Polycythemia requiring exchange transfusion

Initial feeding method:

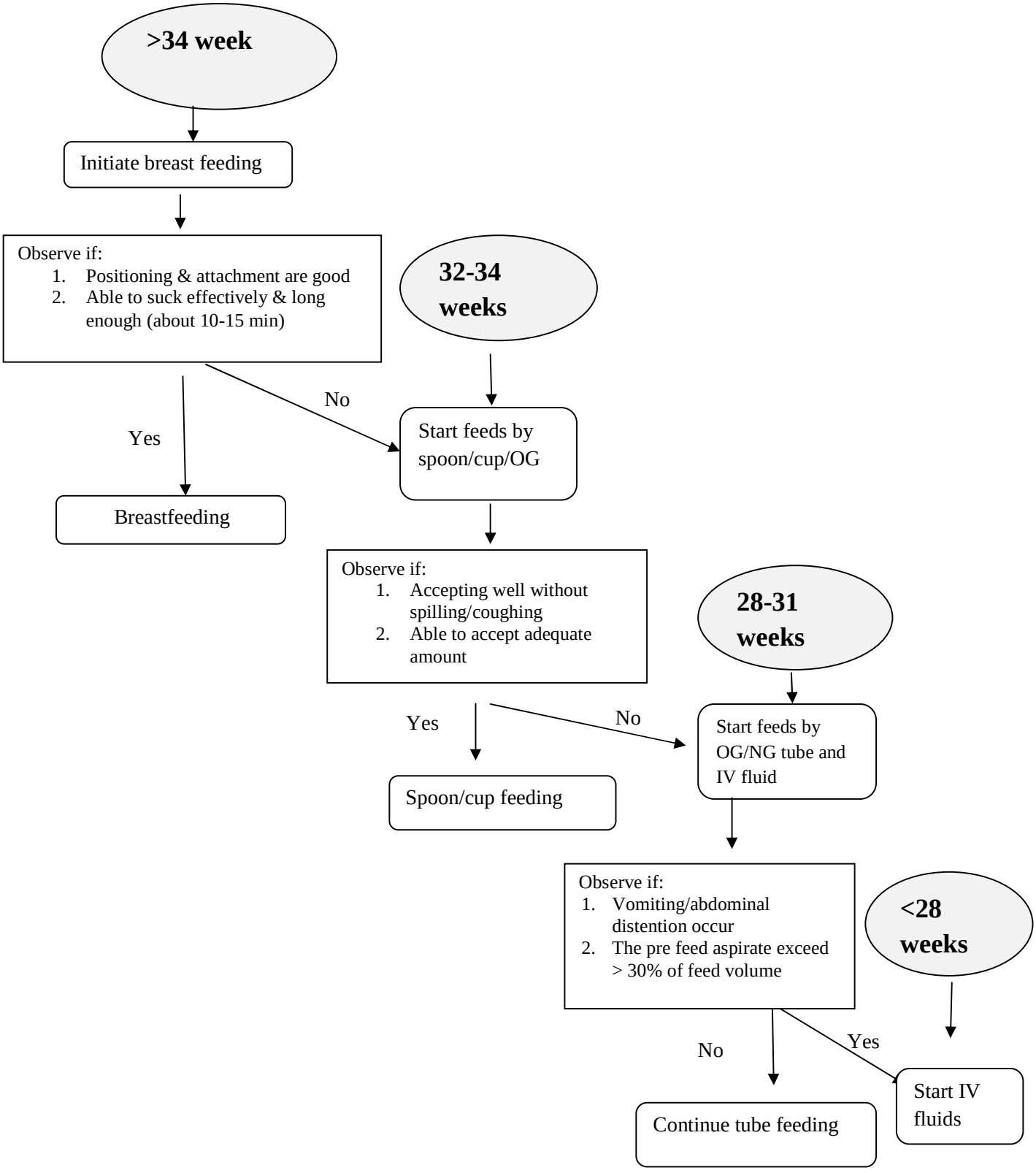
Gestational age	Clinical characteristics (GIT) of the baby	Initial feeding method
< 28 wks	▪ No proper sucking efforts ▪ No propulsive motility in the gut	No enteral feeds Intravenous fluids
28- <32 wks	▪ Sucking bursts develop ▪ No coordination between suck/swallow and breathing	Oro-gastric / naso-gastric tube feeding
32- <34 wks	▪ Slightly mature sucking pattern ▪ Coordination between breathing and swallowing begins	Feeding by spoon / cup or Oro-gastric / naso-gastric tube feeding
>34 wks	▪ Mature sucking pattern ▪ More coordination between breathing and s wallowing	Breastfeeding

Choice of milk: Breast milk.

Volume of milk:

- Volume of milk should be calculated from amount of daily fluid requirement-
  - Start fluid at 80ml/kg/day and 60ml/kg/day for infants birth weight of <1500 grams and 1500-2500 grams respectively. The usual daily increment would be about 10-20 ml/kg/day so that by the end of first week 150 ml/kg/day are reached in both the categories. The maximum volume of feeds may reach up to 180-200 ml/kg/day.

How to decide the initial feeding method:



Minimal Enteral Nutrition (MEN) / Trophic Feeding:

- This is a practice where in small volumes of feeds are given to the baby in order to stimulate the development of the immature gastrointestinal tract of the preterm infant.
- Begin as soon after birth as possible, ideally by postnatal day 2 to 3.
- It is not used in infants with severe hemodynamic instability, suspected or confirmed NEC, evidence of ileus, or clinical signs of intestinal pathology.
- These feeds are of small volume ranging from 10-15 ml/kg/day.
- Trophic feeds decrease duration to reach full enteral feeds and duration of hospital stay without increasing the risk of NEC.

To start with minimal enteral nutrition (MEN):

For the babies weight <1200 gm – 0.5ml 4 hourly

For the babies weight >1200 gm – 1ml 4 hourly

Feeding interval should be reduced everyday by one hour till 2 hourly & only then volume should be increased when 2 hourly feeds are achieved.

Feeding advancement protocol:

< 1200 gm	**Without risk factor***	**With risk factors**
Initiate feeds at :	24 - 48 hours	24-48 hours
Feed interval :	2 hourly	2 hourly
Rate of advancement :	10 ml/kg/day x 10 days, then 20 ml/kg/day (in 2 aliquots) till full feeds	10 ml/kg/day till full feeds

***Risk factors for NEC of this weight group (<1200 grams) refers to any one of the above mentioned risk factor for NEC**

> 1200- 1800 gm	**Without risk factors****	**With risk factors**
Initiate feeding at :	12-24 hours	24-48 hours
Feed interval :	2 hourly	2 hours
Rate of advancement	10 ml/kg/day x7 days, then 20 ml/kg/day (in 2 aliquots) till full feeds	10 ml/kg/day x10 days, then 20 ml/kg/day (in 2 aliquots) till full feeds

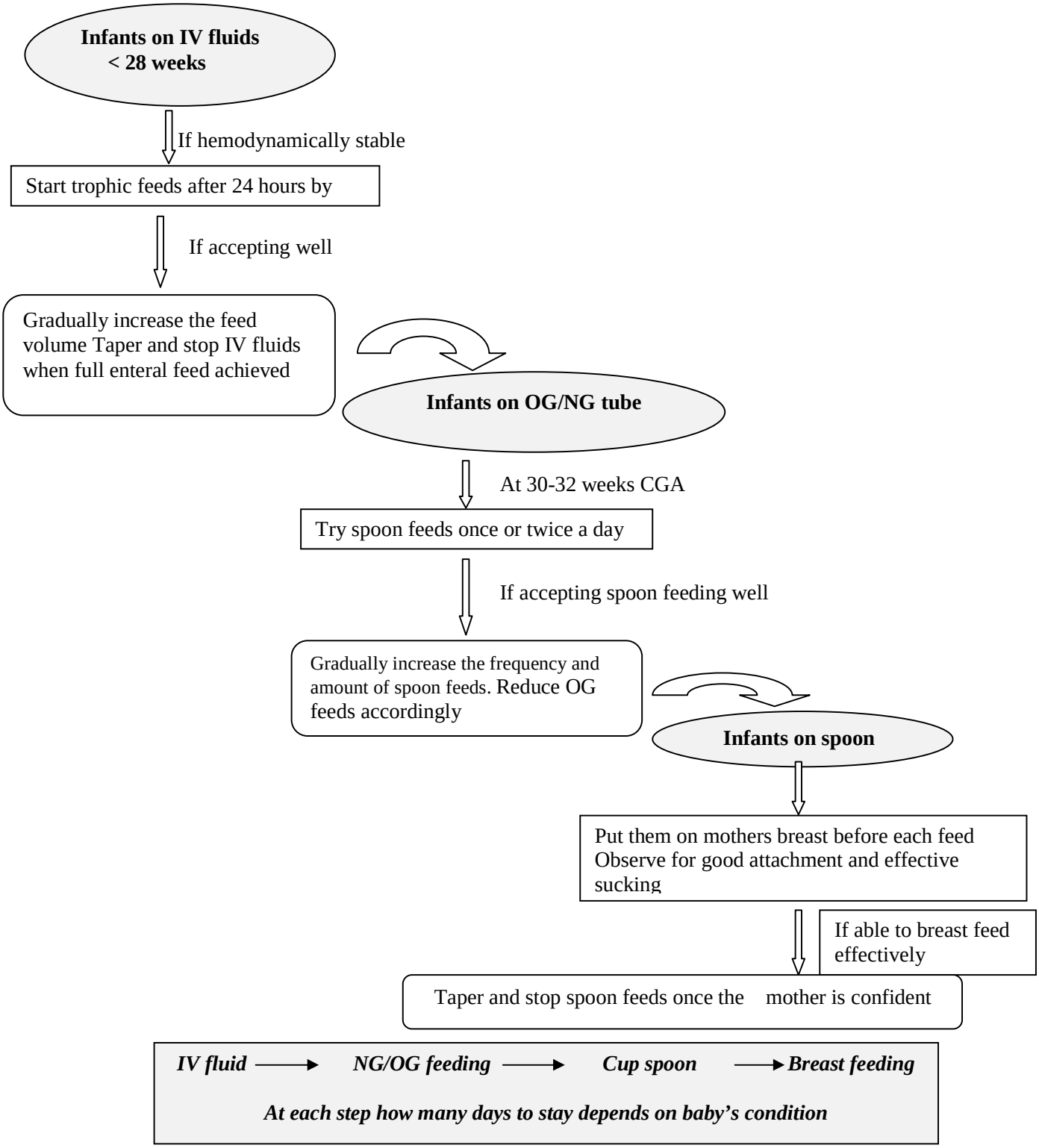
****Risk factor for NEC of this weight group (>1200-1800 grams) refers to IUGR plus any one of the other risk factor for NEC**

Consider advancing feeds at a faster rate than stated guidelines, if baby tolerates oral feeds well with mother's breast milk.

When to stop / withheld feeding:

- Blood / bile stained gastric aspirate.
- Evidence of feeding intolerance –
  - Vomiting (altered milk / bile or blood stained)
  - Abdominal distension and increase in abdominal girth ≥ 2cm from baseline measurement at the level of umbilicus (with or without visible bowel loops)
  - Significant gastric aspirate (30% of previous feed or > 3 ml whichever is more)
  - Reduced or absent bowel sound
- Systemic signs – respiratory distress, lethargy, apnea, convulsion

Mode of Progression of feeding



Goals of feeding:

- Full feeds : 150-180/200 ml/kg/day
- Calories: 110-130 kcal/kg/day
- Anthropometry: Weight gain- between 15 – 25g/kg/day,
  Length- 1 cm / week,
  Head circumference- 0.5- 0.7 cm /week

When to convert from 2 hourly to 3 hourly feeding:

- When full feeds (150ml/kg/day) achieved and/or weight >2000g.
- Maintain same feeding volume when converting to 3 hourly feeds, in order not to deprive infant of caloric intake.

Example: A currently 2 kg infant is fed 20 ml/ 2hrly (240 ml/day). Seasaw can be done within 2-3 days like 18/22, 15/25 on D1 and D2 respectively and so on. First day, feeding order would be 18 ml alternate with 22 ml 2 hourly then convert to 15 ml alternate with 25 ml 2 hourly feeds (Seasaw) for the following day. If no significant gastric residues, on second day, convert to 30 ml/3hrly. Final volume to be achieved is 30 ml/3hrly.

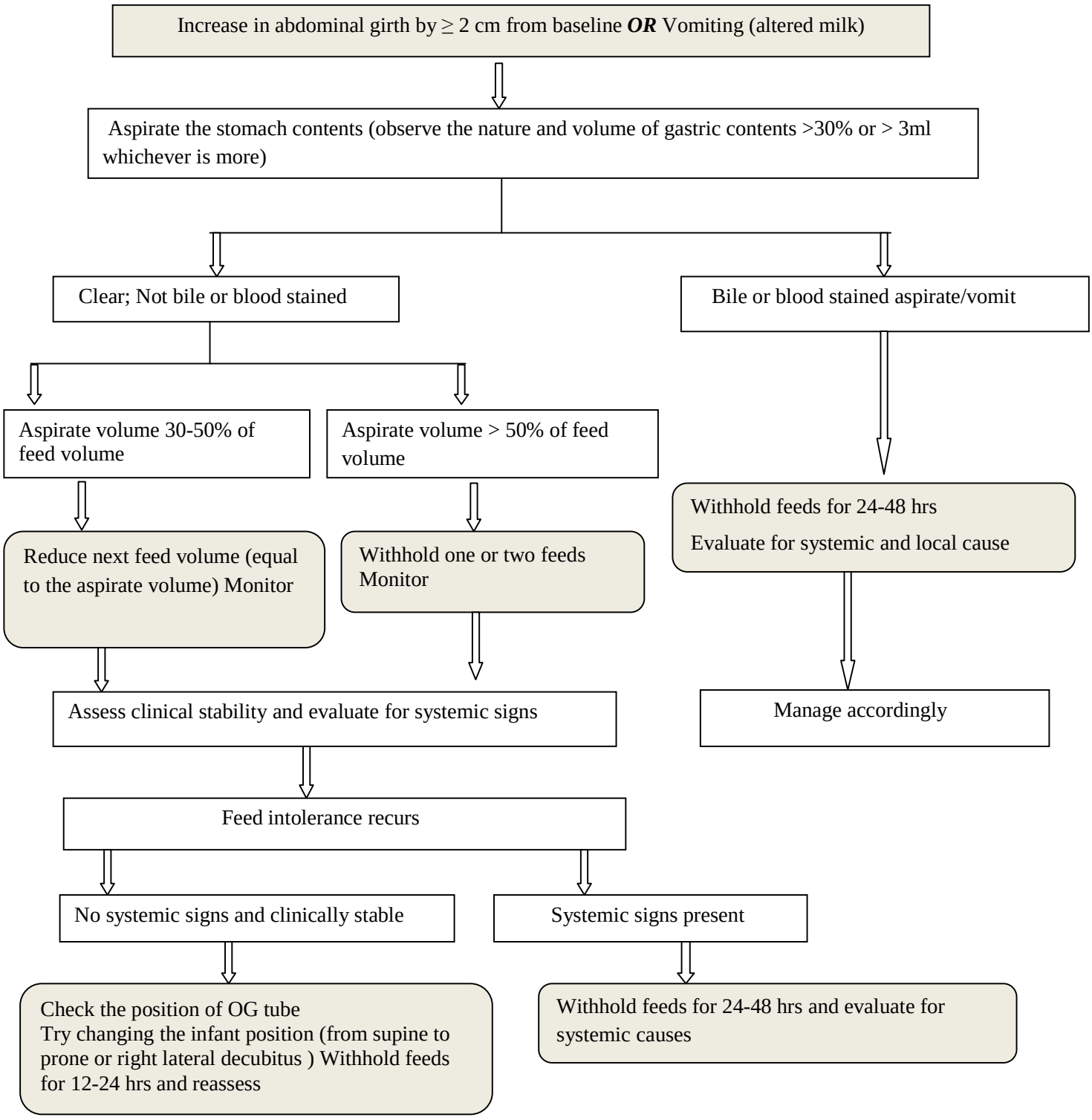
When to convert from oro-gastric / naso-gastric feeding to oral feeding:

- Initiate oral feeding around corrected gestational age of 32- 34 wks once a day.
- Advance to once per shift, then to alternate feeds till full oral feeding achieved.

Multivitamins and iron supplements:

- Supplement in preterm infants <35 wks and/or <1500g
  a) Add multivitamins pediatric drop 0.3ml OD from 2 wks of age and/or when full feeds have been achieved; continue after discharge till 6 months of age.
  b) Folic acid: Dose 50 µgm/day ($1/4^{th}$ tab; each tab contain 5 mg) every alternate day for 6 months.
  c) Add iron (1ml = 50 mg) at the following doses
     - 1 drop OD (~ 2mg/kg/day) at 4 wks of age x 2 wks
     - 1 drop BD (~4mg/kg/day) at 6 wks of age
     - 2 drop BD (~ 5-6 mg/kg/day) at 1.8kg and continue till 6 months of age.

Management of Feed Intolerance



All residual feed less than 2 ml should be re-fed if the abdominal examination is normal

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Breast-feeding

Introduction

Breastfeeding is the best infant feeding practice. Breast milk provides optimum nutrition for the baby and is specific. Starting breast feeding within an hour of birth alone can reduce neonatal mortality by 13%. So, all health professionals must have knowledge and skills about the correct techniques of breast feeding.

Exclusive Breast Feeding

Exclusive breastfeeding means

- No drinks or foods other than breast milk are given to a baby since birth up to 6 completed months (180 days).
- No pacifier, dummies or artificial teats are given to a baby.

Exclusively breast fed babies are at lowest risk of:

Diarrhea

Pneumonia

Ear & other infection

Death in first year of life

Types of breast milk

Colostrum is the milk secreted during first week after delivery. It is yellow, thick and contains more antibodies and white blood cells. Though secreted only in small quantities, it has higher protein content and is sufficient for the needs of the baby.

Transitional milk is the milk secreted during the following two weeks. The immunoglobulin and protein contents decrease, while the fat and sugar contents increase.

Mature milk follows transitional milk. It is thinner and watery but contains all the nutrients essential for optimal growth of the baby.

Fore milk is the milk secreted at the start of a feed. It is watery and is rich in proteins, sugar, vitamins, minerals and water and satisfies the baby's thirst.

Hind milk comes later towards the end of a feed and is richer in fat content and provides more energy, and satisfies the baby's hunger.

Note: For optimum growth the baby needs both fore and hind milk. Therefore, each time the baby should be allowed to empty one breast completely. The second breast should be offered only after emptying the first one or during subsequent feeding.

Assessment of Breastfeeding

- Assess breast feeding in all newborns
- Ask mother if the infant has breastfed in the previous hour

- If infant has not fed in the previous hour, ask the mother to put her infant to the breast. Observe the breastfeed for 4 minutes.

Check attachment of baby on mother's breast

Signs of Good Attachment

Baby's mouth is wide open
Lower lip is turned outwards
Baby's chin touches mother's breast
Most of the areola inside baby's mouth

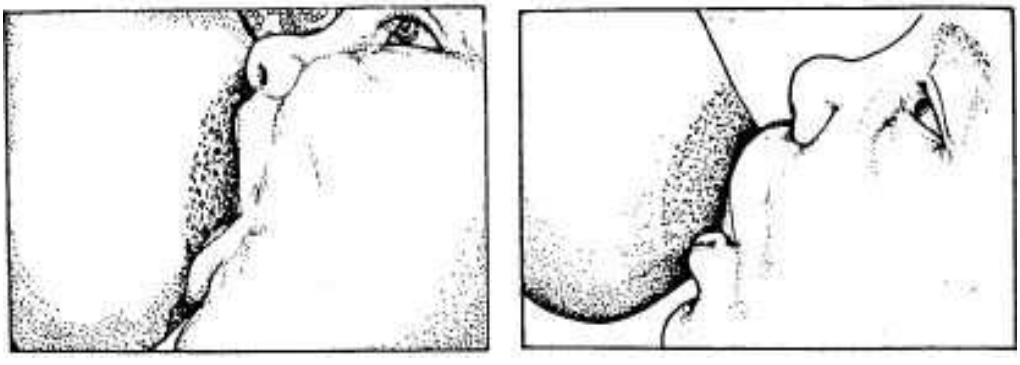


Fig: Good (left) and poor (right) attachment of infant to the mothers breast

It is very important to ensure good attachment because poor attachment results in

- Pain or damage to nipple leading to sore nipple.
- Breast engorgement milk not sucked effectively
- Poor milk supply hence baby is not satisfied and irritable after feeding.
- Less milk production resulting in frustrated baby who refuses to suck. This leads to poor weight gain.

If attachment is not good Check for correct positioning

Signs of good position of the baby while breast-feeding are:

Signs of Good Position

1. Baby's body is well supported.
2. The head, neck and the body of the baby are kept in the same plane.
3. Entire body of the baby faces the mother.
4. Baby is held very close to the mother

Fig:Baby's body close, facing breast

Fig:Baby's body away from mothe, neck twisted

Proper positioning and attachment is very important for successful breastfeeding

Check for baby's sucking

Effective sucking means the baby shows slow deep sucks, sometimes pausing to take breath

- If not sucking well, then look for ulcers or white patches in the mouth (thrush).
- Look for other signs and symptoms of infection

Indicators of adequate breast feeding

i) Passing urine 6 or more times in 24 hours

ii) Weight gain 20-40gm/ day on an average.

How to sustain optimum breast feeding:

1) Starting breast feeding as soon as possible, but no later than 1 hour after birth.
2) Giving no pre lacteals, feeds colostrum
3) Exclusive breast feeding for 6 months
4) Breast feeding on demand, day and night at least 8 times in 24 hours whenever baby wants (frequent night feeds)
5. Giving lactating mother more foods. Mother should take all the family foods plus 450 k.cal/day (One spoon rice, one cup dal, one banana, some amount of vegetable cooked with oil will give rise to 450 k.cal.)
6. Give a high potency vit. A capsule to the mother at birth

   Starting complementary feeding from 6 months (180 days) of age along with breast milk

7. Continuing breast feeding at least for 2 years along with complementary feeding.

Difficulties in breast feeding

Not enough milk

Mothers often complaint that they do not have enough milk. One has to make sure that her perception about adequacy of milk. Reassurance is needed if the baby is gaining weight and passing adequate amount of urine (at least 6 times in 24 hours)

Following are reasons, when baby may not get enough breast milk. These reasons are easily correctable.

• Delayed initiation	• Lack of confidence	• Illness of mother
• Feeding at fixed times	• Worries, stress	• Pain
• Infrequent feeds	• Unwilling to breastfeed	
• No/less frequent night feeds	• Tiredness	
• Short feeds	• Breast engorgement	
• Incorrect positioning	• Mastitis	
• Poor attachment		
• Use of bottles, pacifiers		
• Offering other fluids (sugar water, honey etc)		

Factors do not affect the production of breast milk
• Cesarean section
• Preterm delivery
• Medication e.g. Antibiotics and contraceptives

• Small size of the breast

Management of not enough milk:

- Counsel mother to feed the baby more frequently especially at night
- Make sure that positioning is correct and attachment is good
- Take care of any painful condition in mother such as sore nipple or mastitis
- Back massages are especially useful for stimulating lactation
- Some drugs may also help in some cases
- Ask mother to drink enough fluid and take sufficient family food
- Ask husband and other family member to support the mother

Back massage is helpful in relaxation of mother thus stimulating hormone production. The technique of massage should be demonstrated to the relative who can provide it to the mother. Massages should be done for 15-30 minutes each time, three to four times a day.

Inverted/ Flat nipples

Flat or short nipples which become prominent or pull out easily do not cause difficulty in breast feeding. If needed send the mother to breast feeding support centre for necessary help.

Sore/ Cracked/ Fissured nipple

A Sore/ Cracked/ Fissured nipple is caused by incorrect attachment of the baby to the breast. A baby who sucks only at the nipple does not get enough milk so he sucks more vigorously resulting in a sore nipple.

Causes of sore/cracked/ fissured nipple:

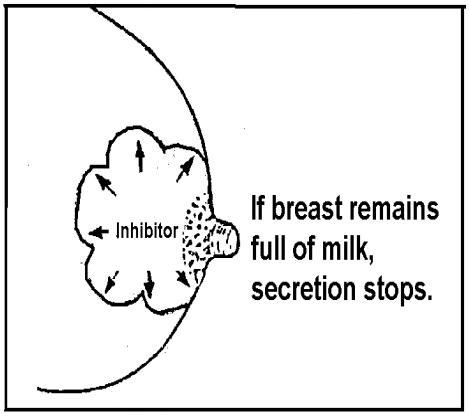
- Incorrect attachment
- Frequent use of soap and water
- Fungal infection of nipple
- Oral thrush of baby

Treatment

- Continue breastfeeding in correct positioning & good attachment
- Apply hind milk to the nipple after breast feed.

Breast engorgement

The milk production increases during the second and third day after delivery. If feeding is delayed or infrequent or the baby is not well attached to the breast, the milk accumulates in the alveoli. As milk production increases, the amount of milk in the breast exceeds the capacity of the alveoli to store it comfortably. Such a breast becomes swollen, hard, warm and painful and is termed as an engorged breast.



Treatment:

Breast engorgement can be prevented by early and frequent breast feeds and correct positioning and attachment of the baby to the breast. Apply warm cloth before feeding and gently express the milk to soften the breast, and then help the mother to correctly latch the baby to the breast. Ask mother to express by herself by hand expression. Paracetamol can be given to the mother to relieve pain.

Mastitis / Breast abscess: Mastitis and breast abscess are infection in the breast. In this condition patient is febrile and breast is swollen, painful, red and hot. If untreated it may develop into breast abscess.

Treatment: Advise mother not to stop breastfeeding. Try to improve positioning and attachment, advise mother to avoid pressure from clothes of fingers, give frequent feeding, gently massage the breast and apply a warm compression before feeding.

Mother must be treated with analgesic and antibiotic. Breast feeding must be continued from the other breast. If there is no improvement, refer the mother to an appropriate health care provider.

Proper motivation and appropriate counseling is essential for successful breastfeeding.

Breast feeding in special situations

Cleft Lip & Cleft Palate

Most of the cases mother is able to breastfeed in these special situations. In a few cases expressed milk need to be given by long spoon.

Feeding LBW babies

Feeding LBW babies differs from that of normal birth weight babies. Low birth weight and preterm babies require higher calories and proteins. The milk of a mother who has delivered prematurely has higher protein content and fulfills the requirements of her preterm baby. The higher level of immunoglobulin protects the baby from infections. These babies, especially those who weigh <1800 gm have difficulty in taking milk directly from breast and may need special support.

When there is more than one baby

How a mother does feed her babies when she has more than one?

- Mother is able to produce enough milk for two, even for three babies. Counsel and motivate her that she can continue exclusive breastfeeding. The supply of milk is related to demand by the baby. More the demand, greater is the milk production.
- She can breastfeed the babies- either both at a time or alternately.

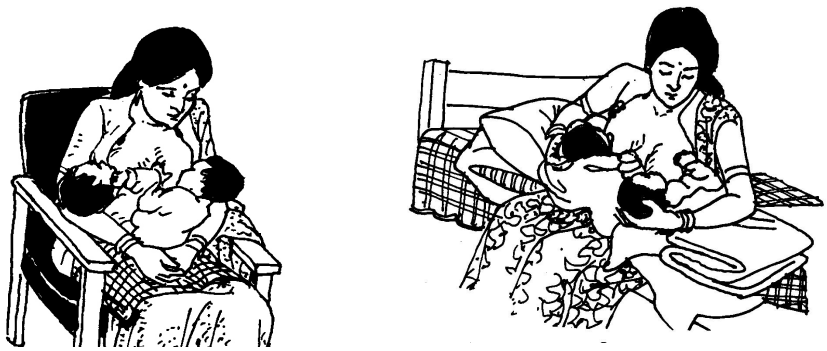


Figure : Feeding twin babies

Mother with Hepatitis B virus infection: Breast feeding is not contraindicated. If the mother HBsAg +ve, only precaution to be taken is that the baby should be given (1) Hepatitis B immunoglobin (Hepabig 0.5 ml) I/M in one thigh, as soon as possible, preferably within 12 hours after birth and (2) hepatitis B vaccine, 0.5ml I/M in the other thigh, Course to be completed later on.

Advice mother to give exclusive breast feeding. **DO NOT support mixed feeding** (i.e Breast milk+formula milk).

Mother with active tuberculosis: If mother has active tuberculosis, baby should be isolated from her during the initial 2 weeks of treatment, till she becomes sputum negative. During that time, breast milk should be expressed regularly and feed the baby. After she becomes non-infective mother can confidently begin feeding her baby.

Breast milk jaundice: Jaundice can persist beyond 2 weeks in a fully breast fed baby. If bilirubin is consistently below 12mg/dl and other serious causes of prolonged jaundice are excluded, no treatment is needed. Mother is assured that baby does not have serious problems and she should continue breast feeding.

Mother with HIV infection: Give exclusive breast feeding, DO NOT give **mixed feeding**. Mixed feeding favors entrance of microorganism into the circulation.

Absolute Contraindications of breast feeding:

1. Maternal psychosis
2. Mother on treatment with anti-cancer drugs
3. Mother on treatment with anti-thyroid drugs

4. Infants with galactosemia

Fluid and Electrolytes

Fluid & electrolyte balance plays an important role in the early medical management of preterm infants and sick term infants coming to neonatal intensive care. Guidelines for the management of fluids according to birth weight, day of life and specific clinical conditions are provided in the protocol.

Guidelines for starting fluid and electrolytes & glucose (Day-1):

Birth weight	Starting volume (ml/kg/day)	Type of fluid
<1000 gm	90	5% Dextrose in Aqua
1000- 1500gm	80	7.5% - 10% Dextrose in Aqua
>1500gm	60	10% Dextrose in Aqua

[Increase fluid volume at a rate of 15-20 ml/kg/day to reach 150 -180ml/kg at 7 days of age. Use dextrose in Aqua up to 24 hrs of age then replace the fluid by Dextrose in 0.225% saline.]

Age (day)	Term & >1500gm (ml/kg/day)	Preterm & ≤1500 gm (ml/kg/day) [except*]	Type of fluid
D-1	60	80	Dextrose in Aqua
D-2	80	100	Dextrose in 0.225% saline
D-3	100	120	Dextrose in 0.225% saline
D-4	120	140	Dextrose in 0.225% saline
D-5	140	150-160	Dextrose in 0.225% saline
D-6 & D-7 onwards	150-160	150-160	Dextrose in 0.225% saline

***Except in babies with birth weight <1000 gm – D1 fluid is 90ml/kg – 5% dextrose in aqua, then increase 10-20 ml/kg/day**

Monitoring of hydration status of a newborn:

- Appearance (Irritable/ lethargic)
- Anterior fontanel
- CRT (Capillary refill time)
- Pulse
- Respiratory rate
- BP
- Skin pinch
- Oedema
- Body weight
- Urine output
- S. Electrolytes particularly sodium

Disorders of serum sodium

Normal: 135-145mmol/l
Values between 130-150 mmol/l well tolerated but outside this range urgent treatment is required.
Daily requirement 2-3mmol/kg/24hours

Hyponatremia

- S. Na level < 135 meq/l.
- Ratio of water to sodium is increased

  Either primary Na depletion, or

  Increased water retention.

Etiology

Hypovolumic hyponatremia (ECF deficit):

Renal losses (spot urinary Na > 20 meq/l)

Diuretics

Renal immaturity: PT VLBW

Postobstructive diuresis

Salt losing nephropathy

CAH

Extrarenal losses (spot urinary Na < 20 meq/l)

GIT loss: Vomiting, Diarrhoea , NG suction

Third spacing of fluid: Ascites , Plural effusion, NEC

Hypervolumic hyponatremia (ECF excess):

CCF

Renal failure

Liver failure

Sepsis

Hypoalbuminemia

Euvolumic Hyponatremia (Normal ECF)

SIADH:

Birth asphyxia, meningitis, IVH, hydrocephalus, Pneumonia

Key differentiating feature

- Hypovolumic hyponatremia : Weight loss, F/O dehydration
- Euvolumic Hyponatremia: Wt. gain but no edema
- Hypervolumic hyponatremia: Wt. gain with edema.

Clinical evaluation for hyponatremia:

Seizures? –urgency!
How much Na and free water is the patient receiving?
Weight gain or weight loss?
Urine output?
Renal salt-wasting medication?

Management:

Hypovolumic hyponatremia:

- If dehydration: restoration of intravascular volume with isotonic saline.
- Replace Na Deficit.
- Deficit calculation: Na deficit = 0.7 x wt (kg) x (desired Na- current Na)
- Half of the deficit is given over 12- 24 hour
- Add daily requirement and ongoing loss if present.

Replete no faster than 0.5mEq/L per hour or 12mEq/L per day to avoid CPM

Hypervolemic hyponatremia

- Fluid restriction
- Diuretics

Isovolemic hyponatremia

- Fluid restriction
- Diuretic

If severe symptom (seizure) – Hypertonic saline, regardless of etiology

Should be managed with 3% NaCl

Infusion of 3% NaCl 4 ml/kg @ 1ml/kg/hr .

Sodium should be raised until it reaches 125 mmol/l or until seizure stops, whichever occurs first.

Sodium content in commonly used infusion fluid:

Solution	Sodium Concentration (meq/ml)
3% normal saline	0.500
Normal saline	0.154
0.50% normal saline	0.075
0.25% normal saline	0.037
0.125% normal saline	0.019

Example:

26 days old male newborn weighing 3kg presented with several episodes of vomiting for 1 day. O/E he was found to have convulsion. His s. electrolyte was 118 mmol/l. How to correct Na?

1st step: 3%NaCl 4ml/kg= 12 ml @ 3ml/hr over 4 hr

Next step:

Na deficit: $0.7 \times (135 - 118) \times 3 = 35.7$ mmol

½ of deficit = 17.8 mmol

Dailly requirement= $3 \times 3 = 9$ mmol

- Total Na to be given over 24 hr=17.8 + 9 = 26.8 mmol
- Amount of IV fluid in 24 hr= 450 ml
- Already given Na = 6 mmol over 4 hr.
- Remaining Na to be given over 20 hr = 26.8 – 6 = 20.8 mmol
- Amount of IV fluid in 20 hr= 375 ml
- 300 ml ½ NS + 75 ml ¼ NS = 23.1 + 2.85 = 25.9 mmol

Monitoring:

Serum sodium levels should be monitored every 12 to 24 hourly.

Hypernatremia: Serum sodium > 145 mmol/L is called hypernatremia.

Common causes of hypernatremia:

- Dehydration
- Excessive hypertonic fluid
- Renal cause

Treatment of hypernatremia

- Minimize trans epidermal fluid loss (humidify incubator, wrap baby in clothes or plastic)
- Exclude osmotic dieresis
- Stop added sodium
- Correction of hypernatremia

Correction of hypernatremia

- Restore intravascular volume (If shock):Normal saline 20 ml/Kg over 20 min (Repeat until intravascular volume restored)
- No features of shock:
  - ✓ Choice of fluid: D5 0.225 NS or D5 with ½ NS
  - ✓ Fluid rate : 1.25 to 1.5 times maintenance
  - ✓ Determine time for correction on basis of initial sodium concentration :

Sodium concentration	Time for correction
145- 157 mEq/L	24 hr
158- 170 mEq/L	48 hr
171- 183 mEq/L	72 hr
184- 196 mEq/L	84 hr

  - ✓ Replace ongoing losses as they occur
  - ✓ Monitor serum sodium every 12 – 24 hourly
- Following formula can also be used to manage hypernatremia
- Calculation of free water deficit (FWD) followed by calculation of replacement volume.
- $\text{FWD} = \frac{Current\ Na-145}{145} \times 0.6 \times weight$
- Replacement volume $= FWD \times \frac{154}{154-Conc\ of\ Na\ replacement\ fluid}$

Example:

- Newborn with weight 3 kg, Serum sodium 160 mmol/l
- FWD= $\frac{160}{145} \times 0.6 \times 3$
- Replacement volume to be given = $FWD \times \frac{154}{154\text{-}77}$ = 0.186×2

= 0.372L

[372ml of half strength normal saline to be given over desired duration]

Disorders of serum potassium

- Normal K level : 3.5 – 5.5 mmol/L
- **Hypokalemia :** When serum K is <3.5 mmol/L

Common causes of hypokalemia:

- Repeated suction (nasogastric)
- Vomiting
- Diarrhea
- Medication (diuretics, kayexalate, steroid, some antibiotics)

Correction of hypokalemia

K^+ deficit = (Required K – observed K) x body weight x 0.3 + maintenance (1-3 mmol/Kg /day)

Example:

A 15days old baby, weight 2 Kg, has serum K = 2 mmol/L

- K deficit = (3.5- 2) x 2 x 0.3= 0.9
- Maintenance = 2 x 2 Kg = 4 mmol/Kg/day
- Total requirement = 0.9+4 =4.9 mmol

As 1ml = 2mmol

So, around 2.5 ml inj. KCl can be given in 24 hours of IV fluid

Another way to remember:

If potassium is

- 3.5 to 2.5 mmol/l-- add 1ml/100ml fluid
- 2.5-2 mmol/l--- add 1.5 ml/100 ml of fluid
- <2 mmol/l ---2 ml/100 ml of fluid

- Monitor: Serum potassium level every 12-24 hourly

Hyperkalamia: If serum K^+ is > 6 mmol / L

Common causes of hyperkalemia:

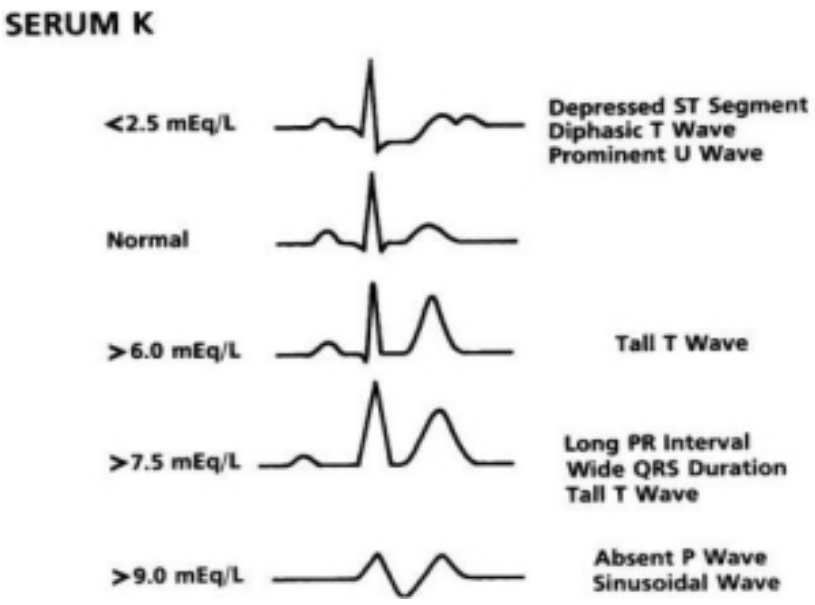
- Haemolysis (due to squeezing during blood collection)
- Small for gesgational age (SGA) babies, very low birth weight
- Respiratory distress syndrome (RDS), asphyxia, sepsis
- Acidosis (metabolic/ respiratory)
- Renal cause

Severity of hyperkalemia:

- Mild – Serum K 5.5 -6.5 mmol/L
- Moderate – Serum K 6.5 – 8 mmol/L
- Severe – Serum K >8 mmol/L

Clinical evaluation for Hyperkalemia:

- Heart rate
- ECG



How to manage?

1. Check Sampling error and recheck value by sending free flow of blood
2. Remove all sources of K^+
3. Following measures to be taken based on serum K^+
   - ✓ K+ up to 7 mEq / L → Kayexelate 1gm / kg at 0.5gm / ml of NS given as enema (up to 1- 3 cm) → minimum retention time = 30 min
   - ✓ K+ > 7 mEq / L
     - Ca – gluconate 1- 2ml / kg over 5 min ***or***
     - Sodium bi carbonate: 1 – 2ml / kg slowly ***or***
     - 2ml / kg of 10% DA + 0.05 units / kg regular insulin infusion ***or***
     - Kayexelate ***or***
     - Salbutamol Nebulisation 4mcg / kg
4. If above measure fails or K+ >8 mEq/L→
     - Peritoneal dialysis
     - Exchange transfusion

Disorder of Calcium

Normal Serum Calcium: 9-11 mg/dL or 2.25-2.65 mmol/L

Hypocalcemia: If serum calcium <7.0 mg / dl

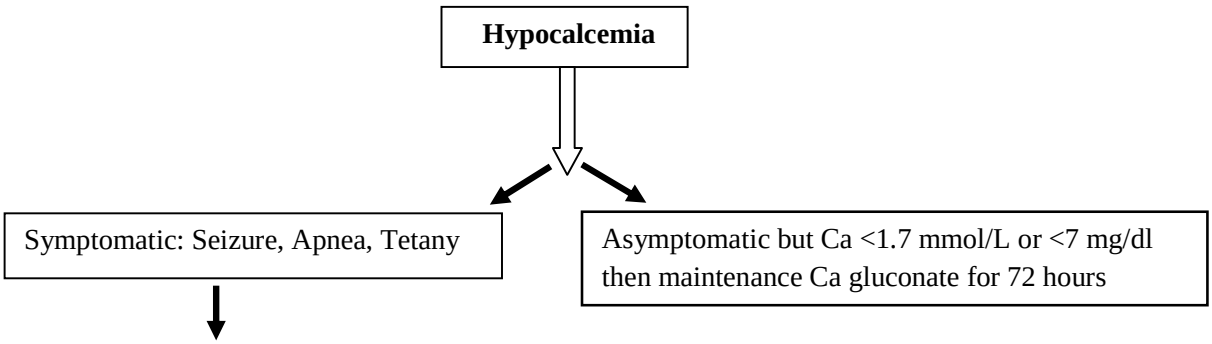
Common causes of hypocalcemia:

- Perinatal asphyxia
- Infant of diabetic mother
- Intrauterine growth restriction (IUGR)
- Sepsis
- Hypomagnesemia

Investigations:

- Serum Calcium
- ECG

Treatment of Hypocalcaemia:



1 – 2ml/Kg Inj.10% Ca-gluconate + 5% DA or NS (1:1 dilution) over 10 min slowly with cardiac monitoring.

↓

No response in 10min → ***REPEAT DOSE***

↓

Maintenance Ca → 6-8ml / kg / day, 8 hourly (48-72 hrs)

↓

Monitor serum Ca level, if normal stop supplementation. [If refractory despite adequate supplementation think of hypomagnesemia]

- ✓ Prophylactic Calcium supplementation: (In patients with increased risk of hypocalcemia) – preterm infants (≤32 weeks), Infant of diabetic mother, severe perinatal asphyxia should receive 4 ml/kg/day 10% Ca gluconate

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Respiratory distress in the newborn

Respiratory distress affects a significant percentage of newborn and is one of the most common causes of NICU admission. Appropriate management includes proper assessment of the infant for the cause, precise decision making about the need for the level of respiratory support and other supportive measures.

Definition: Respiratory distress is defined as presence of any two of the following features:

1. Respiratory rate >60/min
2. Subcostal/intercostal recession
3. Expiratory grunt/groaning.

- *Nasal flaring, suprasternal retraction, decreased air entry* on auscultation also indicates presence of respiratory distress
- Infants with advanced degree of respiratory distress may exhibit *cyanosis, gasping, choking, apnea, and stridor*

Causes:

- The most important factor determining the etiology of respiratory distress is gestational age (GA).
- *In preterm infant RDS being the most common cause (almost 90%) while in late preterm and term infant TTN is the predominant cause (68%).*
- Most common and clinically important causes of respiratory distress according to gestational age are:

Preterm Newborns	Term/Near term Newborns	Irrespective of gestational age
• Respiratory distress syndrome (RDS) • Delayed transition • Hypo/hyperthermia	• Transient tachypnea of the newborn (TTN) • Perinatal Asphyxia (PNA) • Meconium aspiration syndrome • **Congenital malformations**: Congenital diaphragmatic hernia, Trache-oesophageal fistula, Cystic adenomatoid malformation • Persistent pulmonary hypertension of the newborn (PPHN)	• pneumonia, sepsis • Pneumothorax • Congenital heart diseases • Hypoglycemia • Acidosis, Inborn metabolic error • Meningitis, Seizure • Anemia, Polycythemia. • maternal sedation, narcotic withdrawal

Approach to a newborn with respiratory distress:

- ✓ Quick initial assessment for life threatening condition which require immediate management is mandatory
- ✓ Following are the signs of different life threatening condition:

.

Airway obstruction	Insufficient breathing	Circulatory collapse	Poor oxygenation
• Gasping • Choking • Sridor	• Apnea • Poor respiratory effort	• Bradycardia • Hypotension • Poor perfusion	Cyanosis

- ✓ Initial stabilization through management of the airway, breathing, and circulation, is crucial than to find out underlying cause.
- ✓ After initial stabilization, relevant history should be taken which will be guided by gestational age and postnatal age of onset of respiratory distress.
- ✓ All dyspneic newborn babies, should have appropriate blood C/S taken and be treated with antibiotic from the earliest sign of respiratory illness.

Relevant history in a newborn with Respiratory distress:

Antenatal	Natal	Post natal
• Fever / Urinary Tract Infection (UTI) • Diabetes mellitus • Poly/oligohydramnions • Ante partum hemorrhage • Fetal assessment (ultrasonography, biophysical profile) • Rh iso-immunization • Antenatal corticosteroids • Drug abuse • H/O consanguinity • H/O pregnancy loss/ neonatal death	• PPROM/PROM • Chorioamnionitis/fever • Meconium stained fluid • Abnormal fetal monitoring • Birth trauma • Detail of resuscitation	• Gestational age • Postnatal age • Onset • Course of distress • Chocking and coughing during feeding • Malfeeding

Physical examination:

Simple inspection can give a lot of clues.

- ❖ **Look for**
  - o Signs of prematurity
  - o Features of IUGR
  - o Meconium staining
  - o Dysmorphic face
  - o Scaphoid abdomen

- **Vital sign/hemodynamic stability:** Temperature, pulse, respiratory rate, blood pressure, capillary refill time (CRT)
- **Oxygen saturation- Both preductal and postductal.**
- **Respiratory system examination :**

Inspection:

- Respiratory rate
- Asymmetry of chest shape/ movement,
- Features of respiratory distress- Nasal flaring , Chest retractions- (suprasternal, intercostal subcostal and xiphoid area), Grunting, Cyanosis

Auscultation:

- Air entry
- Breath sound,
- Added sounds such as crepitation

Transillumination test: When there is suspicion of pneumothorax.

Precordium should also be examined to document any murmur and/or heart failure

Laboratory Evaluation for Respiratory Distress in the Newborn: Guided by history and examination findings.

- Chest radiography
- Arterial blood gas
- Blood glucose
- Complete blood count with differentials
- Blood culture
- Lumbar puncture
- Echocardiography and CT of thorax

Common causes of respiratory distress in neonate:

Condition	Risk Factors	Clinical course	Radiological features
Respiratory distress syndrome (RDS)	• Prematurity (usually <34 weeks) • Lack of antenatal steroids • Infant of Diabetic mother • Birth asphyxia • Rh isoimmunization	• Onset at or soon after birth • Progresses till 48 hours, static for 48 hrs and improves later. • FiO_2 requirement often more than 40% • Surfactant modifies the typical course	• Low volume lungs • Fine reticulo-granular pattern • Ground glass appearance • Air Bronchograms • White-out lungs
Transient tachypnea of Newborn (TTN)	• Predominantly late preterm and term infants • Born by Caesarean section • Maternal diabetes	• Onset at or soon after birth • Maximum severity at birth and improves gradually • FiO_2 requirement seldom more than 40%	• Hyperinflated lungs • Perihilar sreaking • Fluid in minor fissure • Pleural effusion • Mild cardiomegaly
Early onset sepsis (EOS)/ pneumonia	Risk factors such as PROM, chorioamnionitis, maternal fever, unclean vaginal examinations	• Onset at birth or delayed • May fail to improve with oxygen/ CPAP	Homogeneous/ Non-homogeneous opacities bilaterally in Chest Xray
Meconium aspiration syndrome (MAS)	Meconium stained amniotic fluid	• Onset may be at birth or delayed • Meconium staining of cord/ skin • Hyperinflated chest • Features of PPHN	• Hyperinflated lungs • Coarse nodular opacities • Patchy atelactasis • Areas of overinflation

Treatment: Basic principles of treatments are:

A) Supportive care
B) Respiratory care
C) Specific therapy
D) Monitoring for and
E) Management of complications

A) Supportive care:

- Thermal care
- Management of fluid, electrolyte and nutrition
- Maintenance of adequate haemoglobin
- Monitoring vital signs and

- **Scoring the severity of respiratory distress:** The severity of respiratory distress is assessed by Silverman Score and Downes' Score. While the Silverman Score is more suited for preterms with RDS, the Downes' Score is more comprehensive and can be applied to any gestational age and condition. Scoring should be done at half hourly intervals and a chart should be maintained.

Silverman score:

Feature	Score 0	Score 1	Score 2
Upper chest movement	None	Respiratory lag	See-Saw respiration
Lower chest retraction	None	Minimal	Marked
Xiphoid retractions	None	Minimal	Marked
Nasal flaring	None	Minimal	Marked
Grunting	None	Audible with stethoscope	Audible without stethoscope

The higher the score, more severe is the respiratory distress. Score ≥ 4 indicate clinical respiratory distress, monitoring and ABG should be done and Score >7 indicate respiratory failure.

Downe's score:

Feature	Score 0	Score 1	Score 2
Cyanosis	None	In room air	In 40% FiO2
Retractions	None	Mild	Severe
Grunting	None	Audible with stethoscope	Audible without stethoscope
Air entry	Normal	Decreased	Barely audible
Respiratory rate	<60	60--□80	>80 or apnea

Score: > 4 = Clinical respiratory distress- monitor arterial blood gases
> 7= Impending respiratory failure

B) Respiratory support:

- The objective is to ensure adequate oxygenation and ventilation and thereby decrease work of breathing.

Respiratory support can be provided through

- ❖ Supplemental oxygen – Warm, humidified oxygen should be is given preferably with a FiO_2 meter and pulse oximeter monitoring if possible.
- ❖ Continuous Positive Airway Pressure (CPAP)-
  Indications for starting CPAP are –
  - Failure to maintain adequate oxygenation and ventilation on supplemental oxygen.

- Significant respiratory distress with Silverman or Downe's score >4.
- A FiO2 requirement of >0.4 to maintain an acceptable saturation.

❖ Mechanical ventilation- Indications for mechanical ventilation are-

- Failed CPAP
- Impending respiratory failure.

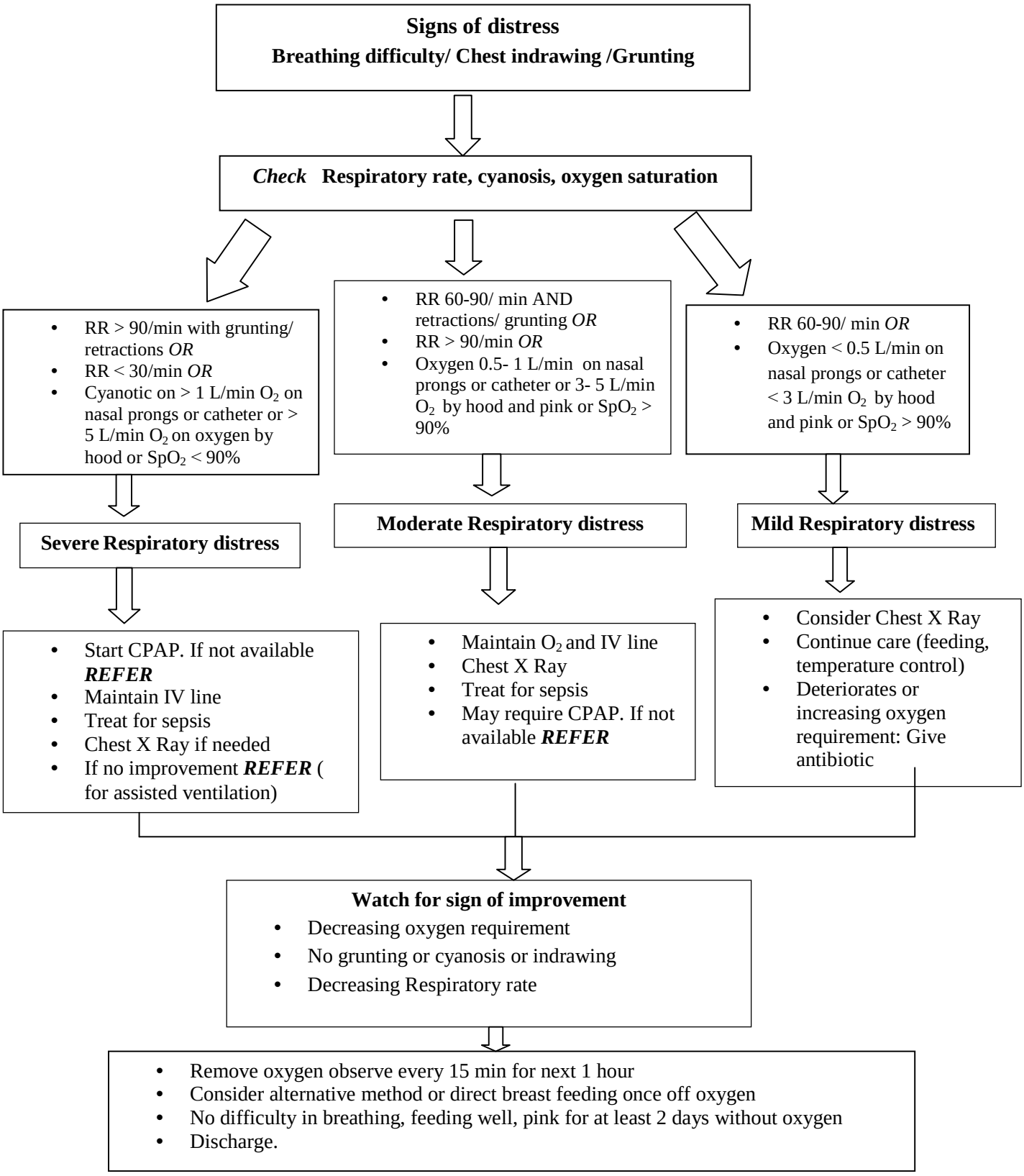
C) Specific therapy: According to the underlying cause-

- Respiratory distress syndrome(RDS) – Surfactant replacement therapy
- Early onset sepsis (EOS)/pneumonia –Parenteral antibiotics
- Lung malformation –Surgical resection

D) Monitoring for and management of complications

- Worsening of distress and impending respiratory failure
- Hemodynamic instability
- Hypoxia related complications like AKI, Convulsions etc.
- Features of PPHN
- Complications of mechanical ventilation

Management of breathing difficulty in newborn



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Surfactant Therapy

Surfactant is a surface tension lowering agent composed of substances including phospholipid, neutral lipid and protein secreted from type II alveolar pneumocyte.

Indication of surfactant therapy:

Primary indication: RDS

Other indication: Pneumonia

MAS

PPHN

Pulmonary hemorrhage

ARDS

Congenital diaphragmatic hernia

Time of administration:

- Prophylactic: Given within 15 min

  Indication: Gestational age < 26 week

  PT babies with RDS who need delivery room intubation.
- Early rescue: Given within 2 hours.

  Indication: FiO2 requirement >0.4 on CPAP

  Need for M/V.
- Late rescue: Given after 2 hours.

Dosage and administration:

- Trade name: Survanta
- Active ingredient: Beractant
- Source: Bovine lung extract.
- Dose: 4 ml/kg in 3 alliquots.
- Method: INSURE (Intubaton, Surfactant administration and extubation to CPAP)

Complication of surfactant therapy:

- Pulmonary hemorrhage
- Pulmonary air leak
- PDA

CPAP

CPAP refers to application of positive pressure to airway of a spontaneously breathing infant throughout the respiratory cycle.

Indication:

ABG Criteria:

FiO2 requirement > 0.40 to maintain PaO2 >50 mm of Hg

Clinical Condition:

- RDS
- Repeated apnea
- Post extubation
- Laryngo/tracheomalacia
- Pneumonia
- MAS
- TTN
- PDA
- Pulmonary haemorrhage/ edma

Application of CPAP:

- Starting pressure: Depends on clinical condition
  - ✓ RDS: 6-7 cm of H2O
  - ✓ AOP: 4-5 cm of H2O
- Then increase pressure @ 1 cm of H2O at 15-20 min interval based on saturation (target Spo2 90-95%)

  Max. pressure :

  - ✓ Preterm - 8 cm of H2O
  - ✓ Term – 9 cm of H2O
- Then increase FiO2 @ 0.05- 0.1 upto max. 0.6. Do not increase FiO2 before increasing pressure.

Monitoring:

- Clinical status:
  - ✓ R/R
  - ✓ Signs of respiratory distress: retraction, grunting, nasal flaring
  - ✓ Downe's score
  - ✓ SPO2
- Chest X Ray: To see the chest expansion.
- ABG: 30 min after application or any set up change.

Optimum CPAP:

- Clinical: Decrease in R/R, signs of respiratory distress, Downe's score.
  SPO2: 90 -95%
- Chest X Ray: Optimum Chest Expansion: 7-8 ICS above diaphragm.
- ABG: PaO2- 60-80 mm of Hg
  PaCO2- 40-45 mm of Hg
  PH- 7.30-7.40

CPAP failure:

- Presence of retraction/grunt
- Apnea >3episode/hr or 1 episode needing bag mask ventilation
- ABG: PaO2 < 50 mm of Hg on FiO2 ≥ 0.6
  PaCO2 >60 or pH <7.25

Causes of CPAP failure:

- Delay in initiating CPAP
- Very severe RDS
- Other co-morbidities
- Very severe extra-pulmonary shunt

Weaning criteria:

- Maintaining blood gas and SPO2 at a low set-up (pressure 4 cm of H20 and FiO2 0.21-0.30)
- Apnea free for > 24 hr

Contraindication of CPAP:

- Congenital diaphragmatic hernia
- Choanal atresia
- Cleft palate
- Tracheo – oesophagial fistula
- NEC
- IVH grade 3 or 4

Side effects:

- Nasal trauma, disfiguration
- Infection
- Abdominal distension (CPAP belley)
- Air leak
- IVH
- Hypoperfusion (if high pressure is used)

Mechanical Ventilation in the Newborn

Indication

a) Absolute indications

- Sudden collapse with apnoea, bradycardia & failure to establish satisfactory ventilation after a short period of bag mask ventilation.
- Failure to establish adequate spontaneous ventilation in the labour ward after prompt and active resuscitation
- Prolonged apnoea
- PaO2 below 50 mm of Hg or FiO2 above 0.80. This indication may not apply to the infant with cyanotic congenital heart disease.
- Paco2 above 60 mm Hg with persistent academia.
- Congenital Diaphragmatic Hernia

b) Relative indications

- Administration of surfactant therapy in infants with RDS.
- Frequent intermittent apnoea unresponsive to drug therapy.
- Early intervention with mechanical ventilation when ABG is deteriorating.
- Relieving "increasing work of breathing" in an infant with signs of moderate to severe respiratory distress.

Basics of ventilator modes

Mode	Features	Benefits	Disadvantage	Target
Assist control(AC)	Each breath is pressure supported	Work of breathing (WOB) is lower	Dysynchrony possible during inspiratory phase if patients i-time do not match vent	Patient who exhibit signs of raised WOB on non vent supported breaths (eg: SIMV)
Synchronized intermittent mandatory ventilation (SIMV)	Ventilator will deliver a breath in response to patient trigger or will deliver a mandatory breath if no trigger is sensed	Patient can breath spontaneously between set vent breaths	WOB increased for patients breathing at rates above fixed rate. Spontaneous breaths non vent supported	It may be the preferable mode in infants who are breathing spontaneously on IMV
IMV/CMV	Breaths are delivered at set interval without regard to patient effort		Non synchronized mode of ventilation	Majority of transport ventilators use this mode due to technical limitations

Selection of ventilation mode

- When the patient is first intubated or during periods of instability A/C mode is customarily utilized because it provide maximal ventilatory assistance.
- When the patient is being evaluated for removal of machine support, pressure support ventilation, SIMV, CPAP or combination of these modes are employed.

Initial conventional M/V settings

Parameters	Normal lungs*	Diseased lungs
PIP	15	18-20
PEEP	3	3
Rate	20-30	40-60
Inspiratory time	0.35-0.4	0.3-0.4
FiO2	0.21-0.3	0.6-0.8

* Congenital myopathy, fractured cervical spine, severe neurological depression due to birth asphyxia, drugs or preterm babies with recurrent apnoea.

Ventilator setting in various diseases

Disease	PIP cm H2O	PEEP cm H2O	I:E (T_I)	VR
RDS	18-20	4-5	1:2(0.4-0.5)	40-50
MAS	15-20	0-3	1:3(0.2-0.3)	40-60
Pneumonia	15-25	3-5	1:2(0.3-0.4)	30-40
Apnea	10-18	3-4	1:1(0.5)	30-40
CLD	16-18	7-8	(0.4-0.5)	<20
Air leak	15-25	0-2	1:2 to 1:3	50-60
Perinatal asphyxia	16-18	3-4	1:1.5	30-40
Post operative	15-20	4-6	1:1.5	20-30

Desired ABG ranges while the newborn is on mechanical ventilator

Parameter	Preterm	Term
pH	7.25-7.35	7.35-7.45
PaCO2	45-59 mm Hg	35-50 mm Hg
PaO2	50-70 mm Hg	60-80 mm Hg
Saturation	88-92%	92-97%

Adjustments to ventilator settings on the basis of blood gas changes

Low Pao_2	High $Paco_2$	Increase peak pressure, which will also increase mean airway pressure: in spontaneously breathing babies ↑ rates may also work
Low Pao_2	Normal $Paco_2$	↑ F_Io_2; ↑ MAP but maintain PIP (i.e. ↑ PEEP or ↑ T_I)
Low Pao_2	Low $Paco_2$	Consider alternative diagnosis, e.g. PPHN, sepsis, overventilation. ↑ F_Io_2; ↑ MAP; use vasodilators
Pao_2 normal	High $Paco_2$	↓ PEEP, ↑ rate; keep MAP constant
Pao_2 normal	Low $Paco_2$	↓ rate: maintain MAP
Pao_2 high	$Paco_2$ high	Rare: check for mechanical problems, e.g. blocked tube, ↓ PEEP, ↓ T_I: ↑ rate ↓ F_Io_2
Pao_2 high	$Paco_2$ normal	↓ MAP (usually ↓ PIP): ↓ F_Io_2
Pao_2 high	$Paco_2$ low	↓ pressure, ↓ rate, ↓ F_Io_2 (see text)
Pao_2 normal	$Paco_2$ normal	Sit tight! Unless plan to wean

Clinical and laboratory indices of adequate ventilation

Clinical parameters

Color (pink)
Adequate chest expansion
Absence of retractions
Adequate air entry
Prompt refilling of capillaries
Normal blood pressure

Pulse oximetry

Oxygen saturation 90-95%

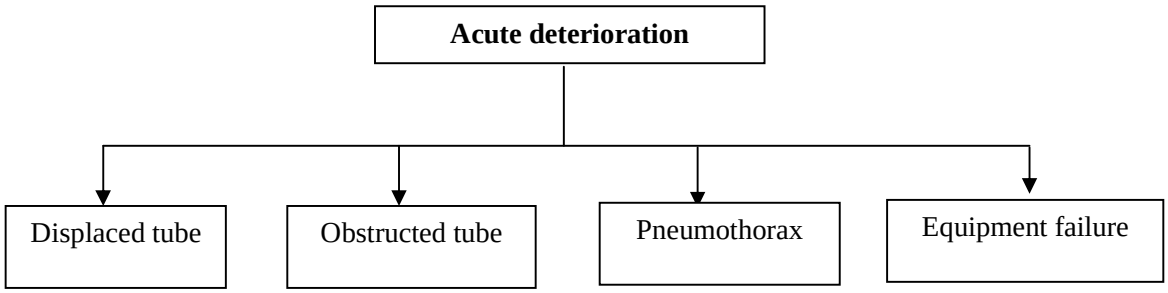
Blood gasses

PH: 7.35-7.45
PaCO2: 40-50(in chronic case upto 60 mm of Hg)
PaO2: 50-80 mm of Hg

Deterioration in the mechanical ventilation

Anytime the infant suddenly deteriorates, remove from ventilator, and stabilize by bag and musk ventilation.

Acute deterioration: consider "DOPE" & large GMH/IVH



Gradual deterioration:

- Respiratory distress syndrome (RDS) who have not received surfactant
- Development of pneumonia
- Intraventricular hemorrhage (IVH may cause acute deterioration)
- Anaemia
- Hypotension
- Air leak or pulmonary edema
- Progression of Bronchopulmonary dysplasia (BPD)
- Partial blockage of endotracheal tube (ETT)

Care of babies on ventilator

Arterial Blood gas analysis (ABG): Arterial blood gas analysis should be done

- 12 hourly
- Following deterioration
- Following change in ventilator setting (preferably after 30-60 minutes of change)

Suctioning:

- The technique of ETT suction must allow oxygen administration throughout the procedure.
- Suction should be discontinued if the baby becomes bradycardic or SpO2 below 80%.
- Inserting the suction catheter until a resistance is felt (when the catheter hits the carina) should be avoided.
- For lubrication the smallest amount of fluid, 0.3–0.5 ml, should be used.

Sedation:

When agitation or distress is associated with excessive liability of oxygenation and hypoxia

- Morphin (0.05-0.1 mg/kg) or fentanyl (1-3 µG/kg),
- Midazolam (0.05-0.1mg/kg/dose every 2-4 hours) in more mature infants.
- Non pharmacological methods: limiting environmental light & noise & providing behavioral supports may help decrease agitation.

Physiotherapy in ventilated neonates:

Indications:

- Pneumonia and increased secretions
- Meconium aspiration

Contraindication:

- Very low birth weight (VLBW) babies.
- Respiratory distress syndrome (RDS)

Posture:

- Should be changed 2–3-hourly from the back to the right and then the left side.
- The prone position (except in babies with UACs) with the baby's head turned to one side should also be used, since this will facilitate drainage of secretions and improvement of blood gases

Weaning strategy

- Assess weaning readiness:
    - Satisfactory ABG: Paco2 40-50mm Hg, pH >7.25
    - Baby has been stable at these levels for 6 hours & breathing spontaneously.
- Settings should be reduced in small increments in every 4-6 hours:
    - PIP: 2-3 cm H2O
    - Fio2: 5-10%
    - PEEP: 1 cm H2O
    - Rate: 5-10 breaths / min
    - I time: 0.3- 0.4 seconds
- PIP should be reduced first down to 25 mm of H2O. Then FiO2 decrease < 0.6.Then PIP and FiO2 decrease simultaneously.
- After each change, it is important to check the blood gases every 30-60 minutes.
- A CXR should be done prior to extubation

- Ensure the pre extubation medications when indicated
    - ✓ In babies <1.5 kg and <32 weeks of gestational age, aminophylline should be adminstered at least 12 hours prior to extubation.[1]
    - ✓ Inj. Dexamethasone 0.25 mg/ kg/ dose every 12 hours starting 8-12 hours before the next extubation to prevent post extubation airway edema.
- Readiness of extubation
    - Neonate is in <30% oxygen
    - PIP: 10-16 cm H2O
    - Rate: <10-20 bpm
    - Normal electrolytes
    - Haemoglobin >13 gm/dl
    - Feeding should be discontinued 6-12 hours before extubation & not started for a further 12 hours.
- Infants with a birthweight less than 1000 gm should be extubated on to nCPAP rather than directly into supplementary oxygen delivered into a headbox.
- If nCPAP is used, after 24–48 hours the baby should then be nursed in a headbox in the same inspired oxygen concentration
- Restart nCPAP if the baby develops apnoeas or shows signs of increasing respiratory distress.
- neonates <1000 gm birthweight, the later stages of weaning may take weeks.
- In babies >1500 gm birth weight, weaning can often be rapid, over a period of 12–24 hours, with no need for prolonged periods on nCPAP.
- Supplemental O2 can be given by hood or by nasal cannula. The O2 concentration should be increased by >5% over the last O2 level obtained while the baby was on the ventilator.

Complications of mechanical ventilation

- **Endotracheal Tube Complications:** Dislodgment, Obstruction, Accidental extubation, Airway erosion
- **Airway Injury:** Tracheal inflammation, Tracheobronchomalacia, Subglotic stenosis, Granuloma formation, Palatal grooving, Nasal septal injury, Vocal cord damage, Necrotizing tracheobronchitis
- **Air Leaks:** Pulmonary interstitial emphysema (PIE), Pneumothorax, Pneumomediastinum, Pneumopericardium , Pneumoperitoneum , Air embolism syndrome
- **Chronic Lung Injury:** Bronchopulmonary dysplasia (BPD), Acquired lobar emphysema
- **Cardiovascular:** Decreased cardiac output, Patent ductus arteriosus (PDA)

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Neonatal Sepsis

Neonatal sepsis is a clinical syndrome characterized by signs and symptoms of infection with or without accompanying bacteremia in the first month of life. It encompasses various systemic infections of the newborn such as septicemia, meningitis, pneumonia, arthritis, osteomyelitis, and urinary tract infections.

Classification of neonatal sepsis

Two major categories:

1) Early onset sepsis (EOS)
2) Late onset sepsis (LOS)

1) Early onset sepsis (EOS):

- It presents within the first 72 hours of life.
- The neonate may be symptomatic at birth
- Usually present with respiratory distress and pneumonia.
- The source of infection is generally the maternal genital tract

Risk factors for EOS:

- Low birth weight (<2500 grams) or prematurity
- Febrile illness in the mother with evidence of bacterial infection within 2 weeks prior to delivery
- Foul smelling and/or meconium stained liquor
- Rupture of membranes >18 hours
- Single unclean or > 3 sterile vaginal examination(s) during labor
- Prolonged labor (sum of 1st and 2nd stage of labor > 24 hrs)
- Perinatal asphyxia (Apgar score <4 at 1 minute)

2) Late onset sepsis (LOS):

- It usually presents after 72 hours of age.
- The source of infection in LOS is either nosocomial (hospital-acquired) or community-acquired
- Neonates usually present with septicemia, pneumonia or meningitis.

Clinical features:

Neonates with sepsis may present with one or more of the following symptoms and signs:

- Hypothermia or fever (former is more common in preterm low birth weight infants)
- Lethargy, poor cry, refusal to suck
- Poor perfusion, prolonged capillary refill time
- Hypotonia, absent neonatal reflexes
- Brady/tachycardia
- Respiratory distress, apnea and gasping respiration
- Hypo/hyperglycemia
- Bleeding, petechie, purpura
- Irritability, high pitch cry, seizure
- Vomiting, abdominal distension
- Multiple pustules, abscess, sclerema, mottling, umbilical redness and discharge

The clinical presentation of sepsis may be silent and therefore a high index of suspicion is mandatory to make an early diagnosis

Investigations:

1. Hematological parameter:

a. Septic screen: If 2(or more) parameters are abnormal, it should be considered as positive screen.

A practical sepsis screen

Components	Abnormal value
Total leukocyte count	<5000/mm^3; >25000/ mm^3
Absolute neutrophil count(ANC)	Low counts <1500/mm^3
Immature/total neutrophil(IT ratio)	>0.2
Micro-ESR	>15 mm in 1st hour
C reactive protein (CRP)	≥ 6 mg/L **

***Cut off value can differ in different laboratory.*

b. Peripheral Blood film: Presence of toxic granules is supporting evidence of sepsis.

c. Platelet count: Platelet count may be low in septic neonate.

2. Culture:

a. Blood culture: It is the gold standard for diagnosis of septicemia and should be performed in all cases of suspected sepsis prior to starting antibiotics.

b. Urine culture: Not indicated routinely.

Indication: In late onset sepsis, at risk for fungal sepsis, with urogenital malformation or vesicoureteral reflux, suspected of UTI (crying during micturition)

c. Cerebrospinal fluid (CSF) culture.

d. Culture of any other body fluid or discharge.

2. **CSF study; if indicated-**

In EOS:

- Convulsion
- Positive blood culture
- Laboratory data strongly suggestive of sepsis

In LOS:

- In all infants prior to starting antibiotic.

Normal CSF values in Neonates

CSF Components	**Normal range**
Cells/mm3	8 (0-30 cells)
PMN (%)	60%
CSF protein (mg/dl)	90 (20-170)
CSF glucose (mg/dl)	52 (34-119)
CSF/ blood glucose (%)	51(44-248)

** The concentration of glucose is not significantly altered by traumatic LP. Therefore a low CSF glucose in the setting of traumatic LP is abnormal.

Supportive Investigations:

- Random blood sugar
- Serum electrolytes
- Serum creatinine
- Coagulation profile
- Arterial Blood Gas analysis

5. Radiology:

Chest x-ray - in the presence of respiratory distress or apnea

Abdominal x-ray – In suspected necrotizing enterocolitis (NEC)

USG of Brain and computed tomography (CT scan) - in selected cases

Management:

1. Supportive:
    - Thermal care
    - Maintenance of oxygen saturation
    - Maintenance of adequate nutrition
    - Maintenance of glycemic status
    - Maintenance of tissue perfusion and blood pressure
    - Blood and blood product transfusion if indicated

2. Specific: Antimicrobial therapy.

Indications for starting antibiotics:

(a) Presence of foul smelling liquor

(b) Presence of 2 antenatal risk factor(s)

(c) Strong clinical suspicion of sepsis

(d) Positive septic screen

Choice of antibiotics:

Antibiotics	
1st Line	Ampicillin + Gentamicin
2nd Line	Ceftazidime + Amikacin
3rd Line (Reserve)	Meropenem, Ciprofloxacin, Vancomycin, Cefepime, Clarithromycin, Netilmicin, Imipenem, Piperacillin+ Tazobactum, Colistin
In case of suspected meningitis	Cefotaxim + Amikacin ***or*** Meropenem + Amikacin

Duration of Antibiotic therapy:

Diagnosis	Duration
Risk factor positive (clinically well, culture negative, screen negative)	2-3 days
Risk factor positive, screen positive (clinically well, culture negative)	5-7 days
Clinically sepsis (screen negative)	7 days
Clinically sepsis, screen positive (Culture negative)	7-10 days
Blood culture positive (no meningitis)	14 days
Meningitis (with or without positive blood/CSF culture)	21 days

3. Adjuvant therapy;

i. Fresh blood transfusion

ii. FFP transfusion

iii. Exchange transfusion

iv. IVIG

v. Colony stimulating factor.

Key Messages

- In suspected sepsis, after sending sepsis screening and blood culture, 1st line intravenous antibiotics should be started without delay.
- Antibiotics once started, should be modified according to sensitivity report.
- If no response is seen within 48–72 hours of starting treatment, repeat blood C/S and change antibiotic therapy with appropriate choice and duration.
- LP should be repeated in meningitis to assess for response to therapy.
- Consider vancomycin if MRSA is suspected
- Consider antifungal in invasive fungal sepsis & in case of prolonged use of broad spectrum antibiotics.

Follow Up and monitoring:

Clinical	Laboratory
• Tone and activities • Irritability and responsiveness • Vital signs • Capillary refill time (CRT) • Fontanel, OFC • Respiratory status including SPO_2 • Skin: Mottling, Bleeding manifestation • Abdomen: distension, bowel sound, hepatosplenomegaly, Gastric residual • Urine output: daily • Monitor weight: daily • Capillary blood glucose (CBG)	• Serum Electrolytes • Serum Creatinine • Complete Blood Count • ABG

Signs of deterioration:

- Respiratory failure requiring mechanical ventilation
- Shock- not responding to therapy
- Persistent or refractory convulsion
- Development of disseminated intravascular coagulation (DIC)

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Neonatal Hyperbilirubinemia

Hyperbilirubinemia is a common problem in neonates with an incidence of 70-80%. About 5-10% of them have clinically significant jaundice that requires treatment. Severe hyperbilirubinemia (serum total bilirubin level >20 mg/dL) can lead to acute bilirubin encephalopathy (ABE). If not treated immediately, they might go on to develop kernicterus, a chronic, neurologically devastating condition resulting from bilirubin toxicity.

Physiological jaundice

- Jaundice appears second day onward
- Bilirubin level rises slowly
- Level rarely goes above 15 mg/dl
- Baby remains otherwise healthy
- Jaundice clears spontaneously within 7-10 days
- Stool color is normal

Pathological jaundice

- Jaundice appeared on the first day of life
- Jaundice extend up to palm & sole
- Jaundice with any sign of sepsis/ in sick neonate.
- Rate of rise in serum bilirubin levels over 0.5mg/dl/hour or 10mg/dl/day.
- Jaundice lasting longer than 14 days in term & 21 days in preterm
- Jaundice with pale stool

Neonates at higher risk of developing significant jaundice

- Setting of Blood group incompatibility (Baby of Rh negative or type O mother)
- Preterm infant
- Previous sibling receiving phototherapy
- Concealed hemorrhage (Cephalohaematoma) or extensive bruising
- Failure of exclusive breastfeeding
- Weight loss >3% per day

Timing of follow-up for hyperbilirubinemia after discharge

Scenario	Age at discharge	Follow-up
None of risk factors present	24-72 h >72 h	48 h after discharge Follow-up optional
Any risk factor present	24-48 h 49-120 h	24 h after discharge 48 h after discharge

Approach to a newborn with hyperbilirubinemia

History

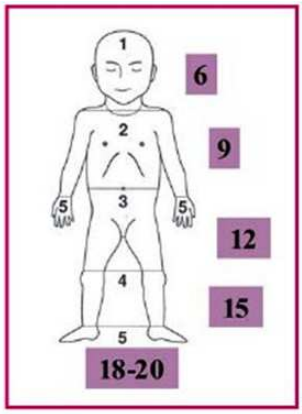
- Age of onset of jaundice
- Gestational age, Birth weight
- Mother's blood group, Baby's blood group, Father's blood group
- Feeding: mode of feeding, amount and frequency
- Stools: number in last 24 hr, Stools (meconium, transitional stools, normal stools)
- Urine: number in last 24 hr
- Antenatal history: Maternal TORCH infection, Hypothyroidism, Diabetes Mellitus
- Natal history: Maternal fever, h/o PROM, APGAR score, Baby with features of sepsis
- Family history: siblings requiring treatment for neonatal jaundice
- History suggestive of acute encephalopathy: hypertonia, retrocollis, opisthotonus, high pitched cry, fever, convulsion

Examination

- Estimate jaundice level by visual estimation
- General: anemia, temperature, hydration status, activity
- Systemic: Hepatosplenomegaly
- Calculate percentage of weight loss from birth weight
- Neurological examination (tone, primitive reflex)
- Presence of concealed hemorrhage (cephalhaematoma), hepatosplenomegaly

Guide to dermal staining with level of bilirubin (Modified from Kramer's original article)

Area of body	Level of bilirubin
Face	4-6 mg/dl
Chest, upper abdomen	8-10 mg/dl
Lower abdomen, thighs	12-14 mg/dl
Arms, lower legs	15-18 mg/dl
Palms, soles	≥ 20 mg/dl



Transcutaneous bilirubinometry (TcB)

Transcutaneous bilirubin (TcB) has a linear correlation to TSB and may be useful as a screening device to detect clinically significant jaundice and decrease the need for frequent TSB determinations. TcB is done only in infants with ≥ 35 weeks and before initiation of phototherapy.

Indication of Transcutaneous bilirubin (TcB)

- Jaundice is identified in first 24 hours of life
- Jaundice appears excessive for the infant's age
- There is any doubt about the degree of jaundice

Indication of Total Serum Bilirubin (TSB) measurement

- Clinically significant jaundice
- TcB assessment is within 2-3 mg/dL or 80% of age-specific threshold for starting PT.
- During phototherapy, for monitoring progress and after phototherapy to check for rebound.

Investigations

- Serum bilirubin
- If phototherapy is required:
  - ABO/Rhesus blood group of baby and mother
  - Complete blood count, Peripheral blood film
  - Reticulocyte count
  - Direct Coombs' test
- If TSB within exchange level:
  - Previous all investigation ***PLUS***
  - Serum albumin
  - Electrolytes, Creatinine
  - Cross match (baby and mother's blood) and screening
- If history and examination suggests sepsis, investigate accordingly

Treatment

Selection of phototherapy unit

i) Single phototherapy: standard practice
ii) Double phototherapy:
- If phototherapy is required at age ≤ 24 hr
- Serum bilirubin rising while on single phototherapy
- Serum bilirubin levels more than 3 mg/dl above phototherapy starting value or serum bilirubin more than 18 mg/dl

Timing of repeat SB measurements while undergoing phototherapy

- After initiation of phototherapy, serum bilirubin should be done after 6 hours of therapy to check the functional efficacy of the phototherapy and whether the bilirubin level is further rising or not.
- If the bilirubin trend is decreasing repeat after 24 hours.

When to stop phototherapy?

- Stop after minimum of 24 hours administered
- Level has fallen below 3 mg/dl lower than the phototherapy threshold for that postnatal age

Indication of repeat Serum bilirubin for rebound jaundice

Jaundice due to hemolysis, early onset of jaundice and discontinuation of phototherapy before 72 hrs, Initial Serum bilirubin close to exchange transfusion levels

- Repeat bilirubin 24 hours after completion of phototherapy
- It is possible to discharge and schedule outpatient visit next day to avoid unnecessarily prolonging hospital stay

Care during phototherapy

- Protect the eyes from light using eye patches once the lights are on
- Keep baby naked with a small nappy to cover the genitalia
- Place the baby around 20-30 cm from the lights or as per manufacturers' instructions
- Encourage frequent breast feeding. No need to supplement breastfeeding with any other type of feed or fluids
- Temporary interruptions for breast feeding or procedures are allowed, but not for oro-gastric feeding or for IV fluids
- Increase fluid intake by 10 % (single phototherapy), and 20 % (double phototherapy)
- Monitor for and ensure urinary frequency 6-8 times /day
- Monitor temperature 4 hourly and weight every 24 hours

Failure of phototherapy

Inability to observe a decline in bilirubin of 1-2 mg/dl after 4-6 hours

Indications for Exchange transfusion

- Serum bilirubin in exchange level.
- Phototherapy fails to prevent a rise in bilirubin to toxic level
- Infant has signs of acute bilirubin encephalopathy
- In hemolytic disease of newborn-antenatal rising antibody titer & previous sib death due to hyperbilirubinemia

Timing of repeat serum bilirubin (SB) measurements if exchange transfusion is done

- After exchange transfusion, serum bilirubin should be done immediately after the procedure and 6 hourly thereafter until bilirubin level is static or there is no further rising.
- If the bilirubin trend is decreasing repeat after 24 hours.

Type and volume of blood for exchange transfusion

Condition	Type of blood
Rh isoimmunization	Rh negative and blood group 'O' or that of baby Suspended in AB plasma Cross matched with baby's and mother's blood
ABO incompatibility	Baby's Rh type and blood group 'O' Suspended in AB plasma Cross matched with baby's and mother's blood
Other conditions (Sepsis, Prematurity, G6PD deficiency, non-hemolytic, other isoimmune hemolytic jaundice)	Baby's group and Rh type Cross matched with baby's and mother's blood

 Volume of blood: Twice the blood volume of baby (85 ml x 2)X body weight in kg
 To prepare blood for Double Volume Exchange Transfusion (DVET), mix two thirds of packed cells and one-third of plasma

Follow up plan

It is recommended that all neonates with hyperbilirubinemia (peak Serum bilirubin > 20 mg/dl) or where there was a need for blood exchange transfusion should be followed up and screened for Sensory Neural Hearing Loss and abnormalities of tone, posture and movements.

- Hearing screening should preferably be conducted before 3 months of age by BAER as oto-acoustic emission (OAE) may be normal in some cases.
- Clinical examination for motor dysfunction should be conducted at 3, 6, 9, 12 and 18-24 months of age.

Chart for Transcutaneous bilirubin (TcB) when to send total serum bilirubin(SB)

Age in hour	Low risk SB (TcB) in µmol/ L	Medium risk SB (TcB) in µmol/ L
18- 24	150 (135)	130 (117)
25- 28	160 (144)	130 (117)
29- 32	170 (153)	140 (126)
33- 36	180 (162)	150 (135)
37- 40	190 (171)	160 (144)
41- 44	200 (180)	170 (153)
45- 48	210 (189)	180 (162)
49- 54	220 (208)	190 (171)
55- 60	230 (207)	200 (180)
61- 66	240 (216)	210 (189)
67- 72	250 (225)	220 (198)
73- 78	260 (234)	230 (207)
79- 84	270 (243)	240 (216)
85- 90	280 (252)	250 (225)
91- 96	290 (261)	260 (234)
97-120	300 (270)	270 (243)
≥ 120	300 (270)	270 (243)

*TcB ---Transcutaneous Bilirubin

**SB—Serum Bilirubin

Number in braket are values of TcB* above which a SB should be done. If corresponding serum bilirubin is at or above the level written in the left side of the Tcb phototherapy should be started.**

Values to consider Exchange Transfusion

Age in hours	Low risk SB in µmol/ L	Medium risk SB in µmol/ L
18-24	NA	NA
24-28	315	265
28-32	325	275
32-36	335	285
36-40	345	295
40-44	355	305
44-48	365	315
48-60	375	325
60-72	385	325
72-84	400	350
84-96	415	350
96-120	425	375
≥120	425	375

Serum Bilirubin (µmol/ L)

Low risk: Gestation full term(>37weeks 0 days) without risk factor.

Medium risk: Gestation 35 to 36 weeks 6 days without risk factor OR
Gestation full term with any of these risk factors:

a. Possible rapid rise in bilirubin- ABO incompatibility, G6PD deficiency,Direct coombs test positive.
b. Altered blood brain barrier- sepsis, asphyxia,lethargy,temperature instability,acidosis, serum albumin <3g/dl

AAP Guideline for Phototherapy & Exchange transfusion (by numerical values)

A) Infant at lower risk (≥38 weeks & well)

	Values to start Phototherapy	Values to consider Exchange transfusion
Age	**Total serum bilirubin (mg/dl)**	**Total serum bilirubin (mg/dl)**
12 hours	9	18
24 hours	11	19
36 hours	14	21
48 hours	15	22
60 hours	17	23
72 hours	18	24
84 hours	19	24
96-108 hours	20	25
120 hours- 7 days	21	25

B) Infants at medium risk (≥ 38wks & risk factor or 35-37 wks +6 days & well)

	Values to start Phototherapy	Values to consider Exchange transfusion
Age	**Total serum bilirubin (mg/dl)**	**Total serum bilirubin (mg/dl)**
12 hours	7	15
24 hours	10	16
36 hours	11	18
48 hours	13	19
60 hours	14	20
72 hours	15	21

84 hours	16	22
96 hours -7 days	17	22

C) Infants at high risk (35-37wks+6days + risk factors)

	Values to start Phototherapy	**Values to consider Exchange transfusion**
Age	**Total serum bilirubin (mg/dl)**	**Total serum bilirubin (mg/dl)**
12 hours	6	13
24 hours	8	15
36 hours	10	16
48 hours	11	17
60 hours	12	17
72 hours	13	18
84 hours	14	18
96 hours – 7 days	15	19

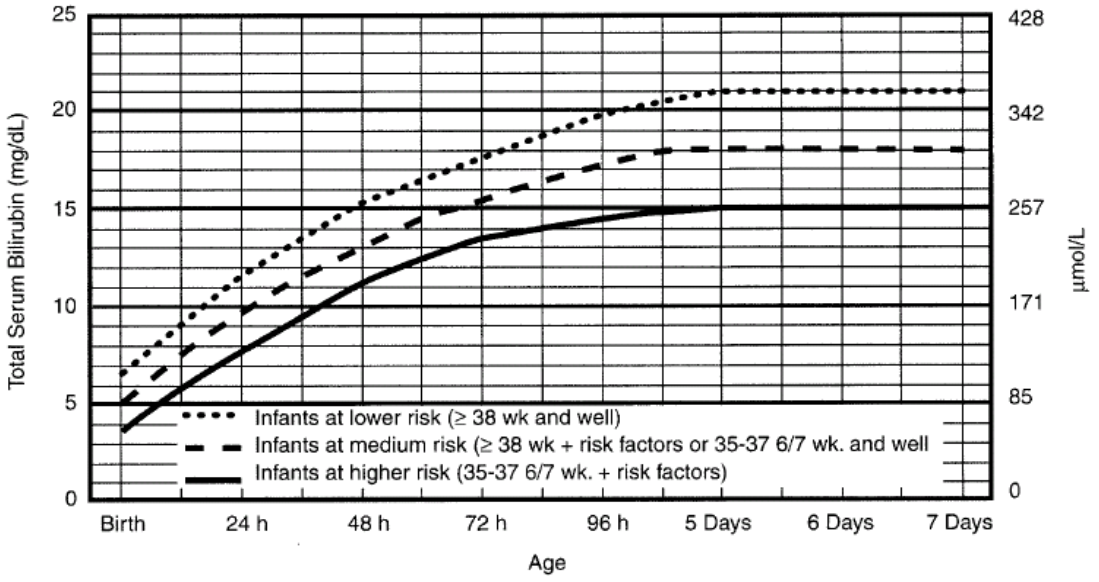
D) Jaundice management guideline for preterm (<35 wks)

Birth Weight (grams)	**Guidelines for PT* (mg/dL) Healthy Infant**	**Guidelines for PT* (mg/dL) Sick Infant**	**Consider Exchange Transfusion (mg/dL)**
<1000	5-7	4-6	10-12
1000>1500	7-10	6-8	12-15
1501-2000	10-12	8-10	15-18
2001-2500	12-15	10-12	18-20

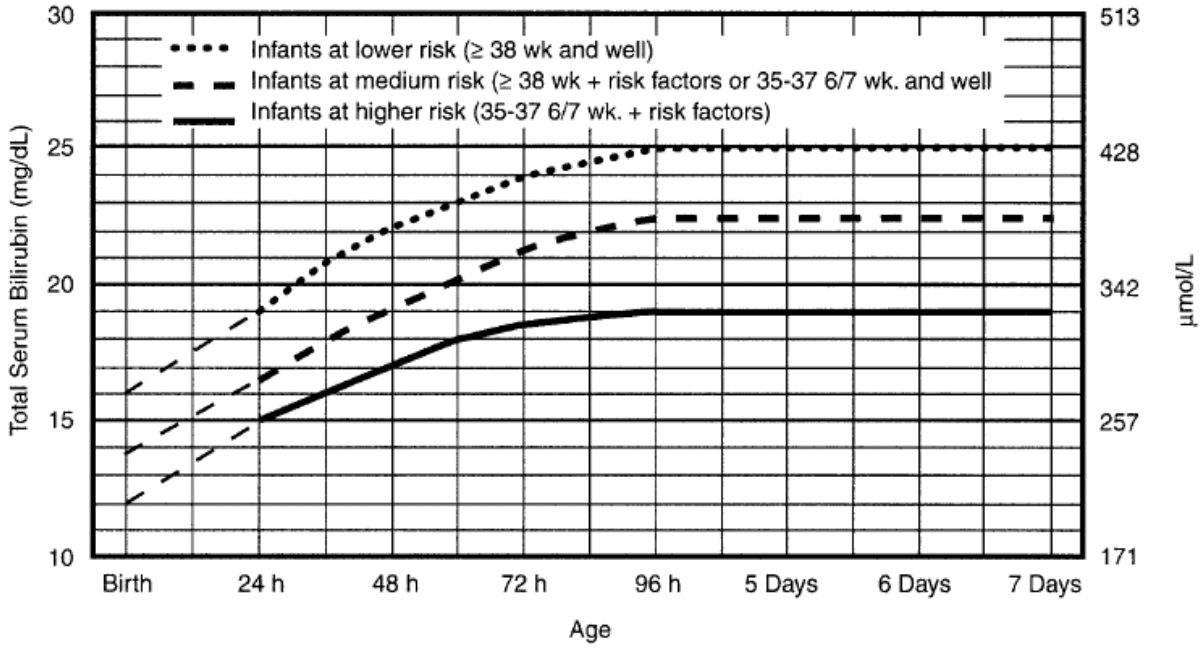
Risk Factors

Isoimmune hemolytic anemia, sepsis, asphyxia, temperature instability, hypothermia, significant lethargy, G6PD deficiency, acidosis and hypoalbuminemia.

Guidelines for phototherapy in infants of 35 or more weeks' gestation



Guidelines for Exchange transfusion for infants 35 or more weeks' gestation



Risk Factors

Isoimmune hemolytic anemia, sepsis, asphyxia, temperature instability, hypothermia, significant lethargy, G6PD deficiency, acidosis and hypoalbuminemia.

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Hypoglycemia

Hypoglycemia is one of the most common metabolic problems seen in newborn especially in sick and preterm neonate. WHO defines hypoglycaemia as blood glucose level of less than 45 mg/dl (<2.6 mmol/L).

Common Causes:

- Infant of Diabetic mother (IDM) / Large for Gestational age (LGA)
- Small for gestational age (SGA) / Intra-uterine growth restriction (IUGR)
- Preterm Low birth weight
- Perinatal asphyxia
- Perinatal stress (Sepsis, respiratory distress, shock etc)
- Hypothermia

Manifestations:

- May be asymptomatic
- Lethargy/ Irritability/ Stuporous
- Poor feeding
- Sweating
- Apnea/ tachypnea/ cyanosis/ weak or high pitched cry
- Jitteriness/ seizure

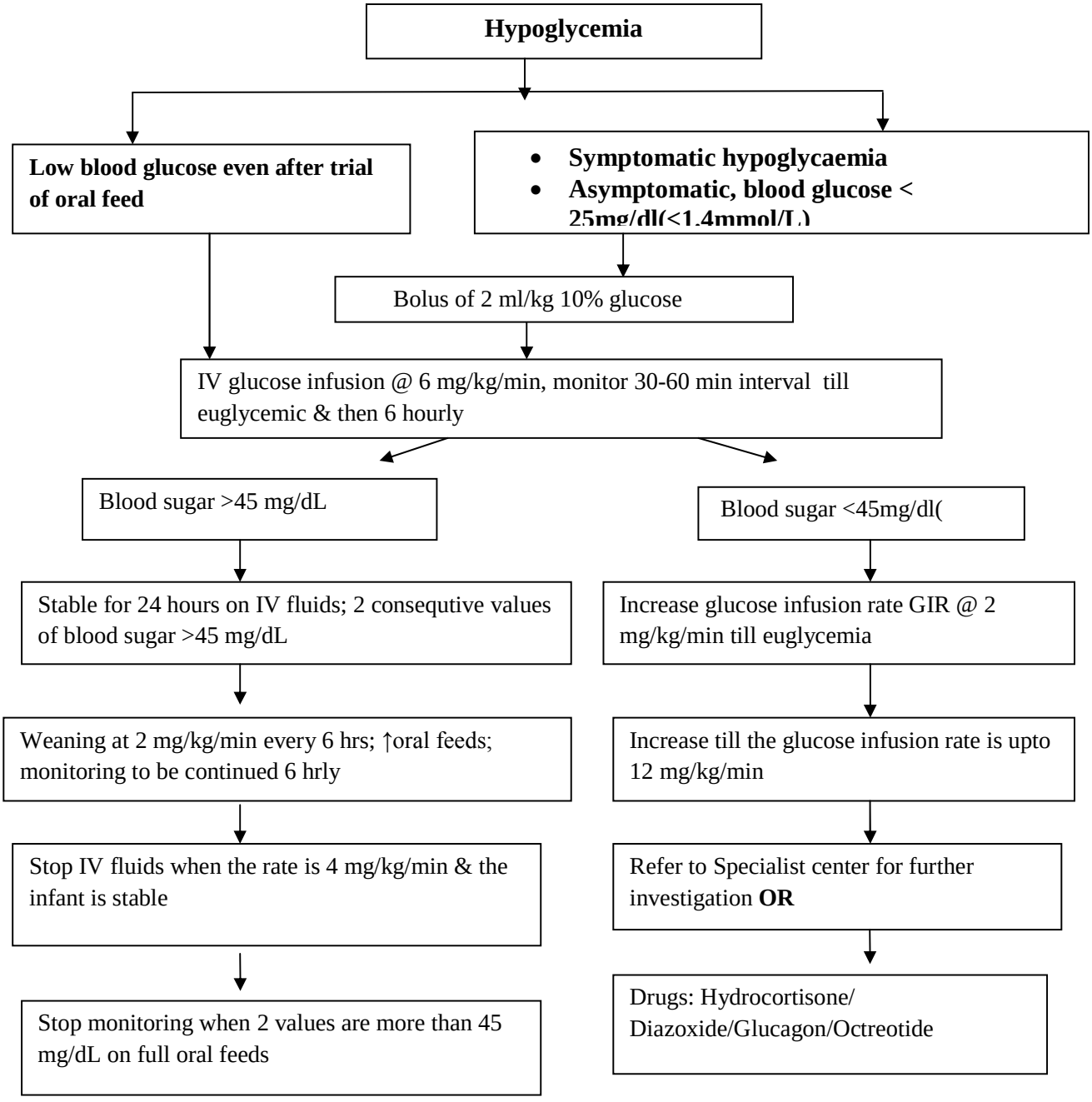
Laboratory Investigations:

- Random Blood Sugar (RBS)
- Serum electrolytes
- Investigations according to cause

Glucose Monitoring Schedule:

Category of infants	Time schedule
Infant of diabetic mother	½, 2 ,4, 6, 12,18, 24,36, 48, 72 hrs
Sick neonate, Preterm baby, IUGR	Initially every 6-8 hourly till becomes stable then once daily
Stable infants on parenteral nutrition	8-12 hourly

Algorithm for management of hypoglycemia



- **Manage asymptomatic hypoglycaemia (blood glucose 25-45mg/dl) with trial of oral feed**
- **Ensure capillary blood glucose monitoring every 30-60 min till normoglycemia**
- **Maximum glucose concentration can be given in the peripheral line is 12.5%**

Indication of Intravenous (IV) glucose infusion

- Symptomatic hypoglycaemia
- Blood glucose value < 1.7 mmol/L
- Inability to tolerate oral feeding (vomiting) or contraindication for oral feed
- Persistent hypoglycaemia despite adequate feed

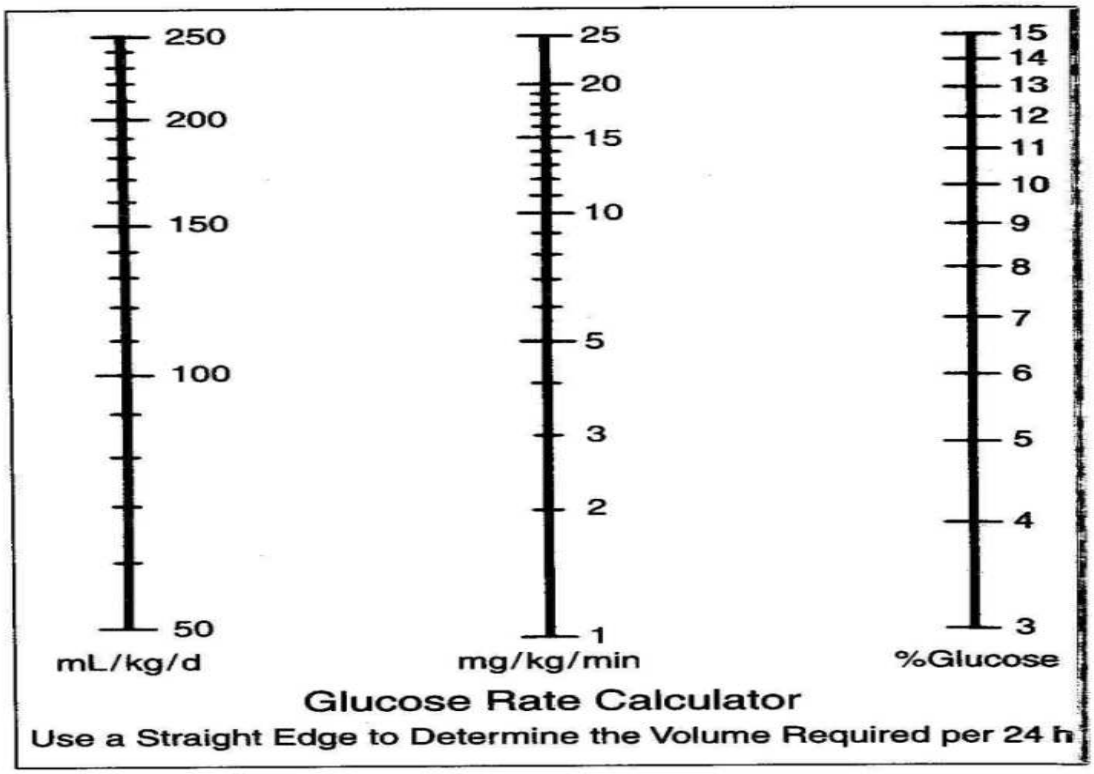
Indication of Intravenous (IV) bolus glucose

- Symptomatic hypoglycemia
- Blood glucose <1.4 mmol/L

Formulae for Calculating Glucose Infusion Rate (GIR):

Infusion rate (mg/kg/min) = [IV rate (ml/kg/day)x % of dextrose] / 144

Glucose rate calculator:



How to use this calculator?

Glucose infusion rate can be calculated by using a straight edge joining amount of fluid and percentage of glucose baby is getting. Similarly to increase or decrease GIR amount of fluid for a specific glucose percentage can be calculated.

Persistent Hypoglycemia:

This condition should be considered when there is a failure to maintain normal blood sugar levels despite a glucose infusion of 12 mg/kg/min or when stabilization is not achieved by 7 days of life.

Drugs used in persistent hypoglycemia:

- Hydrocortisone -5 mg/Kg/day IV or oral in 2 divided dose, 24-48 hours
- Diazoxide – (not in SGA) :10 mg/Kg/d PO 8 hourly
- Glucagon- (not in SGA) : 100 mg/Kg(maximum 300 mg) IM,or subcutaneously- maximum of three doses
- Octreotide – 2 to 10 mcg/Kg/d subcutaneously 6-8 hourly

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Hyperglycemia

Definition: Blood glucose level more than 7.8 mmol/L is called hyperglycemia

Blood glucose > 12 mmol/l is accompanied by (+++) glycosuria or blood glucose > 15 mmol/l in the absence of urine test may need treatment with insulin infusion.

Common causes of hyperglycemia in Newborn:

- Fluid overload
- Sepsis, Necrotizing Enterocolitis (NEC)
- Any stressful condition (pain, respiratory distress, painful procedure)
- Post operative stress
- Transient neonatal hyperglycemia
- Drugs – aminophyline, steroid, phenytoin, diazoxide

Hyperglycemia may lead to:

- Dehydration
- Intraventricular hemorrhage
- Increases risk of sepsis, Necrotizing enterocolitis (NEC) and retinopathy of prematurity (ROP) in ELBW infants
- Electrolyte abnormalities
- Increases mortality
- Developemental delay

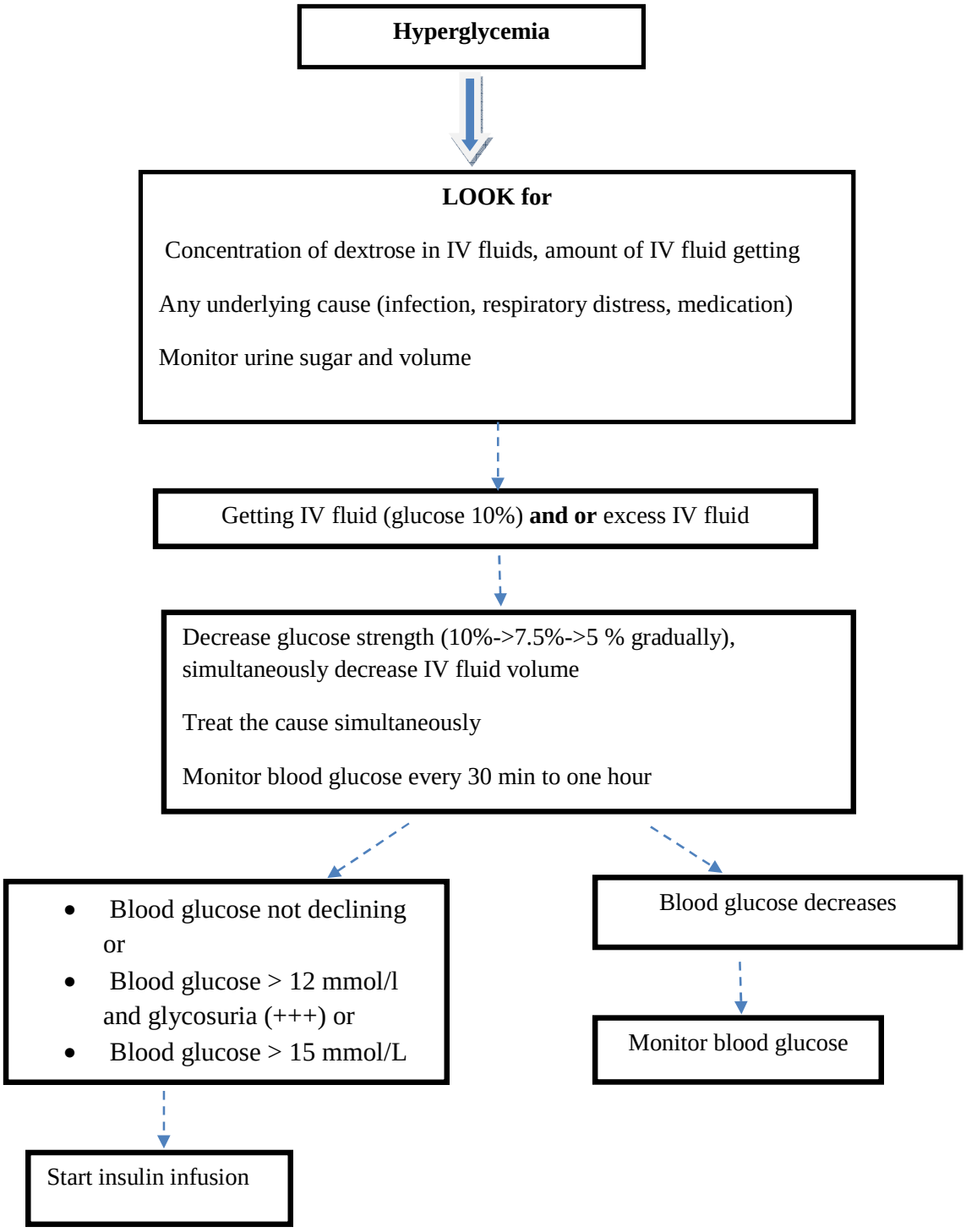
Hyperglycemia in the newborn should be evaluated for

- Any risk factor for hyperglycemia
- Dehydration
- Weight loss
- Fever
- Signs of sepsis (temperature instability, changes in peripheral perfusion)
- Signs of Necrotizing enterocolitis (NEC)

Investigations:

- Random blood sugar (RBS)
- Bed side urine for reducing substance
- Serum electrolytes
- Investigations according to suspected underlying cause

Algorithm for treatment of hyperglycemia



Insulin Infusion:

- Dose: 0.02 -0.1 unit/kg/hr, start with 0.02 unit/kg/hr , gradually increase the dose to titrate the blood glucose level.
- Measurement of insulin dose: Measure insulin to be given for 6 hours then add with 6 hour's IV fluid and then start to infuse.
- Ideal fluid : Normal saline
- Preparation of insulin: take 10 unit of insulin in 100 unit insulin syringe + 90 unit distilled water ----after dilution discard 90 unit ----then again add 90 unit D/W. After this dilution, required amount of insulin is to be infused.
- Follow up:
  - Check Capillary Blood Glucose (CBG) hourly
  - Titrate insulin dose according to the blood glucose level
  - Monitor serum potassium level during insulin therapy

Example:

A 7 days old baby, weighing 3 Kg, lethargic with poor reflex activity, blood glucose was found 20 mmol/L. How will you calculate insulin for the baby?

Calculation:

Total insulin requirement = insulin(short acting Actrapid) dose x body weight x correction time

= 0.02 unit x 3 Kg x 6 hours

= 0.36 unit

- Insulin (36 unit) in IV fluid over 6 hours after double dilution to be given to the baby

Remember: [The calculated insulin dose = same amount of insulin after double dilution, like 0.36 unit = 36 unit of insulin after double dilution as 1 unit insulin preparation contain 0.01 unit insulin of 100 unit insulin syringe]

Referrences:

Jane Hawdon Editor. Rennie & Roberton's text book of Neonatology, 5th edition. Churchill Livingstone. 2012; 27: 850-867.

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Apnea

Definition: Apnea is the absence of breathing for >20 s or a shorter pause (>10 s) associated with oxygen desaturation and/or bradycardia (<100 beats/min).

Types:

- Central apnea (40%): Complete absence of respiratory effort.
- Obstructive apnea (10%): Occurs when an infant breathes but no airflow is present because of an obstruction.
- Mixed apnea (50%): Both central and obstructive apnea.

Periodic breathing

It consists of breathing for 10-15 seconds, followed by apnea for 5-10 seconds without change of heart rate or color.

Differential diagnoses of apnea according to postnatal age

Onset within hours after birth

- RDS
- Asphyxia
- Seizures
- Maternal sedatives
- Maternal $MgSO_4$ leading to hypermagnesemia

Onset <1 week

- Apnea of prematurity
- Periventricular-Intraventricular hemorrhage
- Patent ductus arteriosus
- Postextubation atelectasis

Onset >1 week of age

- Raised Intra cranial pressure (eg. Posthemorrhagic hydrocephalus, Meningitis)
- Neonatal seizures

Onset at 6-10 weeks

- Anemia of prematurity

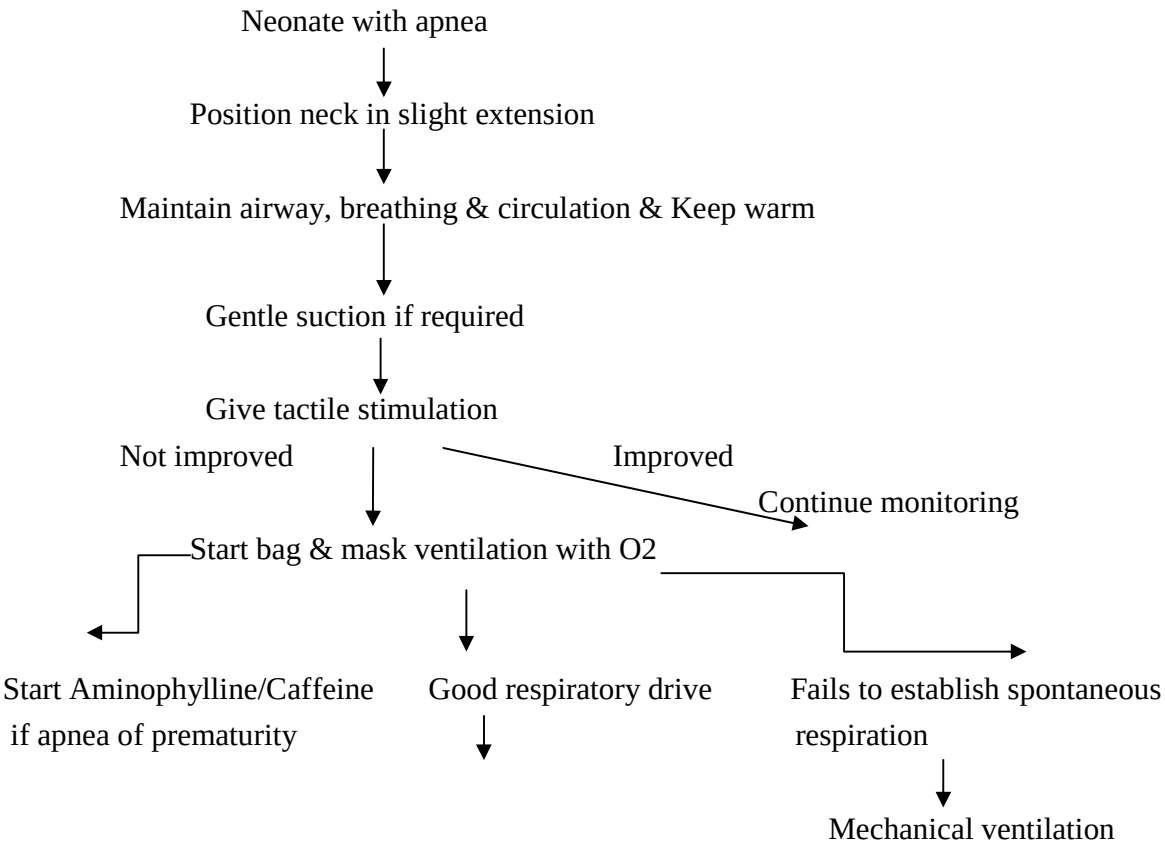
Variable onset

- Sepsis
- Meningitis
- Necrotizing enterocolitis (NEC)
- Temperature instability
- Aspiration
- Gastroesophageal reflux (GER)
- PDA
- Pneumonia
- Cold stress

Apnea of prematurity (AOP)

- It is the commonest cause of apnea in newborn
- Usually presents between day 2 & day 7
- Most prevalent in <36 wks gestation
- 50% of VLBW and 90% ELBW babies are affected

Algorithmic approach for the management of apnea



Continuous positive airway pressure (CPAP)

Other measures:

- Determine the cause of apnea, bradycardia & treat the cause
- Start antibiotic if sepsis is the cause
- Manage hypoglycemia
- Manage electrolyte imbalance
- Correct anemia

Drugs used in apnea of prematurity:

- **Intravenous Aminophylline**

  Loading dose 5-6 mg/kg, then
  1.5 – 3 mg/kg every 8 – 12 hours

- **Caffeine intravenous or oral**

  Loading: 20mg/kg, then 5 – 8 mg/kg daily

When to stop Aminophylline:

Stop drugs if no apnea for last 7 days

Or

Continue till 34 wks of corrected gestational age.

Aminophylline initiated due to facilitate extubation may be stopped after 7 days if no apnoea is present.

Laboratory studies

- CBC with PBF, ANC, IT ratio
- C-Reactive protein (CRP)
- Cultures of blood, urine, and CSF as indicated
- Serum electrolytes, calcium, magnesium, and glucose levels
- Arterial blood gas analysis
- Serum phenobarbital and methylxanthine levels if indicated

Imaging & other studies

- Chest X-ray
- Echocardiography
- Abdominal radiograph
- Cranial sonogram
- Computed tomography of head
- Electroencephalogram (EEG)
- Barium swallow to rule out Gastroesophageal reflux (GER)

How long newborn should be monitored for apneic episodes?

All babies less than 34 weeks gestation should be monitored for episodes of apnea for at least in the first week of life or till absence of apneic episodes for at least 7 days. Babies > 34 weeks gestation should be monitored if they are sick.

Pulse oximeters: It may help for monitoring apnoea, evident by desaturation &/or bradycardia

Neonatal seizure

A seizure or convulsion is a paroxysmal, time-limited change in motor activity, autonomic function and/or behavior that results from abnormal electrical activity in the brain. A seizure is defined clinically as paroxysmal alteration in neurologic functions (i.e. motor, autonomic and /or behavior).

Four major types have been identified--

A. Subtle seizures (The commonest type, > 50%)

- **Eye:** Eye blinking, eye deviation, fixed open stare
- **Oral:** Mouthing, chewing, lip smacking, smiling, tongue thrusting
- **Limbs:** Cycling, paddling, boxing, swimming movement of limbs
- **Autonomic**:Apnea, tachycardia, unstable blood pressure

B. Tonic seizures (About 20%)

- Sustained flexion or extension of axial/appendicular muscle groups
- Seizure may be focal or generalized
- Resemble decebrate (tonic extension of all limbs) or decorticate (flexion of lower limbs)
- More common in preterm neonates

C. Clonic seizures (About 50%)

- Rhythmic movements of muscle groups(1-3 jerks per second)
- Fast and slow components
- Consciousness level usually preserved
- More common in term neonates

D. Myoclonic seizures (About 5%)

- Single or multiple lighting fast jerks of the upper and lower limbs
- More rapid jerks, absence of slow return, predilection for flexor muscle groups
- Usually distinguished from clonic seizure

Causes of neonatal seizure:

Early onset seizures	Late onset seizures
• Perinatal asphyxia(HIE stage: II&III) • Hypoglycemia • Intraventricular hemorrhage(IVH) • Congenital cerebral malformation • Inborn error of metabolism(eg. pyridoxine dependency)	• Meningitis • Hypocalcemia, Hypomagnesemia • Benign familial neonatal seizure • Benign non-familial neonatal seizure (Fifth day fits) • Benign neonatal sleep myoclonus • Bilirubin encephalopathy

Causes of intractable or prolonged seizures:

- Perinatal asphyxia (HIE-stage:III)
- Intraventricular hemorrhage (IVH)
- Structural defect/Cerebral malformation
- Inborn error of metabolism (eg. pyridoxine dependency)

Common causes of neonatal seizures:

- Perinatal asphyxia
- Hypoglycemia
- Meningitis
- Hypocalcemia
- Intracranial hemorrhage

Condition mimicking seizures: Jitteriness, Benign neonatal sleep myoclonus, Benign shuddering attack, Neonatal dystonia, Benign paroxysmal torticollis, Dystonic drug reactions, Neonatal opsoclonus

Difference between Jitteriness and Seizure:

Jitteriness	Seizure
Fine, rapid,oscillatory movement (5-6 per second)	Coarse
Provoked by stimulation	Not stimulus sensative
Stops with restraint—Stops when limb is held	The limbs continue to move if grasped
Autonomic change: Absent	Autonomic change(eg. tachycardia): present
Eye deviation: Absent	Eye deviation: May be present
Neurological examination: Usually normal	Usually abnormal
EEG: Normal	Abnormal/ normal
Prognosis: Excellent	Guarded

Treatment outlines:

A. Stepwise acute management of neonatal seizures

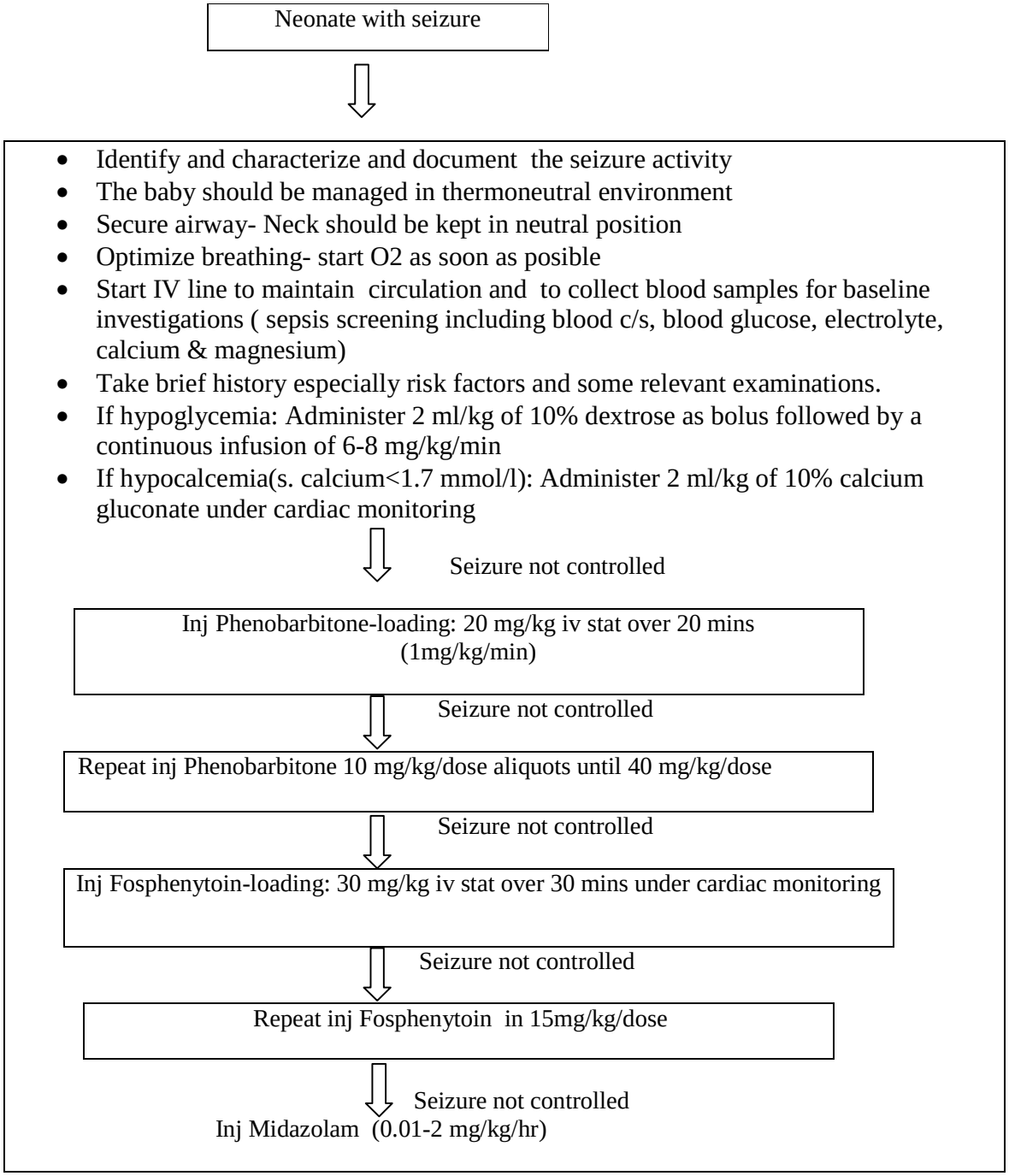
B. Choice of antiepileptic drugs (AED)

C. Maintenance of antiepileptic drugs (AED)

D. Weaning of antiepileptic drugs

E. Specific treatment for the underlying cause

A. **Acute management of neonatal seizures**



- Maintenance dose of Inj Phenobarbitone: 3-5 mg/kg/day in two divided dose
- Maintenance dose of Inj Fosphenytoin: 5-7.5mg/kg/day in two divided dose
- Inj.Phenobarbitone and Inj.Fosphenytoin are to be given over 1mg/kg/min
- Inj.Fosphenytoin should be administered with 0.9% Sodium Chloride.
- Dilute 1 mg/kg of Midazolam up to a total of 50 mL with 0.9% Sodium Chloride, 5% Glucose or 10% Glucose.
- Other drug to consider if seizure is not controlled: Levitiracetum (7.5- 20mg/kg/dose, 8-12 hourly), sodium valproate, topiramate, pyridoxine (50-100 mg IV single dose, followed by a 30 minutes observation period. If a response is seen, maintenance of 50-100 mg PO daily)

B. **When newborn seizures require acute AED treatment?**

❖ Anticonvulsant drugs should be considered to treat seizures after cause specific treatment when there is more than 3 seizures within an hour and/or one seizure lasting more than 3 minutes.
❖ In specialized care facilities where EEG is available, all electrical seizures even in the absence of clinically apparent seizures, should also be treated.

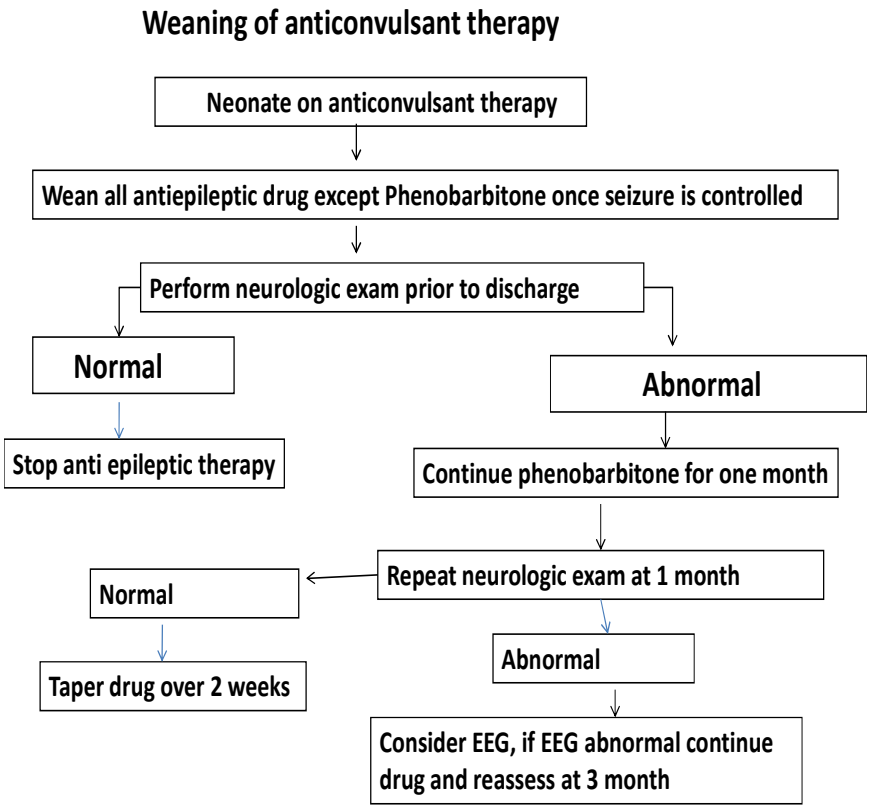
C. Maintenance and duration of treatment:

❖ The requirement for maintenance and duration of therapy is not well defined.
❖ The duration of anticonvulsant drug treatment should be as short as possible
❖ This will depend on diagnosis and the likelihood of seizure recurrence.
❖ Maintenance therapy may not be required if loading doses of anticonvulsant drugs control clinical seizures
❖ Babies with prolonged or difficult to treat seizures and those with abnormality on EEG may benefit from continuing anticonvulsant treatment.
❖ If maintenance therapy is considered:
Serum levels should be monitored
Emergency seizure management plan should be developed, including, a plan for buccal / intranasal Midazolam

D. Weaning of anticonvulsant therapy:

❖ This is highly individualized and no specific guidelines are available.
❖ The goal is to discontinue phenobarbitone as early as possible.
❖ Try to discontinue all medications at discharge if clinical examination is normal, irrespective of etiology and EEG.
❖ If neurological examination is persistently abnormal at discharge, AED is continued and the baby is reassessed at one month.
❖ If the baby is normal on examination and seizure free at 1 month, phenobarbitone is discontinued over 2 weeks
❖ If neurological assessment is not normal, an EEG is obtained.
❖ If EEG is not overtly abnormal, phenobarbitone is tapered and stopped.

- If EEG is overtly abnormal, the infant is reassessed in the same manner at 3 months and then 3 monthly till 1 year of age



Discharge documentation:

Ensure the parents are provided with the appropriate discharge documentation:

- A seizure emergency management plan
- A copy of the discharge summary, including:
  - Types of seizures
  - Medications / Anticonvulsants administered
  - Side effects of anticonvulsant

Follow-up:

- Follow-up will depend on cause of seizure and response to treatment.
- Consider: Specialist (Neonatologist/Paediatric Neurologist) follow-up for babies discharged on anticonvulsant drugs
- Paediatrician will provide follow-up care in their local area
- Multidisciplinary follow-up to identify physical or cognitive deficit and provide timely neuro-rehabilitation

References:

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Rennie M Janet, Rennie and Roberton's textbook of neonatology, 5th edition, elsevier limited, 2012, p1080-94

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Maternal Conditions Affecting the Newborn

The maternal well being, optimal nutritional status & well controlled systemic disorders are essential to provide an optimal in-utero environment for proper growth & development of the fetus. Drugs given to the mother for the management of her illness may also adversely affect the fetus.

Pregnancy associated Hypertensive disorders:

Hypertension is the commonest cause of chronic placental insufficiency leading to oligohydramnios, chronic fetal hypoxia, and intrauterine growth restriction and its consequences in the new born.

Chronic hypertension is diagnosed when it precedes pregnancy or occurs within 20 weeks of gestation and it does not resolve by the 6-week postpartum check-up.

Essential hypertension of a long standing duration may adversely effect the fetal growth because of placental vasculopathy.

Pregnancy-induced Hypertension:

It is manifested by hypertension without proteinuria after 20 weeks of gestation. Gestational hypertension is a major cause of prematurity, intrauterine growth retardation and perinatal deaths.

Preeclampsia is characterized by hypertension (Blood pressure 140/90 mm hg or more) after 20^{th} week of gestation, proteinurea (0.3 g/24hr) and/or edema. The blood pressure must be elevated on at least two occasions 6 hours apart and should return back to normal within six weeks of delivery.

Eclampsia is diagnosed when pre-eclamptic clinical picture is complicated by seizures. Almost one third cases of eclampsia develop during pregnancy.

Management Issues:

- Accidental hemorrhage due to abruptio placenta leads to acute fetal hypoxia, birth asphyxia and respiratory distress due to meconium aspiration.
- Fetal wellbeing should be closely monitored by non stress test, biophysical profile and doppler ultrasonography.
- Antenatal corticosteroids should be given if delivery can be delayed by 48 hours. When there are evidences of fetal distress or impending eclampsia baby should be delivered without delay.

- In women with impending or established eclampsia magnesium sulphate infusion is started.
- A close watch should be kept on respiratory status, deep tendon reflexes and urine output to monitor magnesium toxicity.
- If there are any side effects, magnesium sulphate infusion should be discontinued and calcium gluconate administered.
- Methyldopa is the antihypertensive of first choice during pregnancy because it has no adverse effects on uteroplacental blood flow. Labetelol and calcium channel blockers are useful alternatives.
- Hydralazine, labetelol or nifidipine are safe while other antihypertensives should be avoided during pregnancy due to their adverse effects on the fetus.
- There is a risk of development of sudden hypotension if calcium channel blocker is used in conjunction with magnesium sulphate infusion. Diuretics are contraindicated due to collapsed intravascular volume.

Abnormal Quantity of Liquor:

❖ **Polyhydramnios:** When there is excessive amount of amniotic fluid (>2 liters). Amniotic Fluid Index (AFI) in USG is > 24 cm.

Etiology

Maternal condition: Multiple pregnancy, Diabetes mellitus, syphilis and chronic renal or cardiac disease. Pre-eclamptic toxemia is commonly associated with polyhydramnios. .

Fetal Condition: Anencephaly and spina bifida, high intestinal obstruction, omphalocele, gastroschisis and ectopia vesicae. Hydrops fetalis and aneuploidy may also have associated polyhydramnios.

Complication:

Maternal: Preeclampsia, malpresentation, PROM, preterm labour, cord prolapse, uterine inertia, increase operative delivary, retained placenta, PPH and shock.

Fetal: Increase perinatal mortality, death due to prematurity and congenital anomali. Other factors are cord prolapse, hydros fetalis and shock.

❖ **Oligohydramnios:** Oligohydramnios is often associated with placental insufficiency and postmaturity. AFI is < 5-6 cm.

Causes:

- The fetal disorders which interfere with passage of urine such as bilateral renal agensis, renal dysplasia, polycystic kidney disease and obstructive uropathy and also in fetal chromosomal and structural anomalies, IUGR, post maturity, intrauterine infection, amnio nodusum, drugs: PG inhibitor, ACE inhibitors

- Hypertensive disorder, uteroplacental insufficiency ,dehydration , idiopathic

Complications:

Maternal: Prolong labour, increase operative interference due to malpresentation.

Fetal: Abortion, deformity, pulmonary hypoplasia, cord compression and high fetal mortality.

Antepartum hemorrhage (APH):

- It is define as bleeding from and into the genital tract after 28th weeks of pregnancy but before the birth of the baby. APH may be Placental (70%), unexplained (25%) or extraplacental (5%).
- Fetal hypoxia and intrauterine death, premature delivery, severe birth asphyxia, anemia, shock, birth injury and congenital malformation can occur.

Rhesus and ABO incompatibility:

Rhesus and ABO incompatibility are the major cause of severe jaundice in the neonatal period. The severity of rhesus iso immunization may be assessed by

- History of previous pregnancies and their outcome
- Zygosity and blood group of the father
- Anti-D antibodies titer during pregnancy
- Optical density of amniotic fluid

When to do Anti-D titre?:

Rh antibody titre should be done before administration of Anti-D, for those who have already immunised. However, at 34 weeks gestation, the test may be omitted if prophylactic Anti-D was given at 28 weeks gestation.

Prevention and Prophylaxis:

All Rh (D) negative women (who have not actively formed their own Anti-D) should be offered Anti-D:

- At 28 weeks gestation and again at approximately 34 weeks gestation - 625 IU (125mcg).
- Post-natally, within 72 hours. All women who deliver an Rh (D) positive baby should have quantification of feto-maternal haemorrhage to guide the appropriate dose of anti-D prophylaxis. Dose : 1500 IU(300 µgm)
- First trimester indications - 250 IU (50mcg)
    - Chorionic Villus Sampling
    - Miscarriage
    - Termination of pregnancy

- Ectopic pregnancy

- Second and third trimester indications - 625 IU (125mcg)
  - Obstetric haemorrhage
  - Amniocentesis, cordocentesis
  - External cephalic version of a breech presentation
  - Abdominal trauma or any other suspected intra-uterine bleeding or sensitising event

Management of Rh isoimmunization:

- First thing is to do Rh phenotype of patient husband. If it is Rh positive then antibody (Rh anti D titre) screening should be done in following gestational wks
  - At booking
  - At 20 wks
  - At 24 wks
  - At 28 wks
- If anti D antibody screening does not show evidence of allo immunization (titre<4) the patient should receive anti D immunoglobulin at 28 wks of gestation and further antibody screening should not be done. Next dose prophylactic anti D immunoglobulin is given within 72 hours after delivery.

- Patients in the course of their first sensitized pregnancy should have antibody titers every four weeks unless the following occur:
  - The titer is found to be at or above the critical level (usually 1: 32) on the initial evaluation.
  - The titer reaches or exceeds the critical level any time during gestation.
  - There is a significant rise in the titer (two-tube dilution) between two consecutive examples, even if the upper dilution does not reach the critical level (e.g., an increase from 4 to 32 with a critical level of 64)
- If any of these conditions occur, there is no further use of antibody titers following the first sensitized pregnancy and further management will be on fetal assessment using the middle cerebral artery peak systolic velocity (MCA PSV) and the cordocentesis to detect fetal anemia.
- The MCA PSV is an accurate noninvasive method for the diagnosis of fetal anemia. If it is more than 1.5 MOM, then cordocentesis is considered for detection of fetal hemoglobin.
- Intrauterine transfusion is indicated if hemoglobin% falls below 30%. Termination of pregnancy is done preferably after completion of 34 wks and antenatal corticosteroid therapy.
- Consultation with neonatologist should be done previously for arrangement of exchange transfusion.
- If the antibody titer remains under critical level up to 36 wks, patient should be delivered by elective induction of labor between 38-40wks in presence of neonatologist.

Premature Rupture of Membranes (PROM):

- The marked delay (>18 hours) between the rupture of membranes and the birth of the baby may predispose the fetus to develop bacterial infection by swallowing or aspirating infected amniotic fluid.
- The mother may develop clinical evidences of ammonites in the form of fever, tachycardia (both maternal and fetal) leukocytosis, uterine tenderness and foul smelling amniotic fluid.
- Preterm prolonged rupture of membranes (PROM) is a major risk factor for occurrence of preterm delivery and perinatal infections.
- It is preferable and safer to deliver the baby if there are evidences of chorioamnionitis or when gestational maturity is 34 weeks or more.
- Strict bed rest is advised to the mother with PROM. High vaginal swab should be taken for culture and antibiotics (ampicillin and aminoglycoside) are started if there are evidences of chorioamnionitis.
- Pregnancy should be closely monitored for evidence of fetal hypoxia.

Systemic disorders in pregnancy

- Chronic intractable asthma during pregnancy may be associated with fetal growth retardation. Effect of asthma during pregnancy: Preterm labour, PROM, preeclampsia, IUGR, asphysia and TTN
- Rheumatic heart disease with congestive heart failure or cyanotic congenital heart disease in pregnant women is often associated with increased risk of abortion, prematurity, intrauterine growth retardation and perinatal asphyxia.
- Chronic nephritis and nephrotic syndromes may lead to- Premature delivery and fetal growth retardation. Urinary tract infection or bacteriuria during pregnancy may be associated with prematurity and low birth weight.

❖ **Systemic Lupus Erythematosus (SLE):**

- Pregnancy complicated by maternal SLE may lead to fetal death, abortion, prematurity, intrauterine growth retardation and transient neonatal lupus erythematosus.
- Approximately one third of patient with SLE have antiphospholipid (anticardiolipin) and RO (SSA) antibodies.
- The common manifestations of neonatal lupus at few weeks of life include photosensitive maculo-papular rash on the face, trunk and proximal extremities which is precipitated by phototherapy or exposure to sunlight.
- Mild thrombocytopenia, anemia , hepatosplenomegaly and carditis may occur. Congenital complete heart block does not require any therapeutic intervention except when it leads to congestive heart failure.
- The clinical condition resolves in 10 to 12 weeks without any corticosteroid therapy.

Treatment:

- Supportive and depends on the specific manifestations present
- Cutaneous lesions require sun avoidance, sunscreen, and low-potency topical corticosteroids to hasten solution.
- Infants with severe hepatic and hematological involvement may require treatment with systemic corticosteroids, intravenous immunoglobulin, and/or immunosuppressive agents.

❖ **Maternal Hypothyroidism:**

- Maternal hypothyroidism in pregnancy can be either overt or subclinical. Maternal myxoedema is associated with relative sterility and early deaths.
- In woman with thyroiditis, placental transfer of thyroid –blocking immunoglobulin's may cause fetal hypothyroidism which can be prevented by increasing the dose of thyroxin to mother.
- Unrecognized or untreated hypothyroidism is associated spontaneous abortion, anaemia, preeclampsia, postpartum hemorrhage, placental abruption and need for cesarean delivery.
- Associated fetal and neonatal outcomes include preterm birth, IUGR, congenital anomalies, fetal distress in labor and fetal and perinatal death.

❖ **Maternal hyperthyroidism:**

- Hyperthyroidism complicates 0.1% to 1% pregnancy.
- Poorly controlled maternal hyperthyroidism is associated with spontaneous abortion, preterm delivery, IUGR, fetal demise, preeclampsia, placental abortion, thyroid storm, congestive heart failure.
- Elevated maternal thyroid stimulating antibodies (>300%) are usually associated with neonatal thyrotoxicosis.
- High doses of antithyroid drugs during later pregnancy may cause fetal goiter and hypothyroidism because they readily cross the placental barrier.
- Propylthiouracil (PTU) is the preferred antithyroid drug due to its reduced passage across the placenta and limited excretion in the breast milk.
- ***Breast feeding should be allowed if nursing mother is receiving propyl thiouracil which is sparingly exerted in the milk.***

❖ **Gestational Diabetes Mellitus:**

Gestational diabetes (or **gestational diabetes mellitus**, **GDM**) is a condition in which women without previously diagnosed diabetes exhibit high blood glucose (blood sugar) levels during pregnancy.

- The degree and severity of maternal diabetes and quality of its control during pregnancy determine the outcome of the offspring.
- During pregnancy, diabetes should be effectively controlled with insulin. Strict maintenance of normoglycemia (fasting glucose < 120 mg/dl) can significantly reduce the incidence of neonatal morbidity and mortality.
- Level of glycosylated hemoglobin in the maternal blood truly reflects the ambient plasma glucose concentrations over the previous twelve weeks.
- Fetal macrosomia is directly related to the levels of glycosylated hemoglobin in the maternal blood during third trimester while incidence of congenital malformations is related to periconceptional or early first trimester levels

Infants of Diabetic Mothers (IDM):

Infants of diabetic mother (IDM) and gestational diabetes mellitus (IGDM) are characteristically large, plethoric and moonfaced. They have hypertricosis and hairy-pinna is pathogonomic and should be looked for in all large babies.

- Due to large size (macrosomia), they may be delivered preterm and are susceptible to birth trauma, bruises and birth asphyxia.
- Mother with renal, cardiac or retinal diseases are more likely to have small for gestational age or premature infant, poor fetal outcome, fetal distress or fetal death.

- **Disorder frequently encountered in IDM:**
  Metabolic disorder:
    - Hypoglycemia: Detailed in chapter hypoglycemia.
    - Hypocalcemia: Approximately 50 percent of infant's born to insulin-dependent diabetic women develop hypocalcaemia (total serum calcium < 7mg/dl) during first three days life. The contributory factors appear to be prematurity, birth asphyxia and inappropriate response of parathormone to hypocalcaemia.
    - Hypomagnesemia : <1.54 mg/dl consider as low level. It is related to maternal hypomagnesaemia and severity of maternal diabetes.

  Cardiorespiratory disorder:
    - Perinatal asphyxia: 27% of IDM suffered perinatal asphyxia.

- Respiratory distress syndrome: These infants are at a greater risk to develop respiratory distress due to hyaline membrane disease because of premature delivery and delayed maturation of surfactant and elective cesarean section.
- Transient tachypnea of newborn.
- Hypertrophic cardiomyopathy and septal hypertrophy.

Hematologic disorder:

- Hyperbilirubinemia,
- Polycythemia and hyperviscosity
- Renal vein thrombosis

Congenital malformation:

- Congenital heart disease: TGA, VSD, ASD
- Neural tube defects: anencephaly or meningolcele syndrome
- Renal agenesis, small left colon syndrome and situs inversus
- Skeletal defect: hemivertebra, caudal regression syndrome,
- Unusual faces and micropthalmos

Maternal infection

❖ **Perinatal HIV**

Most children living with HIV acquire the infection through mother-to-child transmission (MTCT). HIV infection can be transmitted from an infected mother to her fetus during pregnancy, during delivery, or by breast-feeding. HIV can be transmitted to the fetus as early as the first and second trimester of pregnancy. However, maternal transmission to the fetus occurs most commonly in the perinatal period.

➢ **Risk factors for Perinatal HIV transmission**

Maternal factors:

- High viral load
- Viral characteristics
- Advanced disease (low CD4 count, symptoms of AIDS)
- HIV acquired during pregnancy or breastfeeding

Obstetric:

- Vaginal delivery
- Rupture of membrane for more than four hrs
- Intrpartum haemorrhage

Infant factors:

- Breast feeding
- Prematurity

Prevention of perinatal HIV:

The risk of MTCT can be reduced to less than 2% by interventions that include

- Antiretroviral (ARV) prophylaxis given to women during pregnancy and labour and to the infant in the first 6 weeks of life
- Obstetrical interventions including elective caesarean delivery (prior to the onset of labour and rupture of membranes) and thoroughly wash the baby to remove maternal blood and secretion
- Complete avoidance of breastfeeding

Breast feeding and perinatal HIV:

- In the absence of any intervention the risk of perinatal transmission is 15–30% in non-breastfeeding populations.
- Breastfeeding by an infected mother increases the risk by 5–20% increasing the risk to a total of 20-45%.

Options for ARVs for HIV Positive Pregnant Women (WHO Recommendation, June 2013)

ARV is indicated for the treatment and prevention of HIV. There are two options:

(i) Lifelong ART to all pregnant and breastfeeding women living with HIV regardless of CD4 count or clinical stage; ***or***

(ii) ART (ARV drugs) for pregnant during the mother-to-child transmission risk period and lifelong ART for those women eligible for treatment for their own health.

Maternal ART and Infant prophylaxis:

Mother

Maternal antepartum daily ART, starting as soon as possible irrespective of gestational age, and continued during pregnancy, delivery, during breastfeeding (if breastfeeding) and thereafter. Recommended regimens include the following, these are numbered according to the preferences:

1. AZT + 3TC + NVP or
2. AZT + 3TC +EFV* or
3. TDF + 3TC (or FTC) + NVP or
4. TDF + 3TC (or FTC) +EFV*

Infant

Daily NVP or twice daily AZT from birth (within 6 hours) or as soon as feasible thereafter until 4 to 6 weeks of age (irrespective of the mode of infant feeding)

AZT: Azathioprine, NVP: Nevirapine, TDF: Tenofovir, 3TC: Lamivudin, EVF: Efavira

**Note: Avoid use of EFV in the first trimester and use NVP instead*

Doses of NVP and AZT according to birth weight for infants are given below:

Birth weight	Nevirapine*	AZT
<2000 g	2 mg/kg body weight one times a day	2 mg/kg body weight two times a day
2000g – 2499 g	10 mg per day	10 mg two times a day
2500 g and above	15 mg per day	15 mg two times day

*Recommended for 6 weeks, but 4 weeks may be considered in settings with replacement feeding.

Maternal and infant ARV prophylaxis to prevent MTCT for HIV infected pregnant women who do not need treatment for their own health

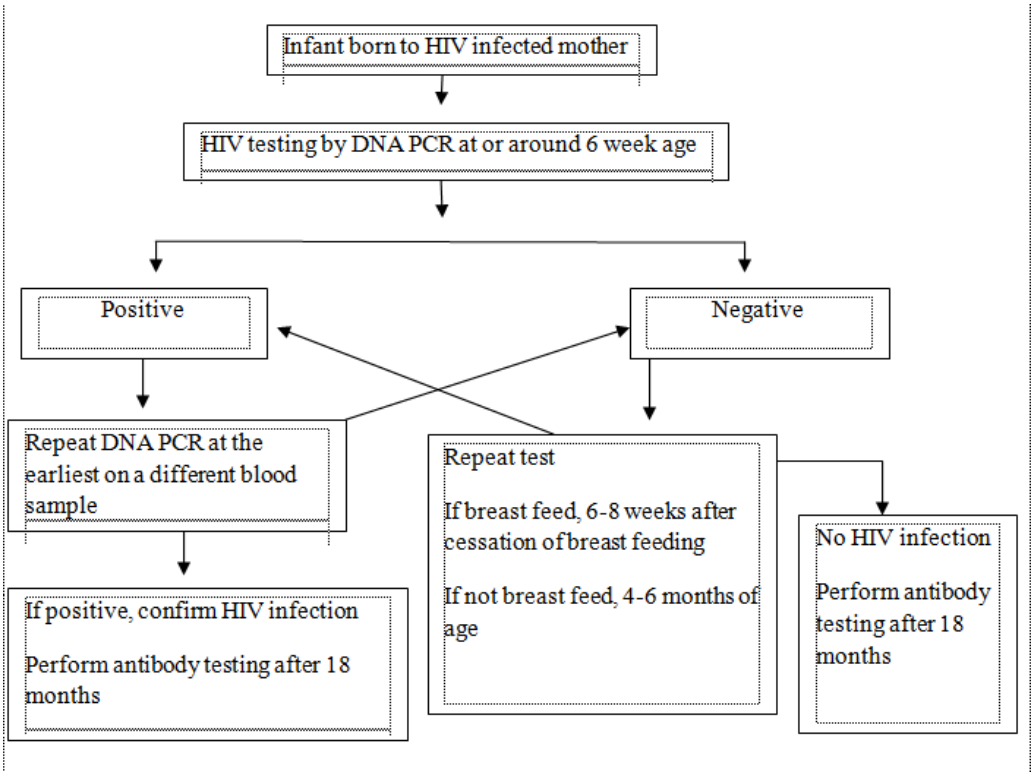
- All HIV-infected pregnant women who do not need ART for their own health require an effective ARV prophylaxis to prevent HIV transmission during pregnancy, labour and delivery, postpartum *and* during the breastfeeding period.
- ARV prophylaxis should be started from as early as 14 weeks of gestation (second trimester) or as soon as possible thereafter if women present later in pregnancy, in labour or at delivery.

Intrapartum interventions

- Avoid rupture of membranes unless medically indicated.
- Delivery by elective caesarean section at 38 weeks before onset of labour and rupture of membranes.
- Avoid procedures increasing risk of exposure of child to maternal blood and secretions like use of scalp electrodes.

Postnatal Diagnosis of HIV Infection in children:

- In children younger than 18 months diagnosis of HIV infection is based on: a positive virological test at 6 weeks for HIV or its components (usually by HIV-DNA PCR).
- The diagnosis should be confirmed by a second test on a separate sample and should be repeated at the earliest.
- If an infant or child is breastfeeding, he or she remains at risk of acquiring HIV infection throughout the breastfeeding period.
- Virological assays to detect HIV infection should be conducted at least six weeks or more after the complete cessation of breastfeeding to rule out HIV infection.
- Positive antibody testing is not recommended for confirmatory diagnosis of HIV infection in children until 18 months of age.



*Test may also need to be repeated in infants who develop symptoms or signs suggestive of HIV infection.

Breast feeding

- Breast-feeding is an important mode of transmission of HIV infection in developing countries. The risk of HIV infection via breast-feeding is highest in the early months of breast-feeding. Exclusive breastfeeding has been reported to carry a lower risk of HIV transmission than mixed feeding.
- Factors that increase the likelihood of transmission include detectable levels of HIV in breast milk, the presence of mastitis and low maternal CD4+ T cell count.
- Mothers known to be HIV-infected should only give commercial infant formula milk as a replacement feed when specific conditions are met.
- **It is referred to as AFASS (2006 WHO recommendations on HIV and Infant Feeding)**
  - ✓ **Affordable**
  - ✓ **Feasible**
  - ✓ **Acceptable**
  - ✓ **Sustainable**
  - ✓ **Safe**
    - Mother or other caregiver can reliably provide sufficient infant formula milk to support normal growth and development of the baby.
    - Mother or caregiver can prepare it cleanly and frequently enough so that it is safe and carries a low risk of diarrhea and malnutrition.

- Mother or caregiver can, in the first six months, exclusively give infant formula milk.
- Family is supportive of this practice.
- Mother or caregiver can access health care that offers comprehensive child health services.

Co-trimoxazole prophylaxis for prevention of opportunistic infection

- Co-trimoxazole prophylaxis is recommended for all HIV-exposed infants under age 18 months starting at 4–6 weeks of age or when first seen and continued until HIV infection can be excluded (14).
- Co-trimoxazole prophylaxis is also recommended for a breastfeeding child of any age, continued until HIV infection can be excluded following cessation of breastfeeding, with testing performed six weeks or more after breastfeeding was stopped.
- In children < 6 month dose is 2.5 mL once a day (trimethoprim 40 mg & sulphamethoxazole 200 mg/ 5mL)

❖ Congenital Syphilis

Untreated syphilis during pregnancy has a vertical transmission rate approaching 100%, with profound effects on pregnancy outcome. Transmission rate ranges from 70-90% in primary and secondary syphilis, 40% for early latent syphilis and to 8% for late latent syphilis.

The adverse pregnancy outcomes include stillbirths or spontaneous abortion, perinatal death, serious neonatal infection or low birth weight. Fetal infection occurs in 40-50% of women with primary syphilis. Reactive syphilis serology is a significant risk factor for perinatal mortality in developing countries, where the prevalence of seropositivity among pregnant women may be as high as 10%.

Risk factors:

- Infants whose mother received no or inadequate treatment (dose unknown, inadequate or undocumented).
- Mother received a non-penicillin treatment during pregnancy for syphilis.
- Mother was treated within 28 days of the infant's birth.
- Drug abuse, HIV infection, Teen pregnancy, CSW (commercial sex work), lack of early prenatal care.

Clinical Manifestation:
Approximately two-third of live born neonate with syphilis is asymptomatic at birth but have low birth weight.

Early manifestation (<2 years) are:

- Snuffles
- Maculopapular or vesiculobullous rash, petichiae
- Hemolytic anemia, jaundice
- Fever, Pneumonia
- Hepatosplenomegaly
- Lymphadenopathy
- IUGR
- Leucocytosis,thrombocytopenia
- Periostitis, osteochondritis, abnormal bone radiograph
- Pseudoparalysis, central nervous system manifestation

Late manifestation (>2 years): Harison triad (blunted upper incisors, interstitial keratitis and eight nerve deafness) and saddle nose.

Diagnosis:

- **Nonspecific nontreponemal antibody (NTA) test: VDRL** and **RPR (rapid plasma regain) test:** A titer of 4 fold higher in the infant's serum than the mother signifies probable active infection. CSF VDRL**:** any positive result should be followed up with STA Test**.**
- **Specific treponemal antibody (STA) test:** It should be performed if NTA test results are positive. They verify a diagnosis of current or past infection and do not correlate with disease activity. Once positive, remain positive for life.
    - **FTA-ABS** (Fluorescent treponemal antibody absorption test)
    - **MHA-TP** (Microhemagglutination test for antibodies to *T. pallidum*)
- **Direct Identification of *T. pallidum* :**
    - Microscopic Dark field Examination
    - Direct Fluorescent Antibody staining of appropriate specimen to detect spirochetes and their antigen.
- **Radiographic Examination of long bones:** positive in 65% cases. Periostitis, Ostitis, Sclerotic Metaphyseal changes, Pathological fracture.

Treatment

The decision to treat an infant for congenital syphilis is based on the clinical presentation, previous maternal serology results and treatment history, result of the serologic testing of the mother at delivery and reliability of subsequent infant follow-up.

Treatment regimen:

1. Infant with proven or highly probable disease (abnormal physical examination consistent with congenital syphilis, NTA 4 fold higher than mother's titer, or positive dark field or FTA-ABS test)

- ✓ **Intrvenous Aqueous Crystalline Penicillin G** 50,000 units/kg/dose every 12 hours during the first 7 days of life and every 8 hours thereafter for a total of 10 days, **OR**
- ✓ **IM Procaine penicillin G** 50,000 units/kg/dose in a single daily dose for 10 days

2. Asymptomatic infant who have normal physical examination and NTA titer ≤ 4 fold the mother titer.

a. Maternal treatment uncertain: (not treated, inadequate treatment, no document of treatment, treated with erythromycin other nonpenicillin regimen,or mother receive treatment <4 weeks before delivery):

Infant should be fully evaluated and treated as before or,

Benzathine penicillin G 50,000 units/kg/day in a single IM dose

b. Maternal treatment during pregnancy is adequate :(penicillin therapy given>4weeks before delivery and mother has no evidence of infection or relapse):

Benzathine penicillin G 50,000 units/kg/day in a single IM dose with no evaluation

c. Maternal treatment before pregnancy is adequate, mother NTA titer low and stable during pregnancy and delivery: No evaluation or treatment is needed for infant**.**

Follow ups: Repeated quantitative NTA test (VDRL/RPR) at 3, 6, and 12 months. Titer becomes negative with adequate treatment. A rising titer requires further investigation and retreatment.

❖ Viral Hepatitis:

Hepatitis-A: Women infected with hepatitis A are encouraged to breastfeed with care. Make sure washing hands with warm water and soap before touching the breasts and nipples, especially after using the washroom or changing baby's diaper.

Hepatitis-B:

Mode of transmission:

- Transplacental transmission: Either during pregnancy or at the time of delivery secondary to placental leaks accounts for <25% of neonatal infection.
- Natal transmission: By exposure to HBV in amniotic fluid, vaginal secretions and maternal blood accounts for 90% of neonatal infection.

- Postnatal transmission: By fecal-oral spread, blood transfusion and other mechanisms.

Risk of vertical transmission to infant: in women with acute hepatitis B infection in pregnancy:

- 1st trimester = ~10%
- 2nd or 3rd trimester = ~75%

The risk of vertical transmission is increased in infants of HBeAg positive mothers:

- HBsAg and HBeAg positive mothers = ~71%.
- HBsAg positive and HBeAg negative = ~10%.

Clinical presentation:
Maternal hepatitis B infection has not been associated with abortion, still birth or congenital malformations except prematurity in some instances.

Infants do not present in the neonatal period and are rarely ill beyond neonatal period with jaundice in <3% cases.

Management of Infant born to HBsAg positive Mother:

- Infant should receive Hepatitis B Immunoglobulin (HBIG), 0.5ml IM within 12 hours after delivery and Hepatitis B Vaccine (0.5 ml) at birth then follows the EPI schedule.
- Preterm infants weighing <2000gm, this initial dose of vaccine should be counted as 0 dose and should receive 3 doses of vaccine starting at 30 days old.

Hepatitis B Immunoglobulin (HBIG), & Hepatitis B Vaccine should be given simultaneously in separate thigh on anterolateral aspect with separate syringe.

Breast Feeding: With appropriate immune-prophylaxis, breast feeding poses no additional risk.

Follow-up: Infants born to HBsAg positive mother with appropriate immune-prophylaxis should be tested for HBsAg and Anti HBs at 9 months of age
HBsAg Negative, Anti-HBs concentration >10mIU/ml- immune from Hepatitis B
HBsAg Negative, Anti-HBs concentration <10mIU/ml- Re-vaccinate for Hepatitis B
HBsAg positive, Anti-HBs negative, refer to pediatric gastroenterologist.

Hepatitis C:

- Woman with risk factors for hepatitis C (exposure to transfusions, contaminated needles, or injected drug use) should be screened for hepatitis C before and during pregnancy.
- The risk of a pregnant woman passing the hepatitis C virus to her unborn child has been related to the levels of quantitative RNA levels in her blood, and also whether she is also HIV positive.

- Mothers without hepatitis C RNA levels detected did not transmit hepatitis C infection to their infants.
- There is no preventive treatment at this time that can influence the rate of transmission of the virus from mother to infant.

Hepatitis-E:

- During pregnancy, the risk of fulminant HEV disease and maternal mortality occurs in 20% of patients when the disease presents during the third trimester.
- Premature deliveries with high infant mortality of up to 33% are also observed.

❖ Varicella

This is the form of disease that occurs when a pregnant women suffers chicken pox during the last 3 weeks of pregnancy or within the first few days postpartum. Maternal disease near or soon after delivery may cause severe or fatal illness.
Infection can be acquired in utero or post partum. If chicken pox develops after 10^{th} to 12^{th} day postpartum, it is most likely post natal varicella infection.

Risk factor:

- Maternal chicken pox during the last 3 weeks of pregnancy or within the first few days postpartum.
- Higher mortality rate if maternal onset of disease is between 5days before and 2 days after delivery.
- Premature infant's <28 weeker.

Clinical presentation:

- Skin: characteristic rash on face, trunk and extremities.
- Lung: usually after 2-4 days up to 10 days after onset of rash. Signs include fever, cyanosis, rales, hemoptysis. CXR- diffuse nodular milliary pattern especially in the perihilar region.
- Other organs: Focal necrosis of liver, adrenals, intestine, kidneys and thymus. Glomerulonephritis, myocarditis, encephalitis, cerebellar ataxia.

Diagnosis: mainly clinical

- PCR
- VZV Antibodies-IgM may be detected 3 days after appearance of symptoms.

Management:

- Newborns whose mothers develop varicella in between 5 days before to 2 days after delivery should receive one vial of VZIG (125U) as soon as possible not later than 10days.
- All premature infant <28weeks born to a mother with active chickenpox at delivery (even if present > 1 wk) should receive VZIG.

- IVIG (400mg/kg) may be used in absence if VZIG as it may provide some protection.
- Prophylactic oral Acyclovir 15mg/kg every 8 hourly starting 7 days after exposure may prevent or attenuate varicella disease in exposed infants.
- Prophylactic oral Acyclovir 15mg/kg every 8 hourly as a treatment of symptomatic neonates.
- Because perinatally acquired varicella may be life threatening, it should be treated with acyclovir (10 mg/kg q 8 hr IV).
- Infants with community-acquired chickenpox who develop severe varicella, especially those who develop a complication such as pneumonia, hepatitis, or encephalitis, should also receive treatment with intravenous acyclovir (10 mg/kg q 8 hr IV) for 7 days.
- Maternal rash occurring >7days before delivery-VZIG not indicated.

Post Natal chicken pox:
Presents on days 12-28 of life and does not represent transplacental infection from the mother.

Risk factor:
- Seronegative mother.
- Delivery before 28 weeks.
- Birth weight <1.5 kg
- Postnatal age >2 month (maternal transplacental immunity has waned)
- Immunocompromised neonates (sepsis, steroid etc)

Presentation:
- Typical chicken pox rash with centripetal spread from trunk to face and scalp (Red macule > clear vesicle > crusting lesion.).
- Complicated with secondary infection and varicella pneumonia and necrotizing fascitis.

Management:
Full term infant in the community, disease is usually mild, acyclovir therapy is controversial.

For nosocomial chicken pox in the NICU.
- VZIG, recommended for all exposed <28 weeks GA or weighing <1000grams regardless of the maternal history or for infants of seronegative mothers.
- Acyclovir therapy for 7 days (if prophylactically beginning 7 days after exposure, or for breakthrough lession) or for 48hour after the last new lesion has appeared.

Isolation:
Exposed infants should be placed in strict isolation for 10-21 days after the onset of rash in index cases. Exposed infants received VZIG, should be in strict respiratory isolation for 28 days.

❖ Tuberculosis (TB)

Tuberculosis is an infection caused by the organism *Mycobacterium tuberculosis*. TB is a global disease that has important implication for affected neonate who can acquire the disease either the postnatal period or more rarely, through congenital transmission from an infected mother.

Risk factor:

Maternal: live in endemic area of TB or over crowded condition and HIV infection**.**

Neonatal:

- Congenital- Maternal extra pulmonary TB such as military TB, tuberculous endometritis.
- Post natal- Respiratory transmission from untreated mother.

Maternal treatment for 2-3 weeks in antenatal period reduces risk of postnatal infection.

Transmission:

Congenital transmission

Vertical transmission via hematogenous and transplacental route (aspiration or ingestion of amniotic fluid)

Postnatal transmission-

- Airborne transmission from an adult with infectious pulmonary tuberculosis.
- Contamination of traumatized skin or mucous membrane

Perinatal tuberculosis:

Maternal TB especially extrapulmonary disease, does increase pregnancy and perinatal complication such as-

- Preeclampsia
- Vaginal bleeding
- Early pregnancy loss
- Prematurity,
- Fetal growth retardation,
- Low birth weight and

Congenital tuberculosis:

- Congenital tuberculosis is rare because the most common result of female genital tract tuberculosis is infertility.
- Congenital transmission usually occurs from a lesion in the placenta through the umbilical vein. Primary infection in the mother just before or during pregnancy is more likely to cause congenital infection.
- The tubercle bacilli first reach the fetal liver, where a primary focus with periportal lymph node involvement may occur, then passes into the main fetal circulation and infect many organs like lung and also gastrointestinal tract, bone marrow, skin, mesenteric nodes. In the lung the bacilli usually remain dormant until after birth.
- Aspiration or ingestion of infected amniotic fluid.

Clinical features

Symptoms of congenital tuberculosis may be present at birth but more commonly begin by the 2nd or 3rd wk of life. Clinical features are non specific similar to that of sepsis or other

congenital infections whose response to antibiotic and other supportive therapy is poor and evaluation for other infections is unrevealing.

The most common signs and symptoms are

- Respiratory distress
- Fever
- Hepatic or splenic enlargement
- Poor feeding
- Lethargy or irritability
- Lymphadenopathy
- Abdominal distention
- Failure to thrive
- Ear drainage
- Skin lesions
- Meningitis (30-50% cases)
- Sometimes cough,wheeze, stridor, crepitation may present when obstraction of bronchi present.

Diagnosis:

- ***Most important clue for rapid diagnosis of congenital tuberculosis is a maternal or family history of tuberculosis.***
- Diagnosis of congenital tuberculosis require- primary criteria (the presence of tuberculous lesion) and at least one of the secondary criteria (cantwell's criteria)
    - Lesion in the 1st week of life
    - Primary hepatic complex or caseating hepatic granuloma
    - Placental or genital TB and
    - Exclusion of possibility of postnatal transmission by thorough investigation of contact.
- **Positive AFB Stain** from early morning gastric aspirate. Direct acid-fast stains on middle-ear discharge, bone marrow, tracheal aspirate, or biopsy tissue (especially liver) can be useful.
- **Polimarase Chain Reaction (PCR)**
- **Tuberculin skin test (TST):** The infant's TST result may be unreliable in infant < 3 months of age
- **Chest radiograph:** Most often a miliary pattern is found. Some infants with no pulmonary findings early in the course of the disease later develop profound radiographic and clinical abnormalities. Hilar and mediastinal lymphadenopathy and lung infiltrates are common.
- **Imaging:** Sonography, CT and MRI.
- **Laboratory marker:** Nutrophilic leucocytosis with raised CRP, thrombocytopenia

- **CSF should be examined and cultured, although the yield is low.**
- **Examination of placenta** if possible.

Management:

Mother diagnosed with TB in the last 2 month of pregnancy (or who has no documented sputum smear conversion) need to be carefully managed.

Asymptomatic baby:

- Give Isoniazide preventive therapy (IPT) for 6 month.
  Isoniazide (INH) preventive therapy: 10 mg/kg/day, single dose; crush with appropriate fraction and dissolved in water and multivitamin syrup.
- Withhold BCG at birth and give after completion of 6 month INH therapy.
- No separation of mother and infant is required except only if the mother is severely ill, noncompliant, or has MDRTB.
- Mother should be encouraged to breast feed.
- If INH resistance is suspected or the mother's adherence to medication is in question, separation of the infant from the mother should be considered. The duration of separation must be at least as long as is necessary to render the mother noninfectious. Rifampicin is used as prophylaxis instead of INH.
- If baby developed symptoms, the baby needs to be referred to hospital for evaluation to exclude TB.
- BCG is contraindicated if the infant is known to be HIV infected.

Symptomatic baby:

- The baby needs to be referred to hospital for evaluation to exclude TB.
- If baby has TB, should receive full course of TB treatment.
- BCG should be given after completion of treatment.
- Exclusively breastfed infants should receive pyridoxine 5 mg daily (Crush and dissolve one 25mg tablet in 5 mL water for injection to make a 5 mg/mL solution. Administer 1 mL (5mg) and discard remainder)

Treatment of TB:

- Pulmonary TB or TB lymphadenitis, TB pleural effusion, pericardial TB, abdominal TB, who live in low HIV prevalence or low resistance to INH and HIV negative: HRZ for 2 month followed by HR for next 4 month.
- Extensive Pulmonary TB who lives in low HIV prevalence or low resistance to INH should be treated with HRZE for 2 month followed by HR for next 4 month.
- TB meningitis: (HRZ) S for 2 month and HR for next 10 months.
- Corticosteroids - if TB meningitis, pericardial TB is confirmed.
- Multidrug-resistant TB regimen should be given for 20 months.

MDR-TB regimen is:

8(Km-Z-Ofx/Lfx-Eto-Cs)/12(Ofx/Lfx-Eto-Cs-Z)

(Km: kenamycine, Z: pyrizinamide,Ofx: ofloxacine, Lfx: levofloxacine, Eto: ethionamide, Cs: cycloserine)

Recommended dose of first line anti-TB drugs:

Isoniazide (H)	10 mg/kg
Rifampicine (R)	15 mg/kg
Pyrizinamide (Z)	35 mg/kg
Ethambutol (E)	20 mg/kg
Streptomycine (S)	15 mg/kg

Miscellaneous disorders:

Uterine Disorders:

Cervical incompetence, fibroids and bicornuate uterus may lead to premature delivery.

Epilepsy:

- Untreated seizures during pregnancy can produce fetal death, brain damage due to hypoxia and neurological sequeale in later life.
- Epileptic mothers on anticonvulsant therapy have greater risk of congenital heart disease and a five to ten times risk of giving birth to babies with cleft lip and cleft palate than the general population.
- In case anticonvulsants are inescapable, phenobarbitone and carbamazepine and possibly hydantoin are safe as far as congenital malformation is concerned.
- Vitamin K should be routinely administered at birth to newborn babies who have been exposed to anticonvulsants during pregnancy.

Thrombocytopenic Purpura:

Idiopathic or drug induced auto-immune thrombocytopenic purpura in the mother may be associated with transient thrombocytopenia in the baby. Mother should be given prednisolone 10- 20 mg 4 times daily for 10 to 14 days before delivery. High dose intravenous Ig G therapy, corticosteroids and platelet transfusions are indicated in infants with severe thrombocytopenia.

Effect of drugs on the fetus:

Effect of drugs used for the management of cardiovascular disorders:

- Warferin is associated with risk of embryopathy (15%-25%) and fetal hemorrhage.
- Maternal propranolol therapy during pregnancy includes: intrauterine growth retardation, birth asphyxia, depression, bradycardia, hypoglycemia, polycythemia and hyperbilirubinemia.

- Thiazide diuretics during pregnancy are known to cause neonatal liver damage & thrombocytopenia.

Effect due to anticonvulsant drugs:

- Neonatal hemorrhage caused by phenobarbitone , primidone and phenytoin.
- Fetal hydantoin syndrome caused by phenytoin and others hydantoin derivatives.

Effect due to antihypertensive drugs

- Atenolol should be avoided while ACE inhibitors are contraindicated due to risk of congenital anomalies.
- Diuretics should be used with caution if there is associated preeclampsia.

Effect of oral hypoglycemic agent:

Oral hypoglycemic agents are contraindicated during pregnancy due to risk of teratogenesis and intractable hypoglycemia in the newborn baby

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Infection Control

Purpose: To minimize the risk of transmission of infection between infants, visitors, and hospital personnel. Prevention of infection is cost effective than treating infection.

General recommendations

1. Everyone involved should be educated about standard principles of
- ✓ Hand decontamination
- ✓ The use of protective clothing
- ✓ The safe disposal of sharps.

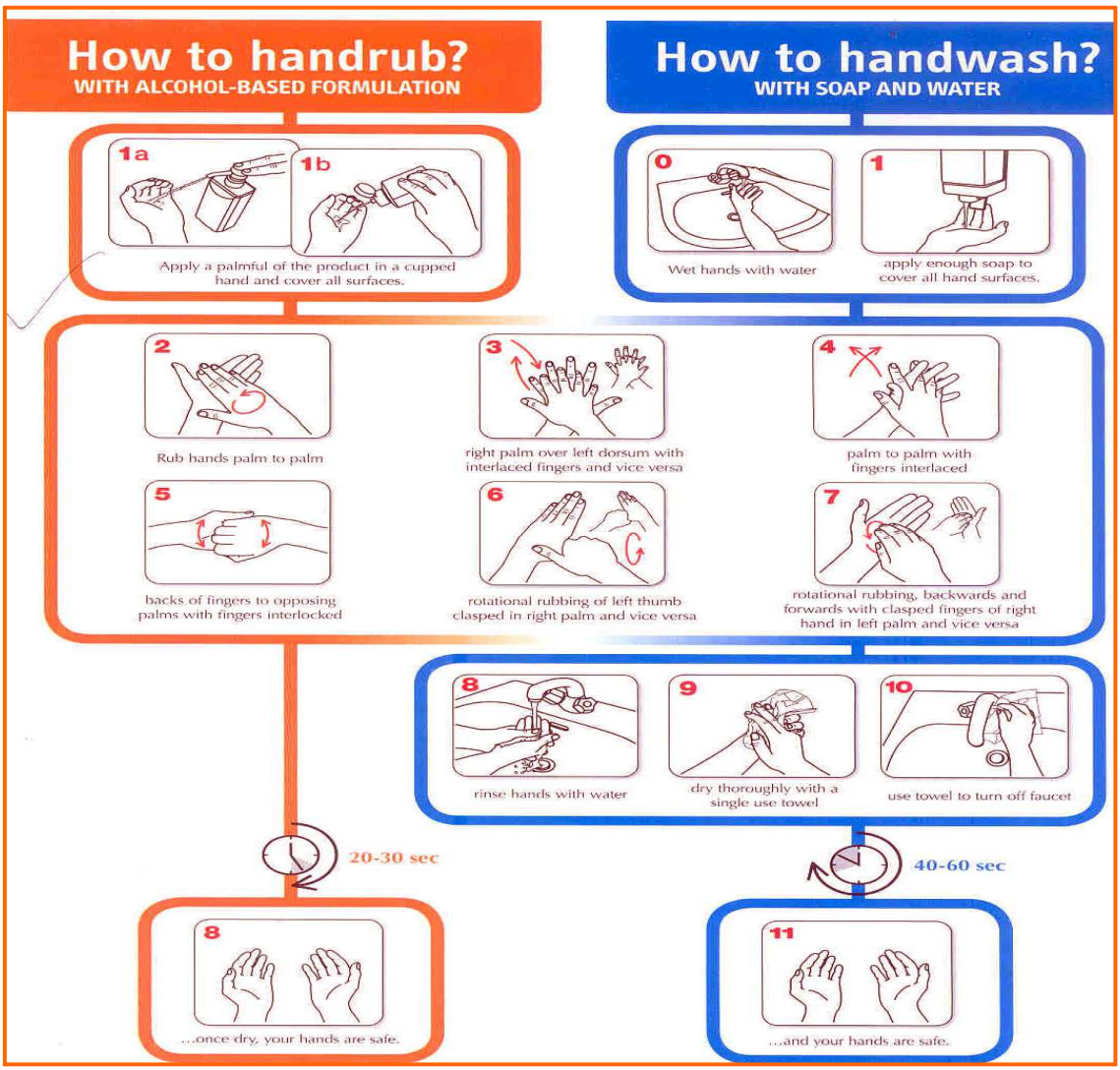
2. Guidelines for entry into the baby care area

- Remove shoes, socks, woolens, watch, bangles and rings
- Roll up the full sleeves up to elbow. Put on clean slippers, wash hands with soap and water
- Put on sterile gown.

Hand Hygiene

- Hand hygiene is required for all persons entering the NICU who will have contact with infants or nursery equipments.
- Decontaminate hands before and between handling infants.
- Hands must be decontaminated, preferably with an **alcohol based hand rub** between caring for different patients and between different care activities for the same patient.
- Before regular hand decontamination begins, all wrist and ideally hand jewelry should be removed. Cuts and abrasions must be covered with waterproof dressings. Fingernails should be kept short, clean and free from nail polish.
- Follow 6 steps of hand washing. (Hand wash duration - 2 minutes)
- Hand wash followed by hand rub ⟹ who will handle the baby.
- Hand rub only ⟹ who will not handle the baby.

Steps of hand washing:



Visitation Policy

- Parents are informed about visit policies prior to the birth of the infant.
- Only mother of the babies should be allowed entry into the unit.
- Mothers are welcome according to departmental instruction.

****Personnel (doctors, nurses & parents) with active infection should not be allowed entry into the baby care area**

Dress Requirements

- Those assigned to the care of babies will wear a clean uniform/ gown.
- Gowns are to be worn once only and then to be autoclaved.

Some Basics for asepsis:

- Keep separate spirit and povidone iodine swab containers, stethoscope, tape measure and thermometer for each baby
- Change intravenous set every 3- 5 days.
- Feeding tube can be left alone for 7 days.
- Urinary catheter (Silicon) to be changed every 7 days Do not keep fomites e.g. files, X-ray films, pens etc. on the baby cot
- Exchange transfusion-Umbilical catheter to be changed every 5-7 days or if no further exchange is required.
- Change antiseptic solution in suction bottles and sterile water in oxygen humidification chambers everyday by dipping in 2% gluteraldehyde (Cidex) for 4-6 hours.

Daily Routines in NICU

- Cord care will be given by keeping bare, clean & dry.
- Strict asepsis will be maintained during all invasive procedures.
- Skin preparation for venepuncture:
    - ✓ Wash and dry hands, rub hands
    - ✓ Wear sterile gloves
    - ✓ Prepare skin site, confine to smallest possible area of skin
    - ✓ Swab with alcohol first, allow it to dry
    - ✓ Swab iodine on site and allow it to dry
    - ✓ Swab again with alcohol to wipe off iodine, allow it to dry
    - ✓ Skin is now ready for puncture or prick
    - ✓ If iodine is not available, alcohol should be applied 3 times

Precautions to be taken in NICU:

- ✓ **Never use stock IV fluids (heparinised saline)**
- ✓ **Do not use a single dextrose/ saline bottle for >24 hours**
- ✓ **There should be separate IV fluid bag for each baby**
- ✓ **Label the bag with date and time of opening**
- ✓ **Change the burette set every 72 hour or as per policy of the unit**
- ✓ **After seal is removed, first clean with spirit swabs, then use povidone iodine soaked sterile cotton to cover the stopper of the bottle**
- ✓ **Antibiotic vials to be changed after 24 hours or as per instruction by the manufacturer. e.g.Injection ampicillin, cefotaxime**
- ✓ **Use separate IV line for giving antibiotics is preferable**

Instruction to mother

- ✓ Mothers put on sterile gown
- ✓ Mothers will be instructed on hand hygiene before handling **&** breast feeding of the baby
- ✓ Expressing breast milk
- ✓ Mothers will be instructed to clean hands before expressing breast milk.
- ✓ Breast Feeding Supplies**:** Supplies that have direct contact with breast milk are washed by parents with soap after every use.

Departmental cleanliness

Housekeeping:

- Floors and routine housekeeping should be done.
- Floor should be cleaned with diluted phenyl once each nursing shift and when required. No dry mopping, only wet cleaning should be done.
- Clean the walls with 2% bacillocid once in each nursing shift
- Phenolics will not be used to clean any surface which will have direct contact with infants.
- Long-term care infants should be placed in clean isolettes every seven days.
- Diaper collection cans are lined with a plastic bag, emptied and cleaned with soap and water on a regular basis.
- Quaternary cleaner - for floors, walls, countertops, diaper cans, cribs, isolettes, scales and other infant contact equipment.
- Asepticare HB- stethoscopes, ophthalmoscopes
- The refrigerator should be defrosted weekly and spot checked daily.

Instruments

Respiratory Therapy

Circuits of ventilators should be changed every 7 days. Water for humidification is supplied by non-refillable containers which are replaced as needed. Sterile water container opened, should be discarded after 24 hours.

Sterile Supplies

- Supplies and trays will be wrapped in plastic protective covers and kept in cabinets or on carts.
- Supplies will be checked by the Support Tech for outdates and are checked for damaged covers at the time of use.

Clean Linen

- Linen is stored in a closed cabinet or on a covered cart.
- All infants will be supplied with linen supplies through the hospital laundry or brought clean from home.

Trash and Soiled Linen

- Trash is emptied when cans become full and at specified times during the day.
- Diapers and other heavily soiled disposable items are disposed of in impervious plastic bags.
- Soiled linen is transported to the Soiled Hold and Laundry in an impervious plastic bag.

Disposables

Items marked disposable will not be reprocessed for another patient.

Refrigerator

- The refrigerators are used only for medication, expressed breast milk.
- The freezer is used for expressed milk. Staff food is not mixed with patient food.

Laryngoscope Blades

The blades (after removing the light source) should be autoclaved.

Protocol for equipment decontamination and housekeeping practices

Items	Decontamination procedures	Frequencies
Thermometers, Tape measures, Stethoscopes, Monitor-probes, Torches, BP cuffs, Telephone, Laryngoscope without the bulb	70% isopropyl alcohol	Daily and after each use
Oxygen hoods, feeding utensils, Ventilator's air filter	Detergent or soap and water	Daily
Infusion pumps, Syringe pumps, Monitors, Ventilator's body	Clean with moist cloth or wet mop , if contaminated with blood should be disinfected with glutaraldehyde(Cidex)	Daily
Incubators, radiant warmers, bassinet, Weighing machine.	Wipe with 2 % bacillocid	Daily
Resuscitation bag and accessories, Rubber goods, plastic tubing, ventilator tubings, oxygen tubings, humidifiers	Soap water clean dry and immerse in 2% Cidex for 10 hours.	Wash after each use
Ventilator's circuits, Instruments, Linens, Procedures sets, gloves, Glass articles, steel swab containers, Cheatles forceps	Autoclaving.	Daily and after each use
Feeding utensils, medicine tray, bowls, knife dish	Clean with soap and water and boil for 20 mins	After each use

Personal Protection Checklist

Standard Precautions Legend: X = Routinely S = If soiling likely** = If splattering likely

NICU	Hand Hygiene	Gloves	Gown	Mask	Eye Protection
Routine Procedures	×				
Peripheral IV Insertion	×	×			
Bilirubin Light	×				
Blood Exchange Transfusion	×	×	×		
Breast Milk Handling	×	×			
Care of Baby after Death	×	×	s		
Chest tube insertion	×	×			
CPR	×	×			
Diaper Changing	×	s			
Dismissal of baby	×				
Drawing Blood sample	×	×			
Endotracheal tube Insertion	×	×			
ETsuctioning	×	×			**
Gastric Tube Insertion	×	×			
Hematec stool/urine testing	×	×			
Equipment/ Incubator cleaning	×	×			
Radiology procedure	×				
Laboratory procedure	×				

Safe use and disposal of sharps

- Sharps must not be passed directly from hand to hand, and handling should be kept to a minimum.
- Needles must not be recapped, bent, broken or disassembled before use or disposal.
- Used sharps must be discarded into a sharps container (conforming to UN3291 and BS 7320 standards) at the point of use by the user. These must not be filled above the mark that indicates that they are full.
- Containers in public areas must be located in a safe position, and must not be placed on the floor. They must be disposed of by the licensed route in accordance with local policy.
- **Needle safety devices must be used where there are clear indications that they will provide safer systems of working for healthcare personnel.**

Isolation guideline:

*** Additional isolation precautions are used for those with multiply-resistant organisms, or with infections spread through droplet or air.**

Preventing transmission of the following diseases requires use of additional isolation techniques,

Chickenpox	Airborne Precautions
Herpes Simplex Virus, if Systemic or Respiratory	Airborne Precautions; Private room, door closed
Influenzae	Airborne Precautions: door closed As long as symptomatic
Meningitis (H-flu), including "Rule out"	Droplet Precautions; door closed Until 24 hours after start of effective therapy
Meningitis (Meningococcal), including "Rule out"	Droplet Precautions; door closed Until 24 hours after start of effective therapy
Rubella	Droplet Precautions; door closed Duration of hospitalization
RSV	Pediatric Droplet Precautions; door closed Duration of hospitalization or 21 days

***The following conditions are spread by CONTACT and transmission can be prevented by use of barrier precautions and meticulous hand hygiene. Babies may remain in open cribs and may be held by parents.**

AIDS/HIV infection	Hepatitis A, B, C
Cytomegalovirus (CMV)	Localized Herpes Simplex
Chlamydia trachomatis	Lice/Pediculosis
Conjunctivitis	Scabies
Diarrhea	Staph aureus
Gonorrhea	Syphilis
Group A or B Strep	Viral meningitis

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Blood and blood product transfusion

Infants are the longest living survivors of blood transfusion and are the patient group most at risk for the long-term consequences of transfusion transmitted infections. Every effort has to be made to reduce transfusions and donor exposure in this most vulnerable group of transfusion recipients.

Blood components used in neonatal intensive care unit (NICU) practice:

- Whole blood
- Packed red blood cell components (PRBCs)
- Fresh frozen plasma (FFP)
- Platelet concentrates
- Cryoprecipitate

Red Blood Cell (PRBCs) transfusion

The purpose of PRBCs transfusion is to improve tissue oxygenation which depends on three factors: cardiac output, oxygen saturation of blood and hemoglobin concentration.

Factors considered for RBC transfusion are:

- Hb%, Hct/ PCV
- Level of respiratory support (Mechanical ventilation/ Continuous positive Airway Pressure -CPAP)
- Presence of some surrogated markers of anaemia that include include respiratory irregularity, recurrent apnoea, oxygen dependency, persistent unexplained tachycardia, poor weight gain, lethargy, poor suck etc.

Guidelines for Packed Red Blood Cells:

Indications for PRBC transfusion is based on maintenance of adequate blood haemoglobin level and/or HCT/ PCV level that is determined on the level of cardiorespiratory support and oxygen requirement

- Baby on mechanical ventilation : if Hb <13 g/dl or PCV <40%
- Baby on CPAP: if Hb < 11g/dl or PCV< 35%
- Baby on supplemental oxygen (>21%) : if Hb <8g/dl or PCV<25%
- Post surgical state, poor weight gain, unexplained persistent tachycardia; if Hb<10g/dl or PCV < 30%
- Stable: if Hb < 7 gm/dL or PCV < 20%

In NICU, where repeated blood sampling done, a cumulative blood loss of 10% of blood volume in a week is the indication for PRBC transfusion for the babies<1500g birth weight

Pre transfusion testing: Whenever possible both neonatal and maternal sample should be collected.

- Maternal sample: ABO & RhD group and screening for atypical red cell antibodies by Indirect Antiglobulin Test (IAT)
- Neonatal sample: ABO and RhD group, Direct Antiglobulin Test (DAT), if maternal serum is not available IAT in neonatal serum for atypical antibodies.

Selection of Blood group:

- Blood should be of the neonate's own ABO and RhD group, or an alternative compatible ABO and RhD group.
- Be compatible with any ABO or atypical red cell antibody present in the maternal or neonatal plasma.

Calculation of blood volume for packed RBC transfusion

$$\frac{\text{Weight in Kg x Blood Volume per Kg x (Desired PCV – Observed PCV)}}{\text{Hematocrit of blood to be given}}$$

Average blood volume of a newborn is 80 ml/kg. The hematocrit of Packed RBCs is 70% and whole blood is around 50%.

Example: In infant weighing 2.5 kg is on ventilator and has a haematocrit of 20. If the desired rise of haematocrit is 40%, the volume of packed cells (Hct 70%) required to be transfused will be 2.5 x 80 x (40-20) /70 = 55ml

- **Usually the required/ practice of packed cell transfusion volume is 10-15 ml/kg. Volumes larger than 15 ml/kg to be given in divided aliquots**

Expected rise of Hb% and Hct %:

A transfusion of 10 mL/kg of 70% HCT would be expected to rise

- Hematocrit by up to 10%.
- Hemoglobin level by 3 gm/dl.

How to minimize donor exposure?

In small and sick neonates, where it is anticipated that blood component therapy may be needed more than once, it may help to have aliquots from a single donor given as sequential transfusions.

Exchange transfusion with packed RBC is preferred when there is severe anemia and large volume is required to correct anemia (as in Hydrops Foetalis). This would help to prevent heart failure due to circulatory overload.

Fresh-Frozen Plasma (FFP) Transfusion

Plasma- fresh-frozen plasma/ thawed plasma: The liquid component of donated whole blood which is separated from cellular component (RBCs) by centrifugation and frozen within 18 hours of collection is called FFP. It contains albumin, immunoglobulins and clotting factors.

The indications for FFP transfusion:

- Vitamin K deficiency bleeding (Haemorrhagic Diseses of Newborn-HDN)
- Disseminated Intravascular Coagulation (DIC)
- Inherited Clotting Factor Deficiency
- To perform invasive procedure in presence of coagulapathy

The Product to Use: FFP for transfusion to neonates should be group AB (since this contains neither anti-A nor anti-B) or the same ABO blood group as the neonate.

Amount of FFP to be given: The dose of FFP is 10-20 ml/kg. Larger dose is preferred in order to limit exposure where repeated dosing is likely.

Platelet Transfusion

Platelet transfusion in newborn is indicated in thrombocytopenia with overt bleeding or increased risk of bleeding. Thrombocytopenia is defined as platelet count less than 1.5 lac/cubic mm. But decision for intervention is considered when platelet count <1 lac/cubic mm. Severe thrombocytopenia is defined as platelet count of less than 50,000/cubic mm. Thrombocytopenia has been observed in 1–5% of newborns at birth and severe thrombocytopenia may occur in 0.1–0.5% of newborns.

Guidelines for platelet transfusion

• Platelet count <30,000/cubic mm:

Transfuse all neonates even if asymptomatic.

• Platelet count 30,000 to 50,000/cubic mm:

Consider transfusion in:

- Clinically unstable
- Newborns <1000 gm and <1 week of age
- Previous major bleeding (IVH grade 3-4)
- Current minor bleeding (petechiae)

- Concurrent coagulopathy
- Requiring surgery or exchange transfusion
- Platelet count falling and likely to fall below 30,000

• **Platelet count** >50,000 to 99,000/cubic mm:

Transfuse only if actively bleeding.

In case of neonatal alloimmune thrombocytopenia (NAITP), HPA- compatible platelet should be transfused if the baby is severely affected (aymptomatic and platelet <30,000/mm^3 or symptomatic at higher platelet count

- **Selection of blood**
  - Platelets for neonatal transfusion should be ABO identical or compatible: RhD identical or compatible
  - Be HPA compatible in infants with alloimmune thrombocytopenia;

Amount of platelet to be given:

- The usual recommended dose of platelets for neonates is 10-20 ml/kg.
- The predicted rise in platelet count would be 20 to 60,000 /cubic mm.

Cryoprecipitate

It is prepared from FFP by thawing at 2 – 4^{0}C. Cryoprecipitate contains about 80 to 100 U of factor VIII in 10-25 mL of plasma, 300 mg of fibrinogen and varying amounts of factor XIII. It is stored at a temperature of -20^o C or below.

Indications for use of cryoprecipitate:

- Congenital factor VIII deficiency
- Congenital factor XIII deficiency
- Afibrinogenemia & dysfibrinogenemia
- von Willebrand disease

Amount of Cryoprecipitate to be given:

Volume of cryoprecipitate to be transfused is usually 5 mL/kg.

Whole blood transfusion

Whole blood transfusion is only indicated when there is need for concurrent replacement of volume and coagulation factors

Common indications are

- Exchange transfusion

- Replacement of blood loss in massive hemorrhage (Subaponeurotic haemorrhage, pulmonary haemorrhage)
- Major surgery

Rate of transfusion:

- **Rate of infusion:** < 10 mL/kg/ hour (in the absence of cardiac failure).
- **Rate should not** be > 2 mL/kg/hour (in the presence of cardiac failure).
- **If more volume is to be transfused, it should be done in smaller aliquots.**

Exchange transfusion

Indications for double volume / isovolumetric:

- Haemolytic disease of the newborn (Commonest)
- Hyperbilirubinaemia severe enough to put at risk for bilirubin encephalopathy
- Sepsis*
- Disseminated Intravascular Coagulation*
- Metabolic disorders causing severe acidosis*
- Severe fluid or electrolyte imbalance*

Pretransfusion compatibility testing:

Samples from both mother and infant should be obtained.

- Maternal sample:

✓ ABO and Rh
✓ Screen for atypical red cell Ab

- Infant sample:

✓ ABO and Rh.
✓ Direct antiglobulin test (DAT) performed on the neonate's red cells

Type and volume of blood for exchange transfusion:

S/N	Condition	Type of blood
1	**Rh incompatibility**	**Rh –ve and blood group O or that of baby** **Cross matched with baby and mother**
2	**ABO incompatibility**	**Rh compatible and blood group O (not that of baby)** **Cross matched with baby and mother**

3	**Other condition**	**Baby's group and Rh type** **Cross matched with baby' and mother**
		Volume: Twice the volume of the baby **DVET: Mix 2/3 of packed cell and 1/3 of plasma**

Partial exchange transfusion:

Indications:

Polycythemia to reduce blood viscosity

Severe anaemia at risk of heart failure (as in hydrops foetalis)

Procedure:

One third whole blood volume exchange i.e 20 -30 ml/kg is usually preferred[8]. In the presence of symptomatic hyperviscosity, the aim of partial exchange transfusion to reduce the haematocrit to 0.55 or below.

The formula for calculating the volume (in ml) is:

$$\frac{\text{Blood volume} \times \text{Observed PCV} - \text{Desired PCV}}{\text{Observed PCV}}$$

Transfusion associated risks:

Blood transfusion reactions may be broadly classified as:

Acute immune mediated reactions

- Immune mediated hemolysis
- Transfusion related acute lung injury (TRALI)
- Febrile nonhemolytic transfusion reactions (FNHTR)
- Allergic reactions

Acute non immune reactions

- Fluid overload
- Metabolic complications
    - Hyperkalemia
    - Hypoglycemia
    - Acid- base derangements (metabolic acidosis is common)
    - Hypocalcemia
    - Hypomagnesemia

Infectious:

1. ***Viral infections:*** Human immunodeficiency virus (HIV), Hepatitis B, Hepatitis C virus, Cytomegalovirus (CMV) etc.
2. ***Bacterial infections***
3. ***Parasites***: Plasmodium, Trypanosoma, several other parasites

Delayed complications

- Alloimmunization
- Transfusion associated graft versus host disease (TA-GVHD)

Choice of ABO group for blood products for administration to children

Patient's ABO group	**ABO group of blood product to be transfused**		
	Red cells	**Platelets**	**FFP**
O			
1st choice	O	O	O
2nd choice	--	A	A or B or AB
A			
1st choice	A	A	A or AB
2nd choice	O	O	--
B			
1st choice	B	B	B or AB
2nd choice	O	A or O	--
AB			
1st choice	AB	AB	AB
2nd choice	A,B	A	A
3rd choice	O		

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Newborn screening

Newborn screening is a program designed to screen infants shortly after birth for a list of conditions that are treatable, but not clinically evident in the newborn period.

- First screening programme developed for Phenyleketonuria (PKU) in 1962 by dry blood spot testing (Guthrie test).
- In 1990s, the development of Tandem mass Spectrometry screening made large expansion of potentially detectable congenital metabolic diseases (over 30 disorders).

Importance of screening:

- Helps in early diagnosis
- Allows intervention prior to onset of symptoms
- Prevention of disease progression and early death
- To lead a normal life –when adequately and regular treatment given
- Cost effective- simple feeding management can save life
- Helps in genetic counseling

Criteria of diseases for screening:

- Important health problem
- Natural history known
- Difficult to recognize early
- Suitable and acceptable screening test
- Facilities for diagnosis, treatment and follow-up
- Cost-effective to diagnose and treat
- Case-finding should be a continuous process, not just a "once and for all" project

Criteria of a best screening test:

- Ethically safe
- Simple, quick, easy to perform
- Acceptable to public
- Low cost
- Low risk
- Valid, reliable
- High sensitivity
- High specificity
- Confirmatory test available and practical

Types of screening:

1) Universal 2) Selective 3) Research purpose

Screen positive means:

Screening tests do not diagnose illnesses. An abnormal result means that the child should have additional testing to confirm or rule out the condition. If follow-up testing confirms that the child has a disease, treatment can be started, before symptoms appear. Normal values for each screening test may vary depending on how the test is performed.

Types of Newborn Screening

- **Universal clinical screening in newborn:** Detail history can be a clue to identify the condition to be screened. Complete physical examinations should be done within 72 hours of birth. Second examination should be done at 6-8 weeks of age.
  Emphasis to be given on 5 specific screening examinations-
  - ✓ Screening for visible birth defects eg. Cleft palate and cleft lip
  - ✓ Eye exam- Congenital cataracts and retinoblastoma
  - ✓ Hip exam by Ortolani and Barlow test- Developmental dysplasia of the hip (DDH)
  - ✓ Testes in boys- Undescended testes
  - ✓ Examination and Pulse oxymetry screening- Congenital heart disease (CHD)
- **Newborn metabolic screen for Inborn Error of Metabolism**
  - Guthrie test
  - Tandem Mass Spectrometry

- **Hematological screen:** Blood grouping (ABO and Rh typing) and direct coombs test- should be done on any infant
  - Born to Rh negative mother, having positive antibody titer.
  - Any infant with jaundice within 24 hours of age or there is unexplained hyperbilirubinemia
- **Screening for congenital hypothyroidism**

- **Retinopathy of prematurity (ROP) screening**

- **Hearing screening**

Timing and special considerations:

All newborn infants should be screened regardless of gestational age, weight, and feeding or health status. There is no preparation needed for newborn screening tests.

Blood testing for Inborn Error of Metabolism:

Ideal time for doing the blood test is between 3 and 7 days. Screen must be done before the baby goes home from the hospital.

- Infants screened before 24 hours of life should be re-screened by 2 weeks of age to detect possible missed cases.
- Postnatal age and weight of the baby, detailed history including drug history should be mentioned while sending the sample.
- Toxic metabolites and byproducts in IEM's cannot be detected biochemically until at least 12 hours after the baby has taken feed.
- For infants receiving blood/exchange transfusions, platelets, fresh frozen plasma (FFP), albumin, a sample should be obtained if possible prior to the transfusion. A 2nd sample is collected at least 48 hours after the transfusion when biochemistry is stable. A 3rd sample is collected three weeks later as the genetic profile will be stabilized.
- Sample for blood ammonia and lactate should be transported in ice and immediately tested. Lactate should be arterial and should be collected after 2 hour fasting in pre heparinized syringe. Ammonia sample is to be collected in EDTA vacutainer approximately after 2 hours of fasting. Avoid air mixing and sample should be free flowing.

Screening for congenital hypothyroidism (CH):

Timing: It is usually done from 5^{th} day to 14^{th} day of life.

Three approaches are being used for screening:

1. Primary TSH, back upT4
2. Primary T4, back up TSH
3. Concomitant T4 and TSH

Cut off Value for T4 and TSH:

TSH	≥ 20 µU/ml
T4	< 6.5 µg/dl

Abnormal screening values should be immediately followed up with TSH and free T4 (age appropriate cut-offs) before initiating treatment. Early initiation of adequate therapy is paramount to improve lifelong outcome. Diagnostic testing to determine etiology (using USG, Thyroid uptake and scan, TBG) is optional and does not alter treatment, and it should never delay treatment.

Retinopathy of Prematurity (ROP):

Candidates for screening: Less than 35 weeks gestation or birth weight <2000 gm

Screening tool: Indirect ophthalmoscope

Timing of screening

Screening at 30 days if -

- < 35 weeks of gestation or
- birth weight < 2000 gram or
- High risk babies- perinatal asphyxia, septic shock, ventilated baby, prolonged oxygen therapy.

Screening at 20 days if -

- < 30 weeks of gestation or
- birth weight < 1200 gram

Hearing screening:

Screening tool:

- Transient Evoked Otoacoustic Emission (TEOAE) tests
- Auditory brainstem response (ABR)

Timing of screening:

- Before one month of age or prior to hospital discharge using Transient Evoked Otoacoustic Emission (TEOAE).
- If the test is positive, a 2nd screening of both ears using TEOAE should be done after 1 month or prior to 3 month of age.
- Audiologic testing and medical follow-up: ABR (Auditory brainstem response) should be performed prior to 3 months for all infants who do not pass the 1st and 2nd screen. Rescreening of both ears is recommended.

Screening for Congenital Heart Disease (CHD):

Pulse oximetry is a bedside screening test for critical congenital heart defects. Other screening tools are:

- Fetal USG.
- Physical examination.
- Hyperoxia test.

Developmental dysplasia of the hip (DDH) and other congenital anomaly: DDH can be detected by Barlow test and Ortolani test during 1st full physical examination and or by Ultrasonogram. Lifelong disability can occur if DDH not detected earlier or if untreated.

Neural Tube Defects (NTD): Antenatal screening is optimally performed between 16 and 18 weeks of gestation by measuring S. α-fetoprotein, although samples may be obtained as early as 15 weeks and as late as 22 weeks.

Congenital Adrenal Hyperplasia (CAH): CAH is a potentially fatal disease which can be easily diagnosed. Early recognition and treatment can prevent severe salt wasting dehydration and death. Serum 17α- hydroxyprogesterone (17 OHP) is measured preferably between 2-4 days after birth.

Prematurity and illness can result in false-positive screen results. Results not affected by transfusion if sample collected after several hours.

Hemoglobinopathies: includes-

- Homozygous β thalassemia
- Hb-E beta-thalassemia
- beta-thalassemia trait
- Hb-E disease
- Hb-E trait
- Sickle cell disease
- Sickle cell trait.

Screening is performed by isoelectric focusing (IEF) of a hemosylate prepared from a dried blood spot. Results should be correlated with parental Hb electrophoresis pattern.The confirmatory test done on whole blood by Hb- electrophoresis. Blood transfusion may cause false negative results.

Components of Newborn Screening:

- Sampling - hospital partnerships
- Screening - Lab partnerships
- Reporting - to health care provider
- Referral - to specialist care provider
- Short term follow-up- diagnosis
- Long term follow-up- ongoing treatment & monitoring

Follow up:

- The importance of follow up should be emphasized frequently to the parents.
- Parents should be given advice regarding follow-up visits – where and when

- The permanent and present addresses along with two phone numbers should be kept to ensure follow up.
- If the parents do not turn up for follow up they should be telephoned to ensure good follow up rates.

Newborn screening (NBS) in Bangladesh:

- Newborn Screening for Congenital hypothyroidism included in National Neonatal Health Strategy and Guidelines for Bangladesh in 2009.
- In 2012, DGHS included NBS under the Non communicable disease control programme.

Diseases or conditions that are screened in NICU, BSMMU:

- Universal screening
- Surveillance and screening for birth defects
- Congenital hypothyroidism (CH)
- Retinopathy of prematurity (ROP)
- Hearing impairment

Scope of neonatal screening:

Expansion of newborn screening may include many diseases in future such as-

- Hemoglobinopathies
- Antenatal screening for neural tube defect (NTD)
- Congenital infection
- Congenital Adrenal Hyperplasia (CAH)
- Developmental dysplasia of the hip (DDH)
- Critical Congenital Heart Disease
- Disorder of amino acid, fatty acid, organic acid.

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High-risk Newborn: follow-up and discharge

Definition: Any neonate, regardless of birth weight, size or gestational age, who has a greater than average chance of morbidity or mortality is defined as high risk newborn.

Factors associated with high-risk newborns:
Maternal characteristics and associated risk for neonate

- Age of mother at delivery (Over 40 years & Under 16 years): IUGR, prematurity, child abuse/neglect.
- Severe maternal malnutrition: IUGR to fetal demise
- Drug/alcohol use: IUGR, fetal alcohol syndrome, withdrawal syndrome, sudden infant death syndrome, child abuse/neglect.
- Diabetes mellitus: Congenital anomalies, stillbirth, respiratory distress. syndrome (RDS), hypoglycemia, macrosomia,birth injury,perinatal asphyxia.
- Thyroid disease: Goiter, hypothyroidism, hyperthyroidism.
- Renal disease: IUGR, stillbirth, prematurity.
- Urinary tract infection: Prematurity, sepsis.
- Heart/ lung disease: IUGR, stillbirth, prematurity.
- Hypertension: IUGR, stillbirth, asphyxia, prematurity.
- Anemia: IUGR, stillbirth, asphyxia, prematurity, hydrops.
- Isoimmunization (red cell antigens): Stillbirth, anemia, jaundice, bleeding, hydrops.
- Past history of infant with prematurity, jaundice, RDS, or anomalies.
- Maternal medications: (Narcotics, cocaine, alcohol, phenytoin, trimethadione, valproate, warfarin, aminopterin, retinoic acid.)
- Bleeding in pregnancy: Stillbirth, prematurity, anaemia.
- Premature rupture of membranes: Infection/sepsis.
- TORCH infections: Neurodevelopmental disability
- Trauma: Fetal demise, prematurity.

Fetal conditions and associated risk:

- Multiple gestations: Prematurity, twin-twin transfusion syndrome, IUGR, asphyxia, birth trauma.
- IUGR: Fetal demise, congenital anomalies, asphyxia, hypoglycemia, polycythemia.
- Macrosomia: Congenital anomalies, birth trauma, hypoglycemia.
- Polyhydramnios: Anencephaly, other CNS disorders, neuromuscular disorders, problems with swallowing (e.g.esophageal atresia), diaphragmatic hernia, omphalocele, gastroschisis, trisomy, hydrops, isoimmunization, anemia, cardiac failure, intrauterine infection, maternal diabetes.
- Oligohydramnios: IUGR, placental insufficiency, postmaturity, fetal demise, intrapartum distress, renal agenesis, pulmonary hypoplasia, deformations.
- Abnormal fetal position/presentation: Congenital anomalies, birth trauma, hemorrhage.
- Abnormality of fetal heart rate or rhythm: Hydrops, asphyxia, congestive heart failure, heart block.
- Decreased activity: Fetal demise, asphyxia.

High risk neonates who need follow-up care

- Babies with <1800g birth weight and/or gestation <34 weeks.
- Small for date (<10^{th} centile) and large for date (>90^{th} centile).
- Perinatal asphyxia - Apgar score 3 or less at 5 min and/or hypoxic ischemic
- encephalopathy.
- Mechanical ventilation for more than 24 hours.
- Metabolic problems – Symptomatic hypoglycemia and hypocalcemia
- Seizures.
- Infections – meningitis and/or culture positive sepsis.
- Shock requiring inotropic support.
- Major morbidities such as chronic lung disease, intraventricular hemorrhage, and periventricular leucomalacia.
- Infants born to SLE, TB,Thyroid disorder, HBsAg & HIV-positive mothers.
- Twin with intrauterine death of co-twin.
- Twin to twin transfusion.
- Hyperbilirubinemia > 20mg/dL or requirement of exchange transfusion.
- Rh hemolytic disease of newborn.
- Major malformations.
- Inborn errors of metabolism / other genetic disorders.
- Abnormal neurological examination at discharge.

Setting up of follow up services

High risk infants' follow-up requires a multidisciplinary approach involving a team.

The respective role of each team member is summarized in Table

Team member	Role(s)
Pediatricians / neonatologists	➢ Serves as the nodal person of the team. ➢ To assess growth and screen for developmental delay. ➢ To manage intercurrent illnesses.
Pediatric neurologist	➢ Long-term management of neurological illnesses such as seizures
Child psychologist(s)	➢ For formal neurodevelopmental assessment. ➢ Screening for behavioral problems and their Management.
Ophthalmologist	➢ Follow-up of ROP screening/treatment. ➢ Assessment of visual acuity and screening for problems such as strabismus, nystagmus, refractory errors, etc.
Otorhinolaryngologist	➢ Hearing assessment. ➢ Management of hearing impairment, if any.
Dietician	➢ Dietary advice regarding complementary feeding ➢ Management of infants with failure to thrive and those with special needs (e.g. galactosemia)
Medical social worker	➢ To take care of the social issues to help improve follow up rates.
Physiotherapist	➢ Assessment and grading of muscle tone and power. ➢ Plan an appropriate training program for each infant with tone abnormalities. ➢ To teach the parents for continuing the prescribed exercises at home.
Speech / occupational therapist	➢ Rehabilitation of infants with impairment/ disability

Follow-up schedule of at-risk infants:

Cohort	Schedule for follow-up
Infants with <1800g birth weight and/or gestation <35 weeks	• After 7-14 days of discharge to check if the baby has been adjusted well in the home environment. Every 2-4 weeks until a weight of 3 kg. • At 3, 6, 9, 12 and 18months of corrected age and then every 6 months until age of 8years.
All other conditions	• 2 weeks after discharge. • At 6, 10, 14 weeks of postnatal age. • At 3, 6, 9, 12 and 18months of corrected age and then every 6 months until age of 8years.

**If danger sign present, any time without delay.

Follow up plan for high risk infants:

1. Assessment of feeding and dietary counseling.
2. Growth monitoring.
3. Developmental assessment.
4. Ongoing problems.
5. Immunization.
6. Neurological assessment.
7. Eye evaluation: Mentioned in newborn screening chapter.
8. Hearing evaluation: Mentioned in newborn screening chapter.

Early stimulation

The high risk baby requires more attention of the family members. The activities of the child should be appreciated. This makes him happy and encourages doing more activities.

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Discharge from NICU

Discharge criteria:

- Hemodynamically stable
- Able to maintain body temperature in open crib.
- On full enteral feeds (either breast feeding or by spoon/cup feeding)
- Parents/Caregiver confident enough to take care of the baby at home.
- Has crossed birth weight and showing a stable weight gain for at least three consecutive days; weight should be at least 1500 grams before considering for discharge.
- Not on any medications (except for vitamins and iron supplementation). Ideally preterm babies on theophylline therapy for apnea of prematurity should be off therapy for at least five days to make sure that there is no recurrence.
- ROP, Hearing, Thyroid screening has been completed.
- Received vaccination as per schedule (based on postnatal age).

Counseling prior to discharge:

Parents should be given advice regarding:

- Feeding –Breast feeding and nutritional supplementation, if any.
- Temperature regulation – proper clothing, cap, socks, Kangaroo mother care etc.
- Prevention of infections – hand washing, avoidance of visitors, etc.
- Danger signs [Convulsion, Lethargy, Reluctant to feed (stopped feeding well), Hypothermia/Hyperthermia, Fast breathing (respiratory rate $\geq$ 60/min), Chest indrawing]– recognition and where to report if signs are present.
- Follow-up visits – where and when.
- Vaccination – schedule, next visit, etc.
- Special needs – e.g. next visits for ROP, hearing screening.
- If possible the family should be provided with the telephone number of the health care provider e.g. on-duty doctor in case the family needs to consult for infant's illness.

NEONATAL DISCHARGE SUMMARY

PARTICULARS OF THE PATIENT

Name	:
Mothers name	:
Fathers name	:
Registration Number	:
NNPD numbe	:
Date and time of Birth	:
Date of Discharge	:
Address and contact number	:
Birth Weight(gm)	:
Gestation at birth(weeks)	:
Blood group	:

Diagnosis:

1.

2.

3.

CLINICAL INFORMATION:

1. Antenatal history: Gestational age, type of delivery and indications, Systemic illness including management, antenatal risk factors, status of antenatal corticosteroid, trelevant peripartum and antenatal history.

2. Immediate postnatal events: APGAR scores, need for and mode of resuscitation, transportation details, details of stabilization in the immediate postnatal period. Birth weight, length and head circumference, whether AGA/SGA.

1. Respiratory system:

a) **Respiratory support:** Mode of respiratory therapy, day of life of initiation of CPAP, CPAP failure, intubation and extubation to mechanical ventilation, weaning from respiratory therapy
b) **Respiratory distress syndrome:** X-Ray findings, number of doses of surfactant, ventilatory settings and blood gases before and after surfactant therapy.

c) **Pneumonia:** Early or late onset, nosocomial or community acquired, ventilator associated pneumonia, antibiotic therapy, X ray findings, response to therapy

d) **Chronic lung disease**: Need for oxygen at 36 weeks corrected gestational age- type and duration of respiratory support needed, treatments given like steroids and diuretics with complications, duration of oxygen therapy/discharged on home oxygen.

2. Cardio-vascular system:

a) Postnatal hypotension/shock: Etiology of shock, requirement for fluid bolus/inotropes.

b) Patent ductus arteriosus (PDA): Suspected on what day of life - symptoms, 2D echo confirmation and size of duct, treatment with and number of doses of indomethacin , side effects of indomethacin, clinical /2Decho confirmed closure of PDA.

3. Gastro-intestinal:

a) Neonatal jaundice: Day of phototherapy with serum bilirubin level, blood groups, etiology, maximum serum bilirubin, duration of phototherapy, level of serum bilirubin at which phototherapy was discontinued, status of rebound serum bilirubin

b) Enteral feeding:
Day of starting enteral feed, Type of milk, evidence of feed intolerance, day of achieving full feed, day of regain birth weight, mode of feeding

4. Central nervous system (CNS):

a) Apnoea of prematurity: treatment – day of life when it resolved
b) Cranial ultrasound findings: day of life and IVH/Ventriculomegaly
c) Relevant clinical symptoms – seizures, tone abnormalities, breath holding spells etc.

5. Haematology:

Anaemia, polycythemia, coagulopathy, need for blood product transfusion (Number and day of life, reason). Latest Hb and reticulocyte count

6. Infection:

Post natal age of sepsis episode, clinical manifestation, supportive laboratory evidences, culture report, findings of CSF analysis, complications, antibiotic therapy, duration of therapy

7. Other systems:

a) Retinopathy of prematurity (ROP) screening: Results, staging and intervention
d) Hearing screening results: date/day of life and result

8. Details of Procedure Phototherapy, UVC insertion, Exchange transfusion, surgical management, complications of procedure (if any)

9. Any other problems:

Case Summary

- RDS requiring --- doses of surfactant
- PDA ----course of indomethacin /surgical ligation
- neonatal jaundice peak SB of ---- requiring phototherapy for --- days
- Apnoea of prematurity – resolved , apnea free for ---
- Chronic lung disease currently on/off oxygen
- Cholestatic jaundice +/- , currently improving/static/worsening
- Anemia of prematurity – latest HB of ---
- IVH+/-
- Hearing screened normal/abnormal
- On feeds of ---- ml of EBM – growing well.

INVESTIGATION RESULTS

- Serum TSH:
- Latest Haemoglobin level:
- Latest Biochemical tests (Serum creatinine, Liver function tests (LFT), serum electrolytes)

CONDITION ON DISCHARGE

1. Weight :
2. Length :
3. Occipitofrontal circumference :
4. Corrected gestational age :
5. Amount / type of feeds:
6. Predischarge examination: All systems including neurological examination
7. Hearing screening :
8. Screening status of Retinopathy of prematurity (ROP):
9. Other relevant issues: Neurology consultation, Surgical consultation, cardiology follow up for CHD, Neuroimaging

MEDICATION ON DISCHARGE (including dose and duration)

IMMUNIZATION

Tentative date of immunization:

FOLLOW-UP PLAN

Follow up with neonatologist
Date of next eye review

Other relevant consultations

SUMMARISED BY

Doctor :

Date :

CHECKED BY

Doctor :

Date :

Equipments in the NICU

❖ Electronic Weighing Scale

Accurate weighing scale is a fundamental need for all special care neonatal units and delivery rooms. Weight record is essential to monitor the adequacy of nutrition as well as fluid balance. Birth weight of birth is the single most useful predictor of neonatal morbidity and mortality. Birth weight helps in identifying the level of care required for the baby and classification into weight categories. Hence, a weighing scale for measuring the weight at birth is essential for all facilities where deliveries take place and where neonates are looked after.

Indications

- At birth.
- All LBW babies at 3 weeks (to check regaining of the birth weight), 4 weeks (to ascertain expected weight gain) and then every month.
- Sick newborn twice a day.
- VLBW (<1500 g) babies once or twice daily to monitor fluid therapy.
- Measuring urine output by pre-weighed napkins.

Procedure

1. Put the machine on a firm even surface. Wipe the weighing pan with the spirit swab.
2. Plug on and wait till the display panel registers zero.
3. Check for and adjust zero error.
4. Place the clean cloth/paper.
5. Press the knob to reset the reading to zero or else you will have to subtract the weight of the cloth from the total weight when baby is weighed along with the sheet.
6. Place the baby over the cloth/paper.
7. Record weight prior to feeding.
8. Keep baby in the middle of the weighing pan; hold the remaining tubes and lines in hand.
9. Detach as many tubes/equipment as possible prior to weighing. Keep the naked baby on the towel and record the weight (subtract the weight of the cloth if the scale has no facility to reset to zero).
10. Record weight on baby record and plot on growth chart.

Precaution For quality assurance check accuracy of weighing scale with standard known weights every week.

❖ Glucometer

Detection and screening of at risk newborn for hypoglycemia is an important skill for all physician responsible for the care of newborns.

Indications

- Premature and low birth weight newborns (<2000gm)
- Infants born to diabetic mother (IDM)
- Sick newborn

Equipments

- Alcohol for skin preparation
- Lancets
- Glucometer
- Test strip

Procedure

1. The foot must be warm (warm by rubbing if required) and well perfused.
2. Clean and prepare the site with an antibacterial swab using a circular motion (70 % isopropyl alcohol/spirit).The preferred areas for capillary sampling are the outer aspects of the heel.
3. Allow the site to dry.
4. Dorsiflex the foot, make a needle stick puncture on the site.
5. Apply gentle pressure and allow a drop of blood to form and to fall on the strip.
6. When samples have been collected, apply pressure with sterile gauze and dress appropriately.

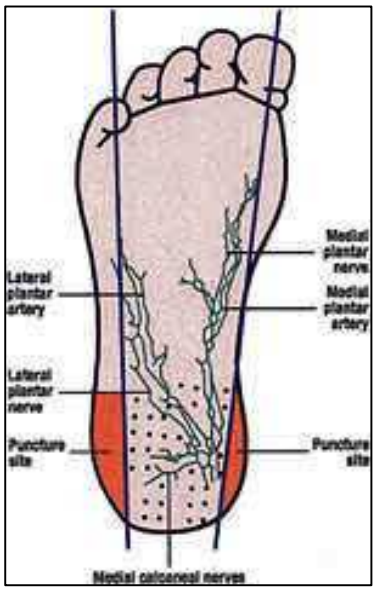

Figure: Red mark areas are preferred site for heel prick

Precautions

- Do not use povidone/betadine as specimen contamination may elevate blood sugar level
- Avoid middle portion of the heel. Because the perichondrium of the calcaneum lies superficially and the risk of osteomyelitis is increased
- Do not make a deep puncture

Complications

- Pain
- Scarring
- Infection, including osteomyelitis of the calcaneum

❖ Pulse Oximeter

Pulse-oximetry provides a simple, non-invasive, portable and inexpensive method for continuous monitoring of oxygen saturation and heart rate with good accuracy.

Indications

- It is indicated for continuous monitoring of oxygen saturation and heart rate
- It is a useful adjunct during resuscitation.
- During titration of oxygen therapy in newborns.
- During transport of newborns
- To monitor for hypoxia during suction and laryngoscopy.

Equipments

- Pulse oximeter with skin probe
- Sterile cotton

Procedure

1. Assemble all necessary equipments.
2. If saturation monitor probe is reusable, cleanse probe with alcohol, let it dry.
3. Connect the power cable to the electric socket and turn monitor on.
4. Apply probe to a site that is well perfused. The probe can be positioned on the fingers, toes, hand, foot, or wrist of the neonate. Other sites will depend on the infant's size. The placement of ear lobe probes is particularly useful in hypo perfusion states. Clean probe with spirit swab before every application.
5. Ensure both sides of probe are directly opposite each other.
6. Secure probe in place. Avoid edematous, bruised sites and excessive pressure.
7. Set high and low alarm limits for saturation (2% above and below desired limits) and heart rate 100 to 160/min. Desired O2 saturation will vary according to the infant's condition. Physician should specify the desired range which is as follows:
    - Premature (1-2 week) 90-93%
    - Term and older neonate, especially with BPD 90-95%
8. Set pulse and alarm volumes.
9. Check the waveform or the perfusion index, if available, for the accuracy of the signal.
10. Check for correlation of depicted heart rate on monitor and the actual heart rate by auscultation.
11. Observe and change site at least once per shift.

Precautions

- Do not allow excess ambient light to shine on the probe, if so cover the probe with an opaque material
- Do not tie the BP cuff proximal to the limb where the probe is fixed
- Do not place equipments generating electromagnetic signals in the vicinity
- Do not run the oximeter on battery alone if back up power is available

❖ Syringe pump

The use of syringe pumps has been advocated over manual flow control system for assuring precise and accurate delivery of prescribed fluid volumes over a specified time and to help in better nursing management.

Indications

- Accurate fluid infusion
- Controlled intravenous delivery of common medications, such as inotropic agents, vasodilators, aminophylline, insulin, heparin etc

Equipments

- Syringe pump
- Intravenous saline/medicine
- Dysposable syringe
- Connecting tubes

Procedure

1. Connect the power cable to the power slot and fix the infusion pump on to the installation pole.
2. Press the On button for 1 second to switch on the syringe pump. All signals on the display unit will glow for a second.
3. Choose the appropriate size and type of syringe as per the need of the patient.
4. Set the syringe in the slot in the driving unit. To do this, lift up the syringe holder and place the drug filled syringe with the inner and the outer cylinders in their corresponding grooves and ensure good fixation.
5. The syringe should be connected to the appropriate tubing. Avoid cutting of the IV set tubing to fit the syringe nozzle.
6. Set the rate of infusion using the up and down arrow keys in the control panel.
7. Before starting infusion press the prime button to flush the tubings to remove all air bubbles.
8. Connect to the patient after ensuring patency of the IV line.

Precaution

In case of spillage wipe the pump with soft cloth soaked in lukewarm water. Do not use alcohol based disinfectant.

❖ Phototherapy Machine

Phototherapy involves exposure of the skin of the jaundiced baby to blue or cool white light of wavelength 400–520 nm. Light is effective in the treatment of hyperbilirubinemia mainly because of its blue content. Sunlight is relatively ineffective despite its ability to bleach the infant's skin because its blue content is low. Besides, hyperpyrexia and skin burns may occur due to prolonged sunlight exposure.

Indication:
Phototherapy is indicated in hyperbilirubinema

- For term healthy babies, follow American Academy of Pediatrics guidelines.
- For babies with gestational age < 35 weeks separate guideline should be followed.
- In case of prolonged jaundice (>3 wk), one should always check fractional bilirubin estimation. Phototherapy is contraindicated in the presence of conjugated hyperbilirubinemia (2mg/dl) because it may result in Bronze Baby Syndrome.

Procedure

1. After ensuring safe power connection, check all bulbs are functioning.
2. Cover eyes with eye patch to prevent retinal damage.
3. Keep the baby naked with a small nappy to cover the genitalia to prevent testicular damage
4. Place the baby 20- 30 cm from the light source or as close to the lights as the manufacturers' instructions allow.
5. Encourage frequent breast feeding. No need to supplement breastfeeding with any other type of feed or fluids.
6. Temporary interruptions for feeding or procedures are allowed. But not for oro-gastric feeding or for IV fluids.
7. If baby is on IV fluids or expressed breast milk increase the volume by 10%(in case of single surface phototherapy), 20% (in case of double surface phototherapy)
8. Monitor for and ensure urinary frequency 6-8 times /day.
9. Monitor temperature 4 hourly and weight every 24 hours.
10. Estimate serum bilirubin as per hyperbilirubinemia protocol. Clinical or visual assessment of jaundice under lights becomes fallacious.
11. Change tube lights every 6 months (or usage time >1000 hrs) whichever is earlier; or if tube ends blacken or if tubes flicker. LED bulbs have longer life of 20,000 – 30,0000 hours while CFL lamps life is 2000-3000 hours .
12. Make sure top surface of the phototherapy unit is not covered (It allows air flow for cooling the bulbs).

Side effects

- Rash
- Overheating
- Dehydration
- Diarrhea
- Maternal seperation

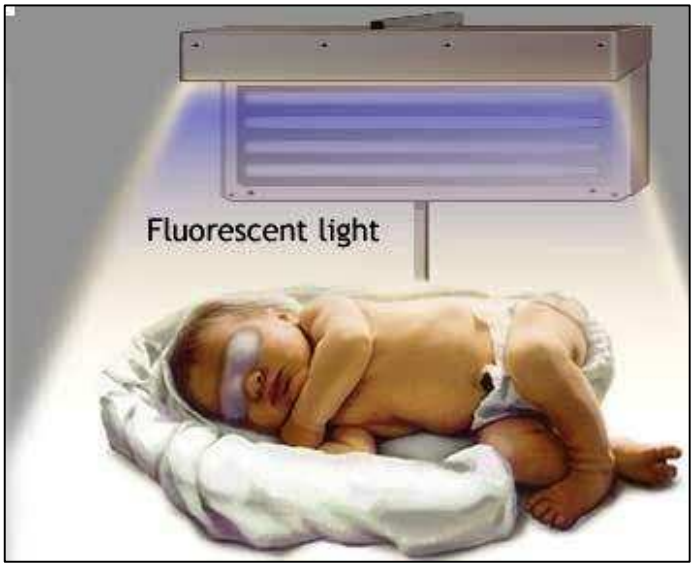

Figure: Procedure of giving phototherapy

❖ Radiant Warmer

Maintaining a stable body temperature is essential to ensure optimal growth of newborn. If temperature is maintained, caloric expenditure and oxygen consumption is minimal. Newborn babies, in particular the preterm and the low birth weight are exquisitely predisposed to hypothermia. No other equipment is identified more with the special care of newborn babies than the radiant warmers.

Indication

For Maintenance of normal body temperature of low birth weight and sick newborn

- At delivery room
- In the nursery or NICU
- During transport

Procedure

1. Ensure that the temperature of the room is not too low (>22°C).
2. Place the warmer away from air currents.
3. Clean the mattress and platform with 2% bacillocid or gluteraldehyde, and cover the mattress with clean linen sheet.
4. When it is known beforehand that a baby is to arrive in the newborn unit, turn on the warmer at least 20 minutes prior to pre-warm the linen and mattress so that the baby does not lie on a cold surface initially.
5. If baby is in supine position place the skin probe on the right hypochondrium. When in prone position, place the probe on the loin area. To prevent skin injury, place tegaderm and fix the probe on it with an adhesive.
6. After placing the baby fix the skin probe aseptically on to right upper abdomen.
7. Read temperature on display. Adjust heater output to:
   - High : If baby temperature is below 36°C
   - Medium : If baby temperature is between 36-36.5°C and to
   - Low : If baby temperature is between 36.5-37.5°C
8. Once the baby's temperature is between 36.5-37.5°C, switch on the servo mode/skin mode.
9. Ensure that the baby's head is covered with cap and feet secured in socks and the baby is clothed or covered unless it is necessary for the baby to be naked or partially undressed for observation or for a procedure.
10. Place only one baby under each radiant warmer.
11. Turn the baby frequently while under the warmer, if possible.
12. Check the temperature of the warmer and of the room every hour, and adjust the temperature setting accordingly. Record the heater output in each shift (every 6 hours). Any sudden increase in heater output is an early indicator of sickness.

13. Move the baby to be with the mother as soon as the baby no longer requires frequent procedures and treatment. If in servo mode the heater output is <20%, it is safe to shift the baby to mothers side.

Servo Mode

- Set temperature at 36.5oC, heater output will adjust automatically to keep baby at set temperature. If baby temperature is below the set temperature, the heater output will increase, if baby is at set temperature or higher the heater output will become zero.
- Look for probe displacement when the baby is in servo mode. Check for and ensure proper probe placement every hour.

Manual Mode

- Once connected to mains heater output regulated by knob on front panel. The output is displayed as % or bars or bulbs.
- Use maximum (100% output) for rapid warming of bassinet in labor room 10 minutes before delivery. Reduce output to 25-75% after 10 minutes depending on ambient temperature. If left on with heater output >80% alarm is activated within 15 or 20 minutes later and there after the heater output goes to 40%; if alarm is silenced the heater will kept on for another 15 to 20 minutes as per manufacturers recommendation.

Precautions

- Do not use the warmer in a cold room.
- The warmer must be pre-warmed around 20 minutes before the arrival of the baby
- While using the manual mode in a warmer without a temperature display, record the baby's temperature regularly, preferably 2 hourly.
- Train junior doctors and nurses about the proper use of servo and manual modes.
- The manual mode is used for initial preparation of bed for the baby; or when rapid warming of a severely hypothermic baby has to be done. This may be hazardous as babies may become overheated.

Neonatal Procedure

❖ Preperation and periprocedural care

Following measures to be taken before performing a procedure in NICU:

- Confirm the identity of the infant and the need for the procedure
- The parents should be informed of the need for the procedure and the rationale
- Explain the mode of the procedure to the parents
- Allow enough time for the procedure
- Put on a disposable apron;
- Wash hands with soap, according to infection control policy, dry well and apply alcohol gel
- Put on well-fitting, sterile glove
- Facial protection must be worn if there is a risk of splashing
- Gather all necessary equipment for the procedure. Ensure all packaging is intact. Arrange blood specimen bottles in correct order of draw
- Consider use of oral sucrose, according to the unit pain protocol
- Prepare the baby. Developmental care interventions should be used always during the procedure e.g. containment holding, cuddling, allowing infant to suck during and after procedure. Therefore, the procedure requires two people to be involved.
- Use an aseptic non-touch technique throughout the procedure
- Re-position the baby comfortably and safely
- Dispose of sharps correctly. Remove gloves and apron
- Wash and dry hands thoroughly
- Document the procedure and post procedure condition of the newborn

❖ Nasogastric/orogastric feeding

Nasogastric tube feeding is common practice in neonates and child health thousands of feeding tubes are inserted daily without incident. All staff and caregivers, caring for neonates with a nasogastric tube in place must be trained to assess the position of feeding tubes.

Indications

- Enteral nutrition in infants who are unable to feed normally
- Decompression of the stomach

Equipments

- Feeding tubes (4 Fr for babies <1000 g, 6 Fr for babies >1000 g, 8 – 10 Fr for decompression of stomach)
- Dressing and tape
- Syringe
- Gloves
- Lubricants

Procedure

1. Wash hands and put on gloves. Place the baby in a supine position. Pass feeding tube before feed to prevent aspiration.
2. Measure the distance from the nose to ear to halfway between the xiphisternum and umbilicus.
3. Make a marking at desired length to be inserted.
4. Lubricate the gastric tube and insert through the nostril, or over the tongue and into the oropharynx. Advance the tube to the predetermined length. Do not push against resistance. Monitor the baby's heart rate and breathing during the procedure.
5. Confirm that the tube is in the stomach by aspirating fluid. If there is no aspirate, take an X-ray to confirm the position of the tube.
6. Tape the tube on the baby's cheek or chin.
7. If the baby is on continuous positive airway pressure, leave on free drainage to decompress the stomach.
8. Tubes should be changed every 7days to prevent bacterial contamination.

Complications

- Gastric tube misplaced into trachea or oesophagus leading to aspiration and pneumonia
- Vasovagal response on passage of tube resulting in apnoea, bradycardia and cyanosis
- Nasal, pharyngeal and oesophageal trauma
- Trauma to skin underlying tube fixation device

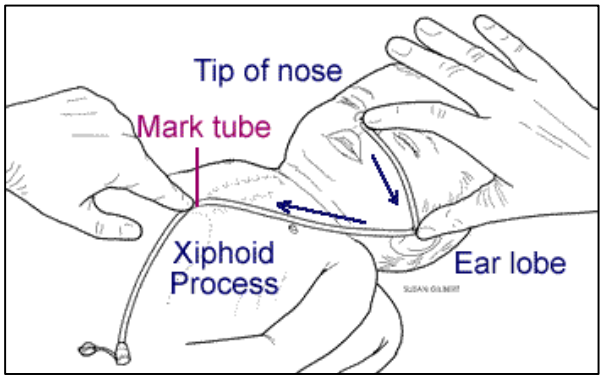

Figure: Taking measurement of nasogastric tube

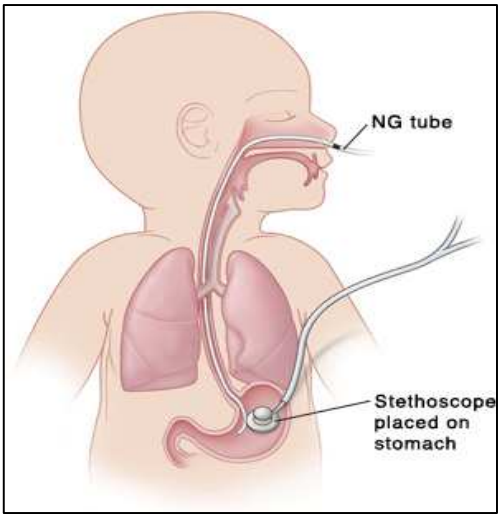

Figure:Ensuring nasogastric tube placement

Figure: Steps of nasogastric tube feeding

❖ Venipuncture

Venipuncture is undertaken when a large volume of blood or a non-haemolysed sample is required. Use veins in the dorsum of the hand or feet. Try to conserve the long saphenous veins and veins in the antecubital fossa in babies who are likely to need a long line.

Indications

- Larger volumes of blood for laboratory testing
- Samples for coagulation
- Blood culture
- Blood for grouping and cross matching

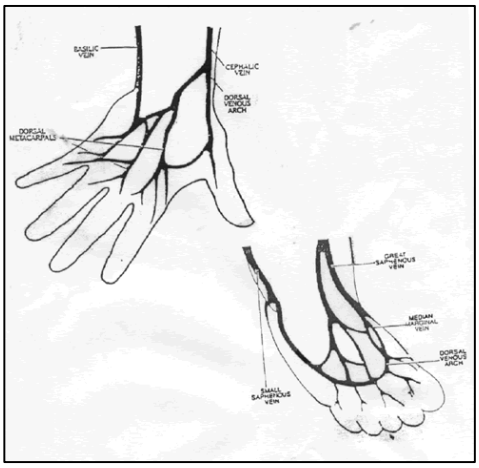

Figure: Preferred sites of venipuncture

Equipments

- 23 G collection needle.
- Alcohol based swab
- Sterile gloves
- Sterile gauze
- Specimen bottles
- Sharps bin

Procedure

1. Clean skin three times first with antiseptic or with an alcohol swab, then Iodine, finally again with alcohol based antiseptic and allow to dry.
2. Occlude the vein proximally, using gentle pressure
3. Insert the needle or butterfly at an angle of 30-45^0 to the skin.
4. Allow blood to drip into the specimen bottles from the needle
5. After needle removal, apply gentle pressure with sterile gauze to prevent bruising/haematoma formation.

Complications

- Pain
- Scarring
- Infection

Figure: Selection of site for venipuncture

Figure: Steps of venipuncture

❖ Peripheral venous cannulation

Indication

- Administration of intravenous medications, fluids, blood products and short-term parenteral nutrition

Equipment

- 24 G cannula
- Alcohol swab
- Gauze swab
- Extension tube with connector
- 0.9% saline in 5-ml syringe
- Adhesive tape
- Steri-Strips, transparent dressing
- Sharps bin

Procedure

1. Flush the extension tubing with saline.
2. Clean skin with antiseptic and allow the site to dry. Veins of the back of the hand, forearm and foot should be used first.
3. Occlude the vessel proximally and apply gentle traction to the skin.
4. Insert the cannula at an angle of 30-45^0 to the skin. As the needle pierces the vein, blood will appear in the hub of the cannula. Push the cannula in a further 1-2 mm, partially withdraw the needle and advance the cannula forward into the vessel. Remove the needle. Collect blood samples by the drip metjod or by aspirating blood from the hub of the cannula with a needle and syringe.

Figure: *Steps of peripheral venous cannulation*

5. Connect the extension tubing to the cannula and flush gently with saline.
6. Secure the cannula using Steri-Strips and a transparent adhesive dressing to allow inspection of the cannula site. Do not apply the dressing around the whole circumference of the limb.
7. Use a size-appropriate splint if the cannula is inserted over the elbow or ankle joint. Do not fix the limb too tightly to the splint.
8. Intravenous infusions should be infused via pressure-sensitive pumps and cannula sites must be checked hourly.
9. Cannula should be removed promptly if the insertion site or vein becomes erythematous or if the limb becomes swollen.
10. Put a mark for date of insertion.
11. Cannula should be changed every 3 days to prevent bacterial contamination.

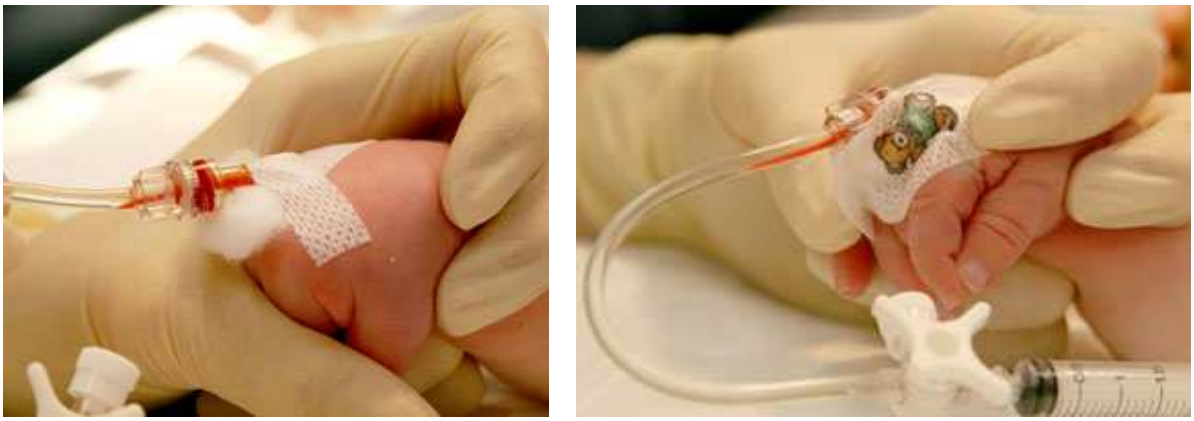

Figure: Steps of fixation of the cannula

Complications

- Haematoma formation
- Thrombophlebitis
- Infection:
- Extravasation injury

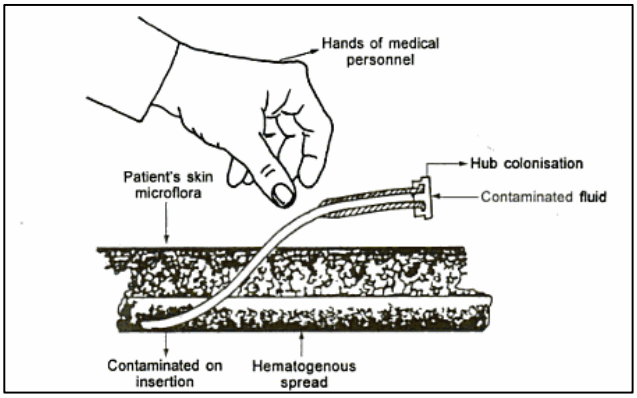

Figure: Ways of skin contamination

Precautions

- Confirm that the vessel empties following proximal occlusion and fills distally.
- Limit the number of attempts at cannulation to two or three per person.

❖ Endotracheal Intubation

Establishing an artificial airway is essential to implementing assisted ventilation in babies.

Indications

a) Absolute indications

- Sudden collapse with apnoea, bradycardia & failure to establish satisfactory ventilation after a short period of bag mask ventilation.
- Failure to establish adequate spontaneous ventilation in the delivery room after prompt and active resuscitation
- Prolonged apnoea
- PaO2 below 50 mm of Hg or FiO2 above 0.80. (This indication may not apply to the infant with cyanotic congenital heart disease).
- Paco2 above 60 mm Hg with persistent academia.
- Congenital Diaphragmatic Hernia

b) Relative indications

- Administration of surfactant therapy in infants with RDS.
- Frequent intermittent apnoea unresponsive to drug therapy.
- Early intervention with mechanical ventilation when ABG is deteriorating.
- Relieving "increasing work of breathing" in an infant with signs of moderate to severe respiratory distress.

Equipments:

- Miller blade ("00" blade for extremely preterm, "0" blade for preterm, "1" blade for term infants. Straight blades are preferred over curved blades).
- Bag-and mask apparatus with 100% oxygen.
- Endotracheal tube
- Laryngoscope with battery
- Suction apparatus
- Tape
- Scissors
- Stylet (optional)
- Personal protection equipment
- Pulse oxymeter

Procedure

1. Tube should be precut to eliminate dead space (cut to 15 cm)
2. Be certain that the light source on the laryngoscope is working before beginning the procedure.
3. Choice of the proper endotracheal tube size based on weight

Tube size (mm) (inside diameter)	Weight (g)	Gestational age (wks)
2.5	Below 1,000	Below 28
3	1,000-2,000	28-34
3.5	2,000-3,000	34-38
3.5-4.0	Above 3,000	Above 38

4. Place the infant in the "neutral position"
5. Cautious oropharyngeal suction

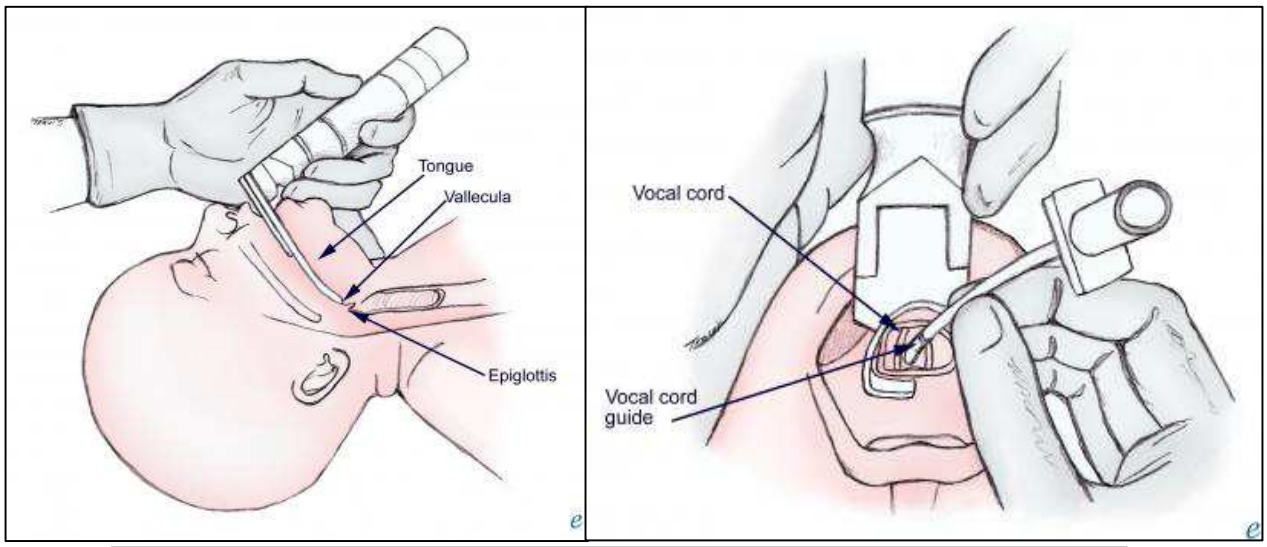

Figure: Steps of endotracheal intubation

6. Preoxygenate the infant with bag mask and monitor heart rate, colour and pulse oxymeter.
7. Pass laryngoscope blade gently along the side of the mouth and gently pull tongue and epiglottis forward by lifting the blade.
8. Insertion of the ET tube and gently pass through the cord. Application of cricoids pressure may be helpful to bring the larynx into view.
9. To limit hypoxia, limit each intubation attempt to < 20 seconds before reoxygenation.
10. Tip to lip measurement: Tube should be inserted upto 6 cm+wt in kg & fixed.

11. Confirm the position of tube:
    - Perform x-ray to confirm tube position. The preferred position of ETT tip is halfway between the thoracic inlet (the medial ends of the clavicles) and the carina.
    - Vapor condensing on the inside of the tube during exhalation
    - Breath sounds audible over both lung fields but decreased or absent over the stomach.
    - Improvement of SpO2, heart rate, colour
    - Symmetrical movement of the chest with each breath
    - No gastric distension with ventilation.

Complications

- Hypoxia
- Bradycardia
- Apnoea
- Injury
- Infection

Some Definitions

- **Fetus:** Fetus is a product of conception, irrespective of the duration of pregnancy, which is not completely expelled or extracted from its mother.
- **Birth:** Birth is the process of complete expulsion or extraction of a product of conception from its mother.
- **Live birth:** A live birth is complete expulsion or extraction from its mother of a product of conception, irrespective of duration of pregnancy, which after separation, breathes or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movements of voluntary muscles. This is irrespective of whether the umbilical cord has been cut or the placenta is attached. [Include all live births ≥500 grams birth weight or ≥22 weeks of gestation or a crown heel length of ≥25 cm]
- **Still birth:** Death of a fetus having birth weight ≥500 g (or gestation ≥22 weeks or crown heel length ≥25 cm) or more.
- **Birth weight:** Birth weight is the first weight (recorded in grams) of a live or dead product of conception, taken after complete expulsion or extraction from its mother. This weight should be measured within 24 hours of birth; preferably within its first hour of live itself before significant postnatal weight loss has occurred.
- **Low birth weight (LBW):** Birth weight of less than 2500 gm
- **Very low birth weight (VLBW):** Birth weight of less than 1500 gm
- **Extremely low birth weight (ELBW):** Birth weight of less than 1000 gm
- **Gestational age (GA best estimate):** The duration of gestation is measured from the first day of the last normal menstrual period. Gestational age is expressed in completed days or completed weeks.
- **Preterm:** Gestational age of less than 37 completed weeks (i.e. less than 259 days)
- **Term:** Gestational age of 37 to less than 42 completed weeks (i.e. 259 to 293 days)
- **Post term:** Gestational age of 42 completed weeks or more (i.e. 294 days or more).
- **Perinatal period:** Commences from 22 weeks (154 days) of gestation (the time when the birth weight is 500 g), and ends at 7 completed days after birth.
- **Neonatal period:** It refers to the period of *less than* 28 days after birth. Early neonatal period refers to the period before 7 days of age. Late neonatal period refers to the period from completion of 7 days up to 28 days of life.
- **Maternal death:** A maternal death is the death of a woman known to be pregnant within 42 days of termination of pregnancy, irrespective of the duration or site of the pregnancy from any cause related to or aggravated by the pregnancy or its management, but not from accident or incidental causes.
- **Prolonged rupture of membranes:** Rupture of membranes or leaking for ≥ 18 hours.
- **Antepartum hemorrhage:** Bleeding per vaginum after 20 weeks of gestation

❖ **Birth asphyxia:**

For outborn babies

- Moderate birth asphyxia: Slow gasping breathing at 1-minute of age.
- Severe birth asphyxia: No breathing at 1-minute of age.

For inborn babies

- Birth asphyxia: Apgar score of less than 7 at 1 minute of age
- Moderate birth asphyxia: Apgar score between 4 to 6 at 1-minute of age
- Severe birth asphyxia: Apgar score of 3 or less at 1-minute of age.

❖ **Respiratory distress**

Presence of at least 2 of the following criteria:

1. Respiratory rare > 60/minute
2. Chest indrawing
3. Expiratory grunt/groaning

❖ **Transient tachypnea/ Delayed adaptation:** Respiratory distress in a term or preterm neonate starting within 6 hours after birth, often requiring supplemental oxygen, but recovering spontaneously within 3-4 days and showing characteristic x-ray changes (linear streaking at hila and interlobar fluid).

❖ **Respiratory distress syndrome (RDS):** Presence of all of the following three criteria

- Pre-term neonate
- Respiratory distress having onset within 6 hours of birth
- Amniotic fluid L/S ratio of <1.5, or negative gastric aspirate shake test, or skiagram of chest showing poor expansion with air bronchogram/ reticulo-granular pattern/ ground glass opacity.

❖ **Meconium aspiration syndrome (MAS)**

- Meconium staining of liquor or staining of nails or umbilical cord or skin.
- Respiratory distress soon after birth, within one hour of birth
- Radiological evidence of aspiration pneumonitis (atelectasis and/or hyperinflation).

❖ **Pneumonia:** In a neonate with respiratory distress, pneumonia is diagnosed in the presence of a positive blood culture or if any two of the following are present.

- Existing or predisposing factors: maternal fever, foul smelling liquor, prolonged rupture of membranes (>18 hours) or gastric polymorphs more than 5 per high power field.

- Clinical picture of septicemia (poor feeding, lethargy, poor reflexes, hypo, hyperthermia, abdominal distension etc.)
- X-ray picture suggestive of pneumonia.
- Positive septic screen (see septicemia)

❖ **Septicaemia**

Culture negative: In an infant having clinical picture suggestive of septicemia, the presence of any one of the following criteria is enough for assigning probable diagnosis of infection:

- Existence of predisposing factors: maternal fever or foul smelling liquor or prolonged rupture of membranes (>18 hrs) or gastric polymorphs (>5 per high power field).
- Positive septic screen (two of the four parameters (namely, TLC (<5000/mm, band to total polymorph ratio of > 0.2, absolute neutrophil count less than 1800 / cmm, C-reactive protein >1mg/dl and micro ESR>10 mm 1st hour).
- Radiological evidences of pneumonia.

Culture positive sepsis: In an infant having clinical picture suggestive of septicemia, pneumonia or meningitis along with either of the following.

- Isolation of pathogens from blood or CSF or urine or abscess(es)
- Pathological evidence of sepsis on autopsy.

❖ **Meningitis:** In the setting of septicemia, if CSF culture is positive; or CSF microcopy and biochemistry are suggestive of meningitis.

❖ **Nectrotizing enterocolitis (NEC):** In a baby at risk for NEC (pre-maturity, sepsis, umbilical venous/arterial catheterization, birth asphyxia, extreme pre-maturity, formula feeding) presence of any two of the following:

- Pre feed gastric aspirate of >50% of previous feed or abdominal distension.
- Bloody stools or occult blood in the stools.
- Radiological evidence of pneumatosis intestinalis/portal air/free air under the diaphragm.

❖ **Hyperbilirubinaemia:** Total serum bilirubin level needing phototherapy and/or exchange transfusion

❖ **Hypothermia:** Skin temperature <36.5^{0}C

❖ **Hypoglycemia:** Whole blood glucose of less than 45mg/dL

❖ **Hypocalcemia:**

Any one of the following:

- Serum total calcium <7 mg/dl. or
- Serum ionized calcium <4 mg/dl.
- Q_OT_C >0.2 seconds on ECG which normalizes after calcium therapy.

❖ **Anaemia:** Hemoglobin <14 g/dl or PCV <40 percent

❖ **Polycythemia:** Capillary hematocrit of more than 70% or venous hematocrit more than 65% after 24 hours of age

❖ **Major congenital malformation:** A malformation that is life threatening or requires surgical correction.

❖ **Tidal Volume (VT):** This is the volume of gas that flows in and out of the chest during quiet breathing.

a) Small baby (<1500gm): 4-6 ml/kg
b) Average baby, big & sick baby 6-8 ml/kg

❖ **Rate / frequency:** The rate of mechanical breaths per minute set on ventilator.

❖ **Minute Ventilation (MV):** Total ventilation per minute. MV = Rate x V_T.
Example: 40 breaths / min x 6 ml/kg = 240 ml/kg/min

❖ **Inspiratory Time and I:E Ratio:** Usually 1:2 to 1:3. Normal inspiratory time range from 0.4 – 1.5 sec depending on postnatal age, ventilatory rate and underlying lung disease

❖ **PIP:** Maximum pressure measured by the ventilator during inspiration. A newborn with normal lung requires a PIP of about 12 cm of H_2O.

❖ **PEEP:** Pressure present in the airways at the end of expiration. A PEEP of 3-4 cm of H_2O is considered physiologic.

❖ **Mean Airway Pressure (MAP):** It is a consequence of ventilator settings. It is determined by PIP, PEEP, Inspiratory time and flow rate.

$$MAP=K[(PIP\times T_I) +(PEEP\times T_E)]/Ttot(T_I+T_E)$$

K= constant depend on flow rate, 1-square wave, 0.8- sine wave
MAP as low as 5 cm of H_2O may be sufficient in infant with normal lung.

❖ **CPAP:** It is the amount of pressure applied to the airway during all phases of the respiratory cycle. Usual CPAP pressure is 5-6 cm of H_2O.

Working doses in NICU

DRUGS	DOSE	INTERVAL
Inj Ampicillin (Pen-A: 250mg/2.5cc, 500mg/5cc)	50mg/kg/dose, =0.5cc/kg/dose =50unit/kg/dose In meningitis:75-150mg/kg/dose	Post natal age(PNA): 0-7days:12hrly >7 days:8hrly
Inj Gentamicin (Genacin, gentin: 20,80mg/2cc)	5mg/kg/dose, =0.5cc/kg/dose =50unit/kg/dose	>1000gm:once daily <1000gm:36hrly *Check trough level with fourth dose*
Inj Ceftazidime/Cefotaxime (250mg/2.5cc, 500mg/5cc)	50mg/kg/dose =0.5cc/kg/dose =50unit/kg/dose In meningitis:100mg/kg/dose =1cc/kg/dose	0-7days:12hrly >7days:8hrly
Inj Amikacin (Kacin, Amikin: 100,250,500mg/2cc)	7.5mg/kg/dose =0.15cc/kg/dose(calculated by 100mg/2cc) =15unit/kg/dose	12hrly
Inj Meropenem (I-penem, Ropenem,Specbac:500mg/10cc)	20mg/kg/dose =0.4cc/kg/dose =40unit/kg/dose In meningitis:40mg/kg/dose =0.8cc/kg/dose =80unit/kg/dose	0-14days:12hrly >14days:8hrly *Infuse over 30 minutes*
Inj Imipenem/cilastatin (500mg/100cc)	20mg/kg/dose =4cc/kg/dose (In meningitis: Dose & Frequency same)	12hrly Infuse over 30 minutes (Should not select baby presented with seizure)
Inj Vancomycin (500mg/10cc)	10mg/kg/dose =0.2cc/kg/dose =20unit/kg/dose In meningitis:15mg/kg/dose =0.3cc/kg/dose =30unit/kg/dose	0-14days:12hrly >14days:8hrly Always infuse over 1 hr *(Check trough level with fourth dose)*
Inj Netilmicin (200,50mg/2cc)	2.5mg/kg/dose =0.025cc/kg/dose (calculated by 200mg/2cc) =2.5unit/kg/dose	0-7days:12hrly >7days:8hrly *Check trough level with fourth dose*

Inj Ciprofloxacin (Neofloxacin:200mg/100cc	7.5mg/kg/dose =3.75cc/kg/dose	12hrly *Infuse over 30 minutes*
Inj Clarithromicin (Klaricid:500mg/10cc)	7.5mg/kg/dose = 0.15cc/kg/dose	12hrly *Always infuse over 1 hr*
Inj Colistin (1million=10,00000unit/10cc)	25,000unit/kg/dose =0.25cc/kg/dose =25unit/kg/dose(by 100 unit insulin syringe)	8hrly *Infuse over 30 minutes*
Inj Cefepime (Tetracef,ceftipime:500mg/10cc)	50mg/kg/dose =1cc/kg/dose In meningitis: Dose& Frequency same	12hrly *Infuse over 30 minutes*
Inj Piperacillin-Tazobactam (Zosyn:4.5gm/20cc diluent) Piperacillin:4gm Tazobactam:0.5gm	80mg/kg/dose(piperacilin component) =0.4cc/kg/dose =40unit/kg/dose	12hrly Range:50-100mg/kg/dose (piperacillin component) *Infuse over 30 minutes*
Inj Linezolid (Arlin:600mg/300ml)	10mg/kg/dose	12 hrly *Infuse over 30 minutes*
Inj Metronidazole (Filmet,Mez:500mg/100cc)	*7.5mg/kg/dose* *=1.5cc/kg/dose*	*< 29 weeks:* 0-28 days – 48 hourly > 28 days- 24 hourly *30-36 weeks:* 0-14 days – 24 hourly >14 days- 12 hourly *37 weeks or more:* 0-7 days- 24 hourly >7 days- 12 hourly
Inj Acyclovir (Xovir,Zovirax:500mg/10cc)	20mg/kg/dose =0.4cc/kg/dose =40unit/kg/dose	8hrly *Always infuse over 1 hr*
Inj Flucloxacillin (Fluclox,Phylopen:250mg/2.5cc,500mg/5cc)	50 mg/kg/dose =0.5cc/kg/dose =50unit/kg/dose In Osteomyelitis: 100mg/kg/dose =1cc/kg/dose	12 hrly In Osteomyelitis: 6hrly for 4-6 wks
Inj Phytomenadion (Inj Konakion:2mg/0.2cc)	Prophylaxis: At birth: 2mg=0.2cc=20units Administer, 1mg=0.1cc=10units, IM stat	

<table>
<tr><td rowspan="5">Tab.Digoxin
(Lenoxin:1 tab=0.25mg)

Syp.Digoxin
(syp centoxin=0.25mg/ml)

Inj.Digoxin
(Dixin:1 amp=0.25mg/2ml)</td><td></td><td colspan="2">Preterm</td><td colspan="2">Term</td></tr>
<tr><td></td><td>IV

(µg/kg/day)</td><td>Oral</td><td>IV</td><td>Oral</td></tr>
<tr><td>Total digitalizing dose(TDD)</td><td>15-25</td><td>20-30</td><td>0-30</td><td>25-35</td></tr>
<tr><td rowspan="2">Maintenance dose</td><td>4-6</td><td>5-7.5</td><td>5-8</td><td>6-10</td></tr>
<tr><td colspan="4">TDD is to be divided 1/2, 1/4 and 1/4every 8 hrs

Oral dose is 25% higher than IVdose</td></tr>
<tr><td>Frusemide+Spironolactone

(Frulac/Lasilactone:1 tab=20/50mg)</td><td>Frusemide= 1mg/kg/dose
Spironolactone=1-2mg/kg/dose</td><td colspan="4">12 hrly or once daily</td></tr>
<tr><td>Captopril

(Acetor,Cardopril:1 tab=25mg)</td><td>0.01-0.05mg/kg/dose</td><td colspan="4">8-12 hrly</td></tr>
<tr><td>Ibuprofen

(Syp inflame, profen:100mg/5ml)</td><td>IN PDA
D1:10mg/kg/dose,orally
D2:5mg/kg/dose
D3:5mg/kg/dose</td><td colspan="4">Contra-indications:
Urine output:<0.6ml/kg/hr
S creatinine:>1.8mg/dl
PLT:<60,000/mm3
GIT bleeding, NEC
IVH</td></tr>
<tr><td>Sildenafil

(Edegra:1 tab =50mg)</td><td>0.5-2 mg/kg/dose</td><td colspan="4">6 -12 hrly</td></tr>
<tr><td>Inj Frusemide

(Lasix:20mg/2cc)</td><td>1mg/kg/dose
=10unit/kg/dose</td><td colspan="4"></td></tr>
<tr><td>Levo-thyroxine

(1 tab=50 µg)</td><td>10-15µg/kg/day</td><td colspan="4">once daily</td></tr>
</table>

Inj Phenobarbitone (Barbit:200mg/cc)	Loading =20mg/kg/dose =0.1cc/kg/dose =10unit/kg/dose	
	Maintenance=2.5mg/kg/dose =1.5unit/kg/dose N.B:10mg/kg/dose=5unit/kg/dose	12hrly
Inj Fosphenytoin (Fosphen:150mg/2cc)	Loading =30mg/kg/dose =0.4cc/kg/dose =40unit/kg/dose	
	Maintenance=3.75mg/kg/dose =5unit/kg///dose N.B:15mg/kg/dose=20unit/kg/dose	12hrly
Inj Midazolam (Dormicum, Dormitol:15mg/ 3cc)	Continuous infusion: <32 wks: 0.03 mg/kg/hr >32 wks: 0.06 mg/kg/hr Range: 0.01-0.06 mg/kg/hr	
Inj Pyridoxine 1 amp= mg/ cc 1 tab= mg	50-100 mg IV single dose, followed by a 30 minutes observation period If a response is seen, begin maintenance of 50-100 mg PO daily. Range:10-200 mg	
Inj Ranitidine (Ranison,Neotack:50mg/2cc)	1mg/kg/dose =4unit/kg/dose	12hrly
Inj Aminophyllin (125mg/5cc)	Loading =5mg/kg/dose =20unit/kg/dose Maintenance=2.5mg/kg/dose =10unit/kg/dose	 12hrly
Inj Dopamine (200mg/5cc)	Cardiac:5-20µg/kg/min N.B: 5 µg/kg/min=18unit/kg/24hrs 7.5 µg/kg/mi =27 unit/kg/24hrs 10µg/kg/min =36 unit/kg/24hrs	*Requirement of Dopamine in 2kg baby* 5×2×24×60=14400µg=14.4mg= 14.4mg÷40=0.36cc=36unit Inj Dopamine(200mg/5cc) 36unit+24mI IV fluid@1 ml/hr
	Renal: 0.5-2µg/kg/min	

Inj Dobutamine (250mg/5cc)	5-20µg/kg/min N.B: 5 µg/kg/min =15unit/kg/24hrs 7.5 µg/kg/min=22.5 unit/kg/24hrs 10µg/kg/min =30 unit/kg/24hrs	*Requirement of Dobutamine in 2kg baby=5×2×24×60=14400µg =14.4mg=14.4mg÷50=0.3cc=30unit* *Inj Dopamine(250mg/5cc)* *30unit+24mI IV fluid@1 ml/hr*
Inj Adrenaline (Inj Adrin: 1 amp=1:1000 dilution) 1 ml mixed with 9 ml distilled H2O to make a 1:10,000 dilution	0.1-0.3 ml/kg IV =10-30 unit/kg	Indication: Severe bradycardia REPEAT DOSE, IF NEEDED
Inj Naloxane (1 amp=0.4 mg/ 1ml)	0.5 ml/kg	If MOM received opiate within 4 hrs of delivery
Inj Immunoglobin Pentaglobin:1 vial=10 ml	5ml/kg/dose Infusion rate:1.7 ml/kg/hr	Once daily, 3-5 doses
Inj 10% Calcium gluconate **Prophylactic** Preterm< 32 wks, sick IDM, severe asphyxia 40 mg/kg/day for 3 days (4ml/kg/day of 10% calcium gluconate) *IV or oral* □ Treatment is for 72 hours □ Continuous infusion is better than bolus □ Symptomatic babies treatment is 48 hrs continuous infusion	***Asymptomatic*** • 80 mg/kg/day for 48 hrs(8 mL/kg/day of 10% calcium gluconate) • Taper to 40 mg/kg/day for one day • Then stop	***Symptomatic*** • Bolus of 2 mL/kg calcium gluconate 1:1 diluted with 5 % dextrose over 10 minutes under cardiac monitoring • Followed by continuous infusion 80 mg/kg/day for 48 hrs • (8 mL/kg/day of 10% calcium gluconate) • Then taper to 40 mg/kg/day for one day • Then stop
Inj Sodium bicarbonate	Total requirement=0.4× wt in kg× base excess	eg. If wt 2 kg and ABG shows BE= - - 15 mmol/l Total requirement=0.4×2×15= 12mmol/l=12 cc • 1^{st} $1/3^{rd}$=4cc mixed with same amount of distilled H2O IV stat • 2^{nd} $1/3^{rd}$ =4cc mixed with 24 hrs IV fluid • Rest $1/3^{rd}$:Auto-correction, if renal functions is in normal limit.

Inj Dexamethasone (Oradexon,Roxadex:1amp=5mg/1 ml)	For extubation: 0.25-1mg/kg/dose	4hrs prior to schedule extubation and then 8hrly for 3 doses
Inj Hydrocortisone	In recurrent rypoglycemia: 2.5 mg/kg/dose, IV or PO	12 hrly for 24 to 48 hrs Recurrent / resistant hypoglycemia [When there is a failure to maintain normal blood sugar levels despite a glucose infusion of 12 mg/kg/min or when stabilization is not achieved by 7 days of therapy.]
Syp Multi-vitamin (Tynisol,V-plex,Panvit paed drop)		6 drops PO once daily for 6months
Tab Folic acid (Folison:1Tab=5mg)	1/4 tab	Every alternate day for 6months
Syp Iron (Compiron:50mg/cc)	4-6mg/kg/day Total daily requirement(in drops) =wt×2	Over 6months NB: Multi-vitamin, Folic acid, Iron should be started in preterm babies when full oral feed is achieved
Syp UDCA (Syp Liconor:250mg/5cc)	7.5mg/kg/dose	12hrly
Nystatin oral suspension (candex,Nystat:100000IU/c)	1cc= 15 drops	6hrly
Domperidone paed drop (Omidon, motigut): 2.5mg/1ml)		Requirement: Per dose(in drops): Wt×1, 8 hrly