SPHMMC NICU

Guiding Protocol

February, 2019.

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ADMISSION AND DISCHARGE CRITERIA TO NICU

Admission criteria

- Birth weight of < 1500 gm.
- Gestational age <34 weeks
- Babies requiring positive pressure ventilation in L& D
- Babies with problems such as respiratory distress or hypoglycemia or hypothermia
- Babies requiring phototherapy
- Babies with congenital anomalies with medical or **surgical emergency**
- Inborn babies immediately after delivery may be kept in NICU for observation for a period of 4 hours if they have mild respiratory distress or have required minimal resuscitation.
- Babies admitted for hypothermia and hypoglycemia should be discharged 4 hours after correction unless other associated problem.
- Critically ill babies brought to emergency (when there is no vacancy) should not be transferred to other hospital in serious condition. Transfer the baby after stabilization and confirmation of bed availability to other hospital. Shift out/ transfer should be done after baby is seen by a consultant.

**Babies with infective diarrhea, chicken pox, open wounds, skin lesions should be admitted to NICU isolation or pediatric isolation room*

Discharge criteria

- Baby feeding well
- Maintains temperature without assistance.
- Weight gain for 3 consecutive days.
- No evidence of infection.
- Discharge summery written
- If there is specific problem the management plan should be documented
- Advice follow up in high risk OPD within 7 days of discharge.
- Enroll the baby for high risk follow up clinic if
  - Birth wt < 1500 gm or GA < 34 wks.
  - Ventilated neonates/CPAP
  - Undergone exchange transfusion and has clinical evidence of kernicterus
  - HIE and/or neurologically abnormal at discharge
  - Meningitis/seizures
  - Syndromic conditions with risk of developmental delay

Examination on Discharge

- Weight.
- Presence of cardiac murmur.
- Umbilical cord - erythema/induration
- Rule out Developmental Dysplasia of Hip (DDH).

Advice on discharge

- Exclusive breastfeeding till 6 months, weaning from 6 months and breastfeeding along with complementary feeding till 2 years of age.
- Immunization.
- Newborn care: Advice on bath, oil application and massage
- Follow up in Well-Baby-Clinic after 15 days.
- Danger signs
- Advice on traditional malpractices

Follow up of NICU graduates

- First visit within 7 days of discharge.
- Subsequent visits – at term (corrected age), 6 weeks, 3 months, 6 months, 9 months, 12 months, 18 months, 2 years, 3 years, 4 years, 5 years
- Monitoring of growth and nutrition.
- Neuromotor assessment.
- Neurodevelopmental assessment.
- Neurosensory examination.
- Neuroimaging assessment.
- Early intervention therapy when indicated.
- Anticipatory guidance to parents.
- Record keeping

- **Monitoring of growth and nutrition** – Record weight, length, head circumference, mid arm circumference at each visit. Plot the measurements on respective charts in follow-up cards.
- **Neuromotor assessment** – Neuromotor assessment by Amiel Tison / INFANIB neuromotor assessment at each visit and recorded in the card.
- **Neurodevelopmental assessment** – Neurodevelopmental assessment at 12 months and abbreviated Bayley's Scale of Infant Development (BSID) at each visit.
- **Neurosensory assessment** –
  - **a) Ophthalmic examination**
    - i.) Indirect ophthalmoscopy till retinal vascularization is complete.
    - ii.) Optometry at 2 months CDOB to find out astigmatism and myopia.
  - **b) Auditory evaluation** – Hearing screening by BERA or Oto Acoustic Emission at 6 weeks CDOB and if abnormal, complete hearing evaluation. Behavioral audiometry if facilities are not available for screening tests.

- **Neuroimaging –**USG, CT scan, MRI scan as indicated. All VLBW babies to have at least a NSG at 40 weeks corrected gestational age.
- **EEG** as indicated.
- **Early intervention therapy** – On detection of abnormality on neurodevelopmental assessment early intervention therapy is started by occupational therapist
- **Anticipatory guidance to parents –**
  a) Parents are made to understand the problems of babies, treatment required, importance of follow-up and prognosis.
  b) Other advises given
    - Immunization
    - Nutrition – re-emphasis on exclusive breastfeeding till 6 months, complementary feeds to be started at 6 months and breastfeeding to be continued till two years.
    - Other aspects of neonatal care.
- **Record keeping** – all babies in follow-up are given special high risk discharge cards with follow-up number and filed yearly.

DISCHARGE CHECKLIST FOR NORMAL NEWBORNS

- ☐ Feeding observed
- ☐ TSH-when available
- ☐ MS-when available
- ☐ Hips
- ☐ Red reflex
- ☐ Femorals
- ☐ Jaundice
- ☐ Weight gain
- ☐ CCHD screening
- ☐ Hearing screen

Transfer out policy

Stable infant: In case of request to continue care at another facility. The doctor will be contacted and informed and ensured bed availability. The infant is shifted ensuring that he/she is warm and vitals and glucose are stable. A discharge summary will be provided

Sick infant: The infant could be transferred out in order to get treatment that is currently unavaible here or at parent's request. The hospital where the infant is being transferred will be contacted . It should be ensured that bed is available. The infant will be transferred in a n ambulance with monitor, IV fluids, oxygen. A resident doctor and nurse will accompany the baby.

Observation

Indications**: Late preterm/ Term infants for RDS / HIE monitoring.**

Procedure:

- The vitals, Spo2 need to be monitored. HIE monitoring by sarnat and sarnat staging needs to be done Q30 min for HIE babies.
- RDS monitoring by Downe's score needs to be done for infants with respiratory distress. The infants need to be shifted out after assessment by **a fellow or senior resident** with a proper shift out notes and instructions for monitoring within 6 hours. If the infant requires > 6 hours, he needs to be shown as admission

Guiding principle in the LABOR ward concerning the newborn care

- ALS nurses must be present in the delivery room
- Every delivery should be communicated to the ALS nurses before delivery
- Every high risk mother should be communicate to the neonatal team in addition to ALS team before delivery and the team should be involved before delivery
- The 3rd year or the 4th year residents of obstetrics need to call the second or third year resident in NICU (night) or neonatology fellow/attending (day).

Things to be communicated: Mother's name, location in the ward, pregnancy/fetal complications, gestational age, when anticipated to deliver, anticipated mode of delivery, whether antenatal counseling is needed

**If at night, resident is to call and update supervising fellow or attending*

Infants requiring observation for: risk of sepsis, hypoglycemia, hypothermia, respiratory distress, or other concerning signs should be observed in the NEST by senior resident/ALS nurse team; neonatologist/neonatology fellow/ pediatrician should be informed. Decision to admit to NICU or return to well newborn with mother should be made jointly after observation of at least 2-4 hours. Antibiotics should be initiated here when infant has historical risk factors of sepsis. Labor and delivery resident to provide hand off to post-natal NICU team, and mother's bedside nurse. Intermittent checks of infant status should be done by the post-natal NICU team.

Infants requiring admission to NICU (high risk) should be stabilized initially in delivery room, then transferred to NEST for initiation of radiant warmer/IV/respiratory support then transported in isolette to NICU. Laboratory studies should be sent from this area. Antibiotics may be initiated here. L and D Resident or ALS nurse will provide verbal handoff to the NICU admitting team.

Residents assigned to NICU rotation may be placed for clinical duty in NICU, L and D (attending deliveries and observing infants in NEST), or on post-natal team, providing checks for well-newborns.

Two fellows or attending neonatologists/pediatricians will be assigned to manage NICU patient, one will attend deliveries and supervise the NEST and post-natal resident, as well as provide antenatal consultation.

Well baby discharge

All infants should be observed in the post-natal unit for a minimum of 24 hours. This is to ensure that infants with developing sepsis, respiratory distress, jaundice, and other common newborn illnesses are not missed. Infants with historical risk factors for sepsis, whether or not they qualify for antibiotics, should be observed a minimum of 48 hours.

Both mother and baby's status should be considered in the discharge from post-natal ward. If an infant requires additional care that does not meet the level of intensive care, they should be transferred to the general pediatrics ward, and remain in the post-natal ward with mother until time of transfer.

Antenatal conditions that need to be referred for Neonatologist consultation

- Preterm delivery less than 34 weeks
- Infants of diabetic mother
- Mother with severe chronic illness like cardiac, hypertension…
- Maternal oligohydrminos or polyhydraminous
- Mother with RH sensitization and also suspected erythroblastosisfetalis, hydrops fetalis
- Pregnancy with chromosomal or congenital anomalies
- Antenatal fetal hydronephrosis
- Diaphragmatic hernia
- Suspected intestinal obstruction

GUIDING PRINCIPLE OF NICU

* Dear, residents, interns, fellows and other students welcome to NICU
* We appreciate and acknowledge your devotion, commitment and team work in the NICU to help the sick newborns.
* During your stay in the NICU we would like to kindly to follow all this rules below
* Punctuality is mandatory as your presence in the unit is helpful to save the life of the babies who cannot speak for them selves
* Always give greeting to the team and introduce your selves especially if you are new everyone's happy to work with you and also help you
* Remember to remove your white coat and change scrubs upon entry to the unit and also change shoes
* It is mandatory to wear short sleeve shirts, remove watches and jewels
* Wash hands before entry to NICU and on exist to the NICU
* Remember always the WHO guiding principle for hand hygiene and apply it
* Keep yourselves net, clean scrubs daily
* Nails must be short ¼ inch, no artificial nails and no nail polish is allowed a, no ring no watch
* Be respectful to the team working in NICU
* Be compassionate to parents
* Every baby has his/her own thermometer, statoscope, tape meter, resuscitation equipment in the bed please clean it before use and after use. There shouldn't be misplacement.

NICU TEAM RESPONSIBILITIES

1. **Responsibility of the Fellow**

    - Will evaluate and put note for ventilated babies, babies on inotropes
    - Leads round
    - Teaches residents, inters and nurses
    - Participate on residents teaching
    - Will be guided by the curriculum for the teaching activity

2. **Responsibility of the 3rd year Resident**

    - Make sure the documentation of every newborn is complete has admission sheet, order sheet, vital sign sheet discharge summery and ENN for is filled
    - Will evaluate critical infants and new babies before the round and makes sure progress note is up-to-date
    - Analyze the cases and plan change of treatment or new treatment
    - Participates on teaching of the juniors on round
    - Inform the consultant difficult and critical cases
    - Actively defend the cases on morning session
    - Evaluate KMC babies
    - Supervises procedures done by the junior residents and interns
    - Gives orientation to interns and residents at the beginning of shift
    - Leads weekly audit of NICU activity in his/her wing
    - Organize NRP training for the new residents in the team with the consultant
    - Must post the name of the residents and interns working in the NICU is posted, duty schedule is also posted
    - Must do counseling for parents and care takers for babies in the NICU
    - Must be involved in follow up of high risk infants

3. **Responsibility of the 3rd year resident assigned in labor and delivery**

    - Participates in morning session of the obstetric department and responds about babies transferred to NICU

- Makes daily round in postnatal ward and put plan
- Actively involved on neonatal resuscitation with the help of neonatal advanced life support nurses
- Be informed of high risk deliveries and high risk mothers and gives counseling

4. Responsibility of the 2nd year resident

- Put progress note for critical babies and also takes equal share with the year 1 resident on progress note and also new case admission
- Primarily responsible for procedures like lumbar puncture, umbilical catheterization, intubation
- Should be always ready with reading of ward cases and should update the team
- Must do daily counseling for parents and care takers
- Decides admission and discharge with the third year resident
- Must do discharge counseling
- Teaches the juniors
- Must be involved in follow up of high risk infants

5. Year one resident

- Must take NRP course and Infection prevention course before starting attaching to NICU
- Responsible for first line evaluation of new patients and consult the senior residents
- Be able to decide and interpret laboratory and other investigations
- Puts admission note, discharge summery death summery
- Makes sure the ENN/ Ethiopian Neonatal Network data is filed
- Must read cases, present assignments
- Must consult senior residents for decision during working and duty hour

6. Intern physician's responsibility during NICU attachment

- Must know and demonstrate basics of neonatal resuscitation, bag mask ventilation
- Must be the primary physician with the year one resident to clerk new babies
- Must put complete history and physical examination and assessment on admitted babies chart
- Has to put management plan for his/her patients
- Make sure ordered investigations and imaging is done on time
- Consult every case of admission to residen

7. Responsibility of residents working in HRIC

- Be punctual
- Evaluate the reason for follow up and do cased based evaluation and management
- Growth assessment and monitoring should be done for every infant
- Developmental assessment must be done
- Consult the responsible senior in the clinic
- Follow the guideline of follow up clinic

8. Responsibility of the Nurse

- Do a proper handover
- Patient care
- Do Nursing Assessment and care plan
- Check if the babies have Identification name if not write immediately
- Clean and decontaminate equipment's
- Write HMIS
- Responsible for the cleanness of the ward
- Do a proper waste segregation
- Participate on the daily rounds with head nurse in the morning
- Drawing blood
- Carrying out orders

- Preparing and administering medications

9. Runners' Responsibility

- Take patient samples to lab and bring results on time
- Bring and return patient medical cards
- Bring and return material to the NICU from pharmacy, laundry and sterilization unit.
- Call mothers for babies who are crying
- Tell mothers and anybody who gets in to the unit to wash hands or provide hand sanitizers

10. Feeder's Responsibility

- Milk preparation and feeding babies timely, whose mothers are not present
- Change diapers and towels for babies whose mothers are not present
- Fill the hand sanitizers
- Stock materials

11. Guard's Responsibility

- Make sure only the allowed people enter the unit
- Make sure people who enter the unit have changed their clothe and shoes before entering the unit
- Make sure the visitor's protocol is implemented.

HEALTHY NEWBORN CARE

Care in delivery room

**Resuscitate if required as per NRP guidelines with the ALS team*

- **Routine care**: if the baby has cried immediately after birth:

- Place the baby on the mother's abdomen on pre-warmed dry and clean cloth. Dry the baby completely, changes the wet linen. Assess respiration and heart rate.
- **Delayed cord clamping** at 1-3 minutes in both term and preterm neonates who do not require resuscitation. Cut the cord at 3-4 cm from skin, after applying plastic sterile clamp. Do not apply any medication.
- **Skin to skin contact** with the mother. Place the baby prone on the mother's chest after covering the head and the body with a warm sterile sheet. Continue skin to skin contact for 1 hour. Even if the baby is separated for routines such as weighing place the baby in skin to skin contact. Ensure the safety of the baby continuously during the procedure.
- **Early breastfeeding**: Help the mother for breastfeeding within 1/2 an hour of normal delivery in the labor room itself and in case of LSCS (low segment caesarian section) as soon as mother is out of anesthesia or within 4 hours of birth.
- **Put identification tag**
    - Mother's name, sex, wt., delivery date and time should be included
    - For twins indicate which is first and second (follow the same for triplets and above)
- **Examine the baby from head to toe:** Look for life threatening congenital anomalies like bilateral choanal atresia, esophageal atresia, tracheo-esophageal fistula, imperforate anus and diaphragmatic hernia. Do not forget to examine
    a. Femoral pulsations.
    b. Umbilical cord for number of arteries and veins.
    c. Eyes for corneal size, corneal opacities and cataract.
    d. Back of baby for tuft of hair, swelling and pilonidal sinus.
    e. Placenta, specially in high risk mothers and neonates. Send for HPE(histopathology examination)in high risk cases.

- Assign sex to the baby and show baby to parents/ relatives.
- Weigh the baby, measure length & head circumference (after 24 hours) of the baby
- Give Inj. Vit.K 1mg IM to babies > 1500 g and 0.5 mg IM to babies < 1500 g.
- Apply TTC Eye ointment to both eyes to all babies.

Cord blood collection

- Collect cord blood for blood grouping in all cases.
- If the mother is O or Rh negative group, send for direct Coomb's test. Follow up DCT within 2 hours. Also do cord Hb and bilirubin if Rh negative mother.
- Cord ABG in babies requiring positive pressure ventilation, and high risk deliveries.

Care in PNC ward

- Keep mother & baby together "rooming in", "Bedding in" is preferred if the mother is conscious and able to care for the baby.
- Keep the baby warm by covering head, body and feet with cotton clothes.
- Monitor the temperature and feeding 6 hourly
- Feed the baby on demand; ensure proper position for breastfeeding & advice regarding breastfeeding. All mothers require lactation support. Assess for risk for lactation problems. At least one feed should be observed by the nurses and pediatrics resident doctor for proper position and attachment.
- Confirm whether the baby has passed meconium & urine within 1st 24 hrs and 48 hrs respectively.
- Check the weight daily. Watch for excessive (>10%) weight loss
- Assess risk factors for severe hyperbilirubemia. Examine the baby twice a day for jaundice. If the baby is icteric on day 1 or below abdomen at any time send for a TB/CB (total bilirubin/conjugated bilirubin) urgently.
- Supplement preterm newborns(less than 37 weeks) with Vitamin D3 400 IU.

If baby has not passed meconium in 24 hours

- Check for vomiting, abdominal distension to rule out surgical etiology.
- If absent - ensure proper supervised breastfeeding and re-examine after 2-4 hrs and reassure the mother.

If baby has not passed urine between first 12 to 24 hours

- Check the antenatal history for oligohydramnios and any renal malformations.
- Examine for signs of dehydration and a palpable bladder.
- Supervise feeds and re-examine after 4-6 hrs.

Skin care

- Don't remove vernix caseosa.
- **No baby bath immediately after birth.**
- No baby bath in hospital
- Examine daily for superficial skin infection.

Cord care

- Clean cord care – Do not apply anything over the cord and let the cord remain open to dry.
- Ensure cord is out of the diaper
- Watch for foul smell, periumbilical erythema or induration.

Eye care

- No special care required.
- Use Azithromycin syrup 10mg /kg for 5 days or ceftriaxone 125mg/kg STAS dose only if discharge is present, after sending discharge swab for gram stain and culture & sensitivity.
- Clean the eye with saline swabs from medial to lateral canthus before instilling eye drops after proper hand-wash.
- Apply TTC Eye ointment to both eyes to all babies.

Newborn Screening

- Collect cord blood for TSH-when available
- Hearing screening by behavioral observation audiometry
- OAE for high risk infants.
- Eye screening: by red reflex assessment
- Critical CHD screening

Management of LBW baby in the OB ward

- Manage LBW babies > 2000 g and > 34 weeks in the OB ward.(consult the ALS team and the pediatrics resident)
- Educate the family regarding keeping the baby warm and frequent feeding. Provide a warm cradle to the baby.
- Kangaroo mother care should be started immediately after delivery. If the mother is unable to do so, anyone from the family can provide KMC.
- Monitor temperature and feeding at least 4 hourly. The mother-baby dyad requires more intensive lactation support.
- Do RBS at 2 hours of birth and subsequently 6-8 hourly for the first 48-72 hours.
- Monitor for jaundice. Routinely test for TB /CB at 48 hours.
- Supplement with calcium, phosphorus and multivitamins.

Discharge policy

- Discharge full-term normal babies after 24 hrs & low birth weight babies after 3 days of postnatal life.

Examination on discharge

- Weight
- Presence of cardiac murmur.
- Umbilical cord - erythema/induration
- Rule out Developmental Dysplasia of Hip (DDH).
- Breast feeding

Discharge check list

- Ensure discharge check list is completed. Discharge check list:
  - wt. gain / or no excess weight loss. Last weight should be mentioned in the discharge summary.
  - No ongoing problems
  - Feeding well established. Mother is comfortable with no feeding problems and latch is good.
  - Newborn screening (MS, hearing, eye, CCHD) is done. TSH screening is reviewed.(when applicable)
  - Immunization is done.
- Advise according to pamphlet & re-emphasize on
  - Exclusive breastfeeding till 6 months, complementary feeds from 6 months and breastfeeding along with complementary feeding till 2 years of age.
  - Sunlight exposure
  - No harmful cultural practices
    - Observing babies with adequate light
    - External feeds like water with herbs, butter, etc….
  - Follow up at 7 days of life.

NEONATAL RESUSCITATION PROTOCOL

Identifying the high risk neonate

Antepartum Factors

Preterm delivery	Oligohydramnios
GA> 41 0/7 weeks	Fetal hydrops
Pre eclampsia / eclampsia	Fetal macrosomia
Maternal hypertension	IUGR
Multiple gestation	Fetal malformation
Fetal anemia	Maternal substance abuse
Polyhydramnios	No prenatal care

Intrapartum factors

Emergency cesarean section	Intrapartum bleeding
Forceps or vacuum-assisted delivery	Chorioamnionitis
Breech or other mal presentation	Narcotics given < 4 h before delivery
Category II or III FHR pattern	Shoulder dystocia
Maternal general anesthesia	MSAF
Maternal magnesium therapy	Proloapsed umbilical cord
Placental abruption	

Preparation for resuscitation

- **Check inventory in the LR daily and enter in the inventory book**

Anticipation and preparation are the key factors to effective resuscitation.
Enquire regarding gestational age, MSAF, singleton?, risk factors.

Personnel

- All deliveries to be attended by certified postgraduate with a nurse.
- < 32 weeks/ < 1500 g / high risk deliveries – senior resident or fellow
- < 28 weeks / CDH / < 1000 g – consultant when possible.
- Consider team briefing and role allocation

Equipment

Warmth

- Radiant warmer (heated for10-20 min prior), 2 sterile warm towels, Cling wrap (GA< 32 wk)

Suction Equipment

- Mechanical slow suction (100 mm Hg) with tubing/bulp suction
- Suction catheters, 8F or 10F, and 12F or 14F

Positive pressure ventilation equipment

- Functioning self-inflating bag – with term and preterm mask
- T piece resuscitator (if preterm delivery)

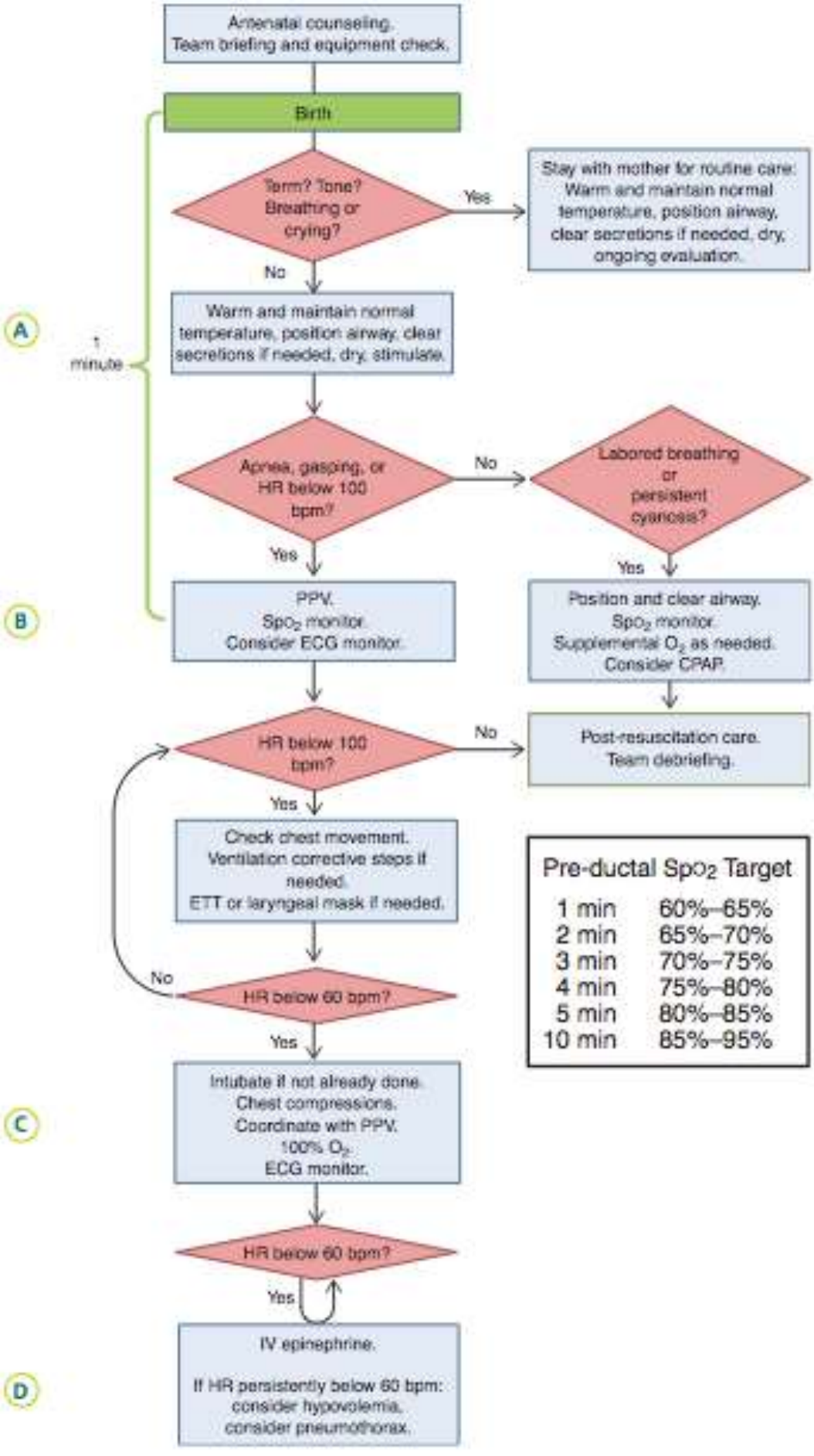
Intubation equipment

- Laryngoscope with straight blades (No. 1 (term);0 (preterm); 00 (extreme preterm)
- Endotracheal tubes: 2.5, 3.0, 3.5 (No. 2 tube not recommended)
- Tape for securing endotracheal tube

Umbilical vessel catheterization kit

- UVC kit – sterile cotton balls, gauze, sterile tie,
- Sterile gloves, Scalpel or scissors, umbilical catheter (5 F feeding tube), 3 way stop cock, dynaplast, 1, 2, 10, 20 ml syringes
- Spirit, Povidone - iodine solution, NS,
- Daily freshly prepared 1:10000 adrenaline solution labeled with name, concentration and date of preparation. If used for a baby, rest is discarded and a fresh set is prepared for next use.
- Others- Thermometer , stop watch

* ***Ensure that transport incubator is switched on and starting to heat while before going for delivery(especially for high risk delivery)***


Antenatal counseling.
Team briefing and equipment check.
Birth
Term? Tone? Breathing or crying?
Yes
Stay with mother for routine care: Warm and maintain normal temperature, position airway, clear secretions if needed, dry, ongoing evaluation.
No
A
Warm and maintain normal temperature, position airway, clear secretions if needed, dry, stimulate.
1 minute
Apnea, gasping, or HR below 100 bpm?
No
Labored breathing or persistent cyanosis?
Yes
Yes
B
PPV.
SpO2 monitor.
Consider ECG monitor.
Position and clear airway.
SpO2 monitor.
Supplemental O2 as needed.
Consider CPAP.
HR below 100 bpm?
No
Post-resuscitation care.
Team debriefing.
Yes
Check chest movement.
Ventilation corrective steps if needed.
ETT or laryngeal mask if needed.
No
HR below 60 bpm?
Yes
C
Intubate if not already done.
Chest compressions.
Coordinate with PPV.
100% O2.
ECG monitor.
HR below 60 bpm?
Yes
D
IV epinephrine.
If HR persistently below 60 bpm: consider hypovolemia, consider pneumothorax.
Pre-ductal SpO2 Target
1 min 60%–65%
2 min 65%–70%
3 min 70%–75%
4 min 75%–80%
5 min 80%–85%
10 min 85%–95%

Assess if the baby cries immediately after birth

If yes – provide Routine Care

- Provide routine care on the mothers abdomen
- If secretions are present, turn head to one side and wipe off secretions gently.
- Dry and discard wet cloth. Cover the head
- Cut cord after 1 minute in both term and preterm.
- Initiate breastfeeding as soon as baby is ready.
- Continue skin to skin care for at least 1 hour.
- All routine care such as Vit K, applying identification band, eye care can be done in skin to skin contact. Routines such as birth weight check, complete examination may be delayed. However if the baby is separated for these routines, the baby should be provided SSC as soon as possible.

Initial steps in resuscitation (30 seconds)

If baby does not cry immediately after birth, then the initial steps of resuscitation are provided. The initial steps in resuscitation consist of

- Preventing heat loss and providing warmth.
- Positioning and clearing the airway.
- Drying and removing the wet linen
- Initiating breathing by gentle stimulation (gently if required).
- Evaluation- HR, respiration and color

Evaluation of the newborn is based on

- Respiratory effort
- Heart rate

Positive pressure ventilation

Indications

- Apnea or gasping respiration
- Heart rate less than 100 per minute

Steps

1. Check the equipment to ensure that there are no tears or leaks.
2. Position the infant correctly with slight extension at the neck
3. Position the mask correctly and apply a firm seal. Provide 5 breaths and check for rising heart rate, if absent, adequate chest movement.
4. If there is no adequate chest rise, take ventilatory corrective steps (MRSOPA).
5. Once effective ventilation starts, continue for 30 seconds at 40-60 breaths / minute. Initiate PPV with room air (21% on blender; 21- 30% in preterm).

6. Connect to pulse oximeter. Titrate as per minute wise saturation targets. In preterm use 21% to 30% oxygen. If blender is not available, a self-inflating bag (with O_2 and without reservoir) provides 40%.
    - Pressures required to inflate the lungs :
        - Normal – 15 – 20 cm H_20
        - Diseased – 20 – 40 cm H_20
7. Evaluate the heart rate after 30 seconds of bag and mask ventilation
8. If heart rate is above 100 and infant has spontaneous respiration, discontinue ventilation
9. Heart rate between 60 & 100 – continue ventilation.
10. Heart rate < 60 beats per minute – ensure ventilation with 100% oxygen and initiate chest compression.
11. Pass an oro-gastric tube if bag and mask ventilation is continued for more than 2 minutes.

Contraindications

- Diaphragmatic hernia

Chest compressions

Indication

If heart rate less than 60/min despite good assisted ventilation for 30 sec.

Methods

- Two thumb method.

Steps

1. Intubate. Use 100% oxygen. Call for help if needed
2. Location: lower third of sternum strictly avoiding applying pressure on the xiphoid.
3. Depth: Compress the sternum approximately 1/3 of the A-P diameter of the chest.
4. Rate: 90 times per minute and ventilation 30 times per minute with a ratio of 3:1.
5. Evaluation: After 45-60 seconds of chest compression, check the heart rate.
6. If HR < 60/min- Continue compression and ventilation, Initiate medications.
7. If HR > 60/min - Discontinue compression. Continue ventilation till HR > 100/min
8. and good respiratory efforts.

Drugs

Epinephrine

Indications: HR < 60/min despite adequate ventilation and chest compression for 45-60 seconds. (at approximately 2 min of life) .

Dose: 0.1 – 0.3 ml/kg IV or 0.5 - 1 ml/kg Et 1 : 10,000 of epinephrine solution, may be repeated every 3-5 min if required. Endotracheal route is easier, but IV is preferred. Initiate UV cannulation as ET dose is given.

Volume expanders

- Normal saline, plasma expanders, whole blood can be used.
- Indication: Shock, acute bleeding, poor response to resuscitative efforts.
- Dose: 10 ml/kg IV over 5 –10 min.

Endotracheal intubation

Indication

- Bag and mask is ineffective or prolonged.
- Before chest compression
- Tracheal administration of medications is desired.
- Congenital diaphragmatic hernia
- ELBW for administering surfactant.

TUBE SIZE(ID mm)	B.WEIGHT(g)	GEST. AGEWks)
2.5	<1000	<28
3.0	1000-2000	28-34
3.5	2000-3000	35-38
4.0	>3000	>38

PLACENTAL TRANSFUSION

- Delayed cord clamping for all babies, both term and preterm who do not require resuscitation. Cord should be clamped at the end of 1 minute. This applies to both normal delivery and cesarean section.
- For babies requiring resuscitation, a 25 cm long segment of cord is secured with the help of cord clamping forceps. While initial steps are being done, the blood in the cord should be milked towards the baby.

Temperature Monitoring during Resuscitation:

- After the 60 seconds of PPV , consider switching to servo mode and monitor temperature.
- Check axillary temperature prior to shifting of infant.
- Pre-warm sheets prior to transfer of infant

Team Debriefing

The resuscitation team needs to discuss what went well and what did not go well and with points to focus after every resuscitation.

THERMAL REGULATION

Newborn infants' thermal control is more limited than that of an adult due to less insulation. Hypothermia has been recognized as a significant contributor to neonatal morbidity and mortality for all newborn infants and has been described in every continent and in many countries that are considered tropical.

Body temperature (Axillary temperature) in the newborn infant

		Temp in Celcius (°C)	**Temperature in Fahrenheit (°F)**
Euthermia	Axillary temperature	36.5-37.5	97.7-99.5
	Skin temperature	36-36.5	96.8-97.7
Mild hypothermia / cold stress	Axillary temperature	36-36.4	96.8-97.5
	Skin temperature	35.5-35.9	95.9-96.6
Moderate hypothermia	Axillary temperature	32-35.9	89.6-96.6
	Skin temperature	31.5-35.4	88.7-95.7
Severe hypothermia	Axillary temperature	<32	<89.6
	Skin temperature	<31.5	<88.7

Thermo Neutral Environment (TNE)

TNE is the range of environmental temperature wherein the body temperature is maintained in a normal range with minimal basal metabolic rate and oxygen consumption. The lower the gestational age, postnatal day and birth weight, higher is the TNE. Knowledge of TNE is required for setting the air mode in incubator and warmer.

Measuring temperature

Clean with Alcohol. Place the bulb of the thermometer in the roof of axilla. The thermometer is placed "parallel" to the arm. The arm is held close to the body for 3 minutes (The WHO recommendation is 5 minutes). Read and document the temperature. Clean and place in the cover. Use separate thermometer for each NICU baby.

Measuring rectal temperature is unnecessary in most situations becauseWe wish to recognize hypothermia before the core temperature falls.

* *Routine rectal monitoring may be associated with more complications such as infection and trauma*

However if the temperature is lower than 35 C, the rectal temperature can be measured with a low reading rectal thermometer. It is inserted to a depth of 3 cm in a term baby and 2 cm in a preterm baby. It is directed backward and upward. The rectal probe of multichannel monitor can also be used to record the rectal temperature in hypothermic infants.

Touch technique for monitoring temperature

Feel by touch **Trunk**	**Feel by touch** **Extremities**	**Interpretation**
Warm	Warm	Normal
Warm	Cold	Cold stress
Cold	Cold	Hypothermia

Management in delivery room

Before the delivery of the baby ensure that the radiant warmer is on at least for 10-20minutes. Adjust the temperature on Manual mode with 100% heater output.

Prevention of hypothermia – The warm chain

1. Warm delivery room (>25° C)
2. Warm resuscitation - Always receive the baby in pre-warmed clean towel.
3. Immediate drying Dry the baby under the warmer, remove wet linen and wrap in a pre-warmed towel covering the head. Infants < 32 weeks are covered with cling wrap prior to drying to prevent evaporative heat loss.
4. Skin-to-skin contact for 1 hour after birth
5. Breastfeeding as soon as possible
6. Bathing postponed – Do not bathe the baby during hospital stay. Baby may be sponged
7. Appropriate clothing – All babies including term normal weight babies should be covered with warm clothes including cap, socks, mittens and sweater.
8. Mother & baby together - Keep the baby with mother in case of normal delivery and stable baby. Initiate KMC in LR for stable LBW babies.

9. Professional alert – Monitor babies at risk for hypothermia.
10. Warm transportation

Management in Postnatal ward

Ensure that the baby is kept warm with head cap and placed in a warm blanket.

- Practice "Bedding in'' whenever possible.
- Kangaroo mother care for stable LBW babies
- Encourage breastfeeding on demand.
- Remove soiled clothes immediately.
- Keep windows closed and fans off.
- Do not bathe the baby.

Management in NICU

- **Ideal NICU temperature: 26-28 °C.**
- **Maintain baby in Thermal Neutral Environment (TNE) by using heating devices like radiant warmer, incubator or warm cradle.**
- **Measure temperature Q 4 h.**

1. Radiant warmers

- All unstable neonates' especially unstable preterm should be managed under radiant warmers. Receive newly born babies admitted for observation under radian warmer (term and preterm).
- Keep the warmer on in anticipation of admission in manual mode with 100% heater output. As soon as baby is received change to skin servo control mode. Place the sensor over abdomen in midline between umbilicus & xiphisternum. In the prone position place the sensor on the flank. Check position of sensor frequently. Do not apply the temperature probe on bony prominences or on areas of brown fat.
- Set appropriate abdominal skin temperature at 36.5°C. Check axillary temperature of baby Q 4 h. If the axillary temperature is < 36.5 C , then increase the set temperature to 37.0 °C Ensure that the skin sensor temperature correlates with the warmer temperature ($\pm$ 0.5% accuracy)
- Keep stable babies not requiring close monitoring adequately wrapped.
- For the extreme preterm babies requiring close monitoring, cover the bassinet with transparent polythene sheet (cling wrap) to reduce convective heat losses. .
- Monitor the amount of heater output required to maintain normal temperature. Need for increasing heater output may be an early sign of sepsis.

2. Incubators

- Air mode : Set at TNE (refer chart)
- Skin mode: set at 36.5 - 37°C
- Preterm stable neonates < 1200 g must be managed in incubators
- All the ports of the incubator must be kept closed.
- For infants < 28 weeks, humidification is required to prevent excessive transepidermal water loss.
- *The core - peripheral temperature differences of more than 3.5 ℃, suggest sepsis.*

Transport sure normal temperature before transport.

- Ideally the baby must be transported in a transport incubator.
- In the absence of a transport incubator, special care needs to be taken to prevent Hypothermia.
- The Embrace bag if available can be used for intramural transport of stable newborns. Ensure that the PCM is in liquid form before use. The temperature is maintained for a period of 4 hours.
- Wrap the baby in prewarmed cotton and swaddle the baby
- Keep all windows of the vehicle closed
- For stable babies, Kangaroo care is recommended during transport.

Management of hypothermic newborn

Babies at risk:

- All newborn babies at birth
- Preterm and low birth weight babies.
- SGA babies.
- Sick neonates.
- Neonates undergoing procedures.
- During transport.

** Monitor temperature Q 4 h. Teach the mother the touch technique in the postnatal wards.*

Signs and symptoms

- Lethargy, poor feeding, respiratory distress, grunting, vomiting
- Cold peripheries, pallor, acrocyanosis, apnea, bradycardia, cyanosis, sclerema,
- Hypoglycemia, hypoxia, metabolic acidosis, DIC, PPHN

Rapid Rewarming

- Mild hypothermia may be managed by skin to skin contact. Record axillary temperature ever 30 min till it is normal.

- Moderate and severe hypothermia should be treated by rapid re warming up to 34C then 1C very one hourly
- Set the desired skin temperature (36.5 C) and allow the baby to rewarm. DO not cover with clothes/ cotton as they prevent the radiant heat from reaching the baby.
- Monitor skin temperature ½ hourly.
- Administer oxygen to avoid apnea and hypoxemia. (since oxygen consumption increases during rapid rewarming).
- Reduce the rate of rewarming if the baby requires more oxygen or has shock.
- Monitor RBS closely.
- Correct metabolic acidosis.
- Treat the underlying cause.

Management of hyperthermic newborn

- If the baby's temperature is > 37. 5 C,
    - In the postnatal ward, keep the baby exposed for 15 minutes. Check temperature. If the temperature has normalized, it is most likely environmental, if not, investigate for infection.
    - A baby in a spread eagle posture with peripheries plethoric and warm are more likely to have hyperthermia due to environmental causes. If the baby is flexed with tummy toe difference, consider endogenous fever and rule out sepsis.
- Paracetamol and tepid sponging are very rarely needed in the newborn period.

Table 1: Thermo Neutra Environmental		
Age and weight	**At start (°C)**	**Range (°C)**
0 – 6 hours		
Under 1200 gm	35.0	34.0 – 35.4
1200 – 1500 gm	34.1	33.9 – 34.4
1501 – 2500 gm	33.4	32.8 – 33.8
Over 2500 gm (and > 36 weeks' gestation)	32.9	32.0 – 33.8
6 – 12 hours		
Under 1200 gm	35.0	34.0 – 35.4
1200 – 1500 gm	34.0	33.5 – 34.4
1501 – 2500 gm	33.1	32.2 – 33.8
Over 2500 gm (and > 36 weeks' gestation)	32.8	31.4 – 33.8
12 – 24 hours		
Under 1200 gm	34.0	34.0 – 35.4
1200 – 1500 gm	33.8	33.3 – 34.3
1501 – 2500 gm	32.8	31.8 – 33.8
Over 2500 gm (and > 36 weeks' gestation)	32.4	31.0 – 33.7
24 – 36 hours		
Under 1200 gm	34.0	34.0 – 35.0
1200 – 1500 gm	33.6	33.1 – 34.2
1501 – 2500 gm	32.6	31.6 – 33.6
Over 2500 gm (and > 36 weeks' gestation)	32.1	30.7 – 33.5
36 – 48 hours		
Under 1200 gm	34.0	34.0 – 35.0
1200 – 1500 gm	33.5	33.0 – 34.1
1501 – 2500 gm	32.5	31.4 – 33.5
Over 2500 gm (and > 36 weeks' gestation)	31.9	30.5 – 33.3
48 – 72 hours		
Under 1200 gm	34.0	34.0 – 35.0
1200 – 1500 gm	33.5	33.0 – 34.0
1501 – 2500 gm	32.3	31.2 – 33.4
Over 2500 gm (and > 36 weeks' gestation)	31.7	30.1 – 33.2
72 – 96 hours		
Under 1200 gm	34.0	34.0 – 35.0
1200 – 1500 gm	33.5	33.0 – 34.0
1501 – 2500 gm	32.2	31.1 – 33.2
Over 2500 gm (and > 36 weeks' gestation)	31.3	29.8 – 32.8
4 – 12 days		
Under 1500 gm	33.5	33.0 – 34.0
1501 – 2500 gm	32.1	31.0 – 33.2
Over 2500 gm (and > 36 weeks' gestation)		
4 – 5 days	31.0	29.5 – 32.6
5 – 6 days	30.9	29.4 – 32.3
6 – 8 days	30.6	29.0 – 32.2
8 – 10 days	30.3	29.0 – 31.8
10 – 12 days	30.1	29.0 – 31.4
12 – 14 days		
Under 1500 gm	33.5	32.6 – 34.0
1501 – 2500 gm	32.1	31.0 – 33.2
Over 2500 gm (and > 36 weeks' gestation)	29.8	29.0 – 30.8
2 – 3 weeks		
Under 1500 gm	33.1	32.2 – 34.0
1501 – 2500 gm	31.7	30.5 – 33.0
3 – 4 weeks		
Under 1500 gm	32.6	31.6 – 33.6
1501 – 2500 gm	31.4	30.0 – 32.7
4 – 5 weeks		
Under 1500 gm	32.0	31.2 – 33.0
1501 – 2500 gm	30.9	29.5 – 35.2
5 – 6 weeks		
Under 1500 gm	31.4	30.6 – 32.3
1501 – 2500 gm	30.4	29.0 – 31.8

KANGROO MOTHER CARE (KMC)

Definition: Early prolonged and continuous skin to skin contact between the mother and her low birth weight infant, both in hospital and after discharge.

- **Kangaroo position** – Continuous skin to skin contact between mother and baby.
- **Kangaroo feeding policy** – Exclusive breastfeeding.
- **Kangaroo discharge** – Early discharge and continuation of KMC at home.

Advantages of the kangaroo care

KMC simulates in-utero environment and facilitate physiological stability. It is the most holistic form of developmentally supportive care providing multimodal stimulation satisfying all the six senses the right way.

Benefits of Kangaroo Mother Care

<table>
<tr><td colspan="2">Benefits in the neonatal period

▪ Improved survival
▪ Temperature regulation – reduced hypothermia
▪ Physiologic stability – heart rate, oxygenation
▪ Reduced apnea , crying
▪ Reduced nosocomial sepsis
▪ Pain reduction
▪ Sleep organization
▪ Improved growth
▪ Improved breastfeeding</td></tr>
<tr><td>Benefits to the mother

1. Increased confidence, satisfaction
2. Better bonding
3. Empowerment
4. Better milk production
5. Early discharge
6. Lower stress
7. Lower postpartum depression</td><td>Benefits in infancy and childhood

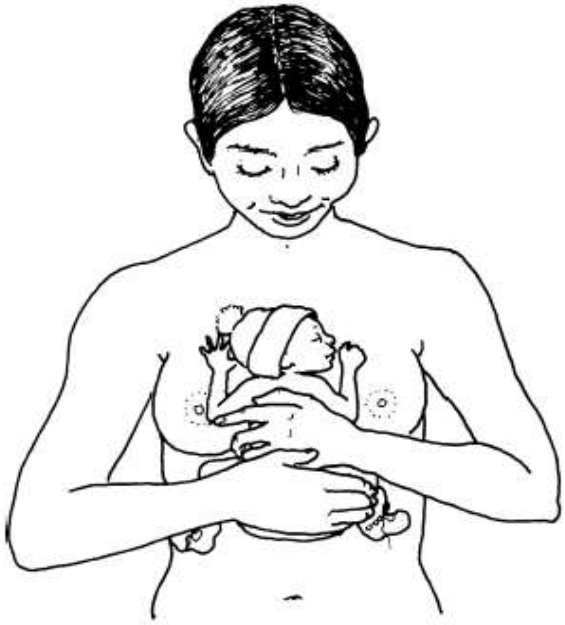
1. Growth
2. Neurodevelopment
3. Increased IQ
4. Better executive functions
5. Physiologic OrganizationLower stress
6. Betterparent- infant interaction
7. Lower admission rate</td></tr>
</table>

Procedure

- Start KMC for babies < 2000 gm as early as possible – after stabilization and on oral feeds. KMC is also beneficial to mother-baby dyads with breastfeeding problems.

Baby between mother's breasts

Head turned to one side



Support baby's bottom

Frog-leg position

- Dress the baby in a soak proof diaper, woolen cap and socks.
- Place the baby between the mother's breasts in skin to skin contact.
- Secure the baby to the mother by long piece of cotton cloth / netela / KMC bag / KMC lycra bag.
- Ensure the baby is in upright position to prevent aspiration. Even when the mother sleeps she should be inclined at an angle of at least 45°
- Encourage the mother to keep the baby in KMC for as long as possible during the day and night.
- The mother and the nursing personnel should continue to monitor the baby. The mother should be taught the touch technique of temperature assessment. She should be able to feel the baby's breathing and apnea.
- Maintain a chart of number of hours the mother has provided KMC.
- Advise the mother to continue to provide KMC at home.

Discontinuation of KMC:

- KMC may be discontinued when the baby refuses KMC by excessive crying or jumping out of KMC. This usually occurs by about 37-40 weeks

KMC in sick infants

CPAP

- Stable parameters over 6 hours (Fio2< 30 %)
- No evidence of shock

Ventilation

- No increase of parameters over 6 hours
- No evidence of shock

In case of UVC, it should be in high position and well covered before KMC is started. Avoid KMC in the presence of UAC till removal. PICC lines need to be well secured before KMC.

CARE OF PRETERM AND LOW BIRTH WEIGHT

- Determine best gestational age – Using first trimester scan or reliable determine if the LMP is reliable.
- Antenatal steroids:
  - If GA is 24-34 weeks, determine if the mother has received adequate antenatal steroids.
  - Betamethasone 12 mg 24 hours apart 2 doses. Or Dexamethasone 6 mg 12 hours apart 4 doses.
  - Record the time of hospital entry and the time the mother received the first dose of steroids.
- Determine if magnesium sulphate for neuroprotection for < 32 weeks given to mother
- Record all risk factors. Obstetric ultrasound and Doppler findings if done.
- Determine risk factors for sepsis – PPROM, UTI in last 1 month, intrapartum fever (other signs of Chorioamnionitis are elevated WBC > 15000/ mm3, uterine tenderness, maternal tachycardia and fatal tachycardia foul smelling vaginal discharge /liquor).
- Determine cause of prematurity – PPROM / Iatrogenic / unexplained preterm. The risk of sepsis is higher in PPROM and unexplained preterm.
- Determine cause for LBW – Calculate the mothers prepregnant BMI.

Care in delivery room

Inform NICU before delivery

- Make sure resuscitation equipment's are ready pulse oximeter, blender and preterm mask and preterm laryngoscope blade is present and working
- Resuscitate as per NRP guidelines.
- Wrap with clean plastic bag
- Increase the temperature of the delivery room to > 25 C. close windows.
- Delayed cord clamping after 1 min should be practiced for all preterm infants (>32 weeks) who cry immediately after birth.
- Skin to skin contact > 32 weeks.
- Cord milking for less than 32weeks

Warmth: Keep the baby under radiant warmer.

- Delivery room CPAP – If laboured breathing, provide CPAP. Connect a pulse oximeter to right upper limb.
- Inform NICU prior to transfer to keep the bed ready.
- Transfer with transport incubator
- For stable preterm babies in delivery room, skin to skin contact can be provided

- Complete each column of proforma after taking history. Look for cause of prematurity from printed list on NICU proforma and mark it.
- Examine placenta; send umbilical cord and placenta for histopathology if required.
- Complete other delivery room practices as mentioned in protocol of care of normal newborn.
- Perform shake test in preterm babies < 34 weeks.

Transport

- Use transport incubator and pulse oximeter during transport.
- Transfer the baby well wrapped in pre-warmed clothes if the baby is stable. If baby has respiratory distress, keep the baby open in transport incubator for observation. .
- During the transfer observe the baby for
    1) Hypothermia
    2) Respiratory distress
    3) Apnea
    4) Cyanosis
- Resident doctor and ALS nurse must accompany the baby.

Neonatal Intensive care Unit (NICU)

On admission

- Receive the baby on sterile sheet.
- Weigh the baby.
- Record temperature.
- Check whether baby has received Inj. Vit. K.
- Check blood sugar level with glucometer.
- Check HR, CRT, SaO_2 and blood pressure. If baby has respiratory distress, provide CPAP (Read RDS protocol).
- After initial stabilization, record anthropometry and calculate gestational age
- According to New Ballard score and classify as AGA, SGA, LGA as per intra uterine growth (Lubchenco's) charts. Calculate Ponderal index in SGA babies.
    - P.I. = Weight ingm÷ (length in cm)^{3}x 100
    - < 2 = Asymmetrical SGA
    - > 2 = Symmetrical SGA

Investigations

On admission:

- RBS
- If symptomatic and has risk for sepsis send blood culture and start antibiotics

Subsequently

- Serum electrolytes, total bilirubin and direct bilirubin, S creatinineand calcium after 24 hours.
- X-ray chest if symptomatic
- Hematocrite after 6 hours oflife and every week.
- RBS monitoring Q 8 h initially. In prolonged hospital stay, this may be reduced on individual cases.
- S. electrolytes every 3 days if on IVF
- Serum bilirubin if clinical jaundice and every day if under phototherapy. More
- Frequently if bilirubin levels are high and near exchange range.

- Cranial ultrasound on day 3 for babies <1500 gm or earlier if clinically indicated. Repeat before discharge.
- Consider hearing and retinopathy of prematurity screening test

Monitoring

- Daily weight.
- Temperature, heart rate, respiratory rate, capillary refill time, abdominal girth and input,output 2 hourly and in stable pretermbabies 4 hourly.
- NIBP every 12 hour
- Respiratory distress, apnea, hypoglycemia, hyperbilirubinemia.
- Hematocrite , Head Circumference and Length weekly

Management

- Start IV fluids for all babies with gestational age < 32 weeks/ birth weight
  - <1500 g, start calcium glucometer day 1 fluid for less than 1000gm, asphyxiated and infant of diabetic mother

- Antibiotics as indicated.
- Start Caffeine citrate 20 mg/kg loading dose followed by 5 mg/kg /dose Q 24 h for
  - Babies < 30 weeks or <1250 g if caffeine not available

- Aminophylline can also be used with loading dose of 5 mg/kg , followed by 2 mg/kg /dose TID. However the therapeutic index of aminophylline is narrower.

- Temperature, Respiratory distress, jaundice, pain management as per protocol
- **Kangaroo mother care** is the most important aspect of developmentally supportive care. It should be initiated as soon as possible in stable LBW neonates. The mother/ caregiver should be encouraged to provide KMC. Even in stable ventilated LBW, KMC can be practiced under supervision. Other aspects of Developmental Supportive Care are : Nesting, frequent change of position, limiting light and noise exposure.
- **Central lines:** Insertion of umbilical catheter should be discussed with the consultant
- **Prevention of infection**: the most important aspect of preterm care is prevention of infection.
- In hospital transfers should be done in thermo-neutral range either using the transport incubator if the baby sick or <1500 g.

Nutrition Management

Total Parenteral Nutrition (TPN).

Start TPN for babies

- <1200 g
- <1500 g who are unlikely to be on significant feeds by day 3
- >1500 g who are not likely to be on significant feeds by day 5
- Gastrointestinal surgical condition like TEF, intestinal obstruction

Enteral feeds :

Classify if the infant is AGA or SGA. Note for any abnormal dopplers(Umb artery Perfusion Index> 95th centile or Middle Cerebral Artery Perfusion Index <5th centile or Absent or reverse end diastolic flow). Be couscous on feeding

Approach to a baby who has inadequate weight gain

- Assess the baby for any illness
- Ensure normal temperature at all times.
- Increase feeds gradually up to 180ml/kg/day provided there are no contraindications like CLD, PDA.
- Provide hind milk. Discard the first 5 ml of milk.
- Provide lactation support to the mother.
- Use Human milk fortifier if available
- Increase the duration of KMC
- If HCT is low, consider transfusion based on Anemia protocol

Discharge routine

- Discharge criteria
    - Weight of 1400 g, Gestation age 34 weeks

- Baby feeding well by cup / direct feeds
- Maintains temperature without assistance.
- Weight gain for 3 consecutive days.
- No evidence of infection.
- Mother is confident of KMC and care of baby
- No apnea
- Mother educated on care of the baby at home

- Advice follow up in high risk OPD within 7 days of discharge.
- Enroll the baby for high risk follow up clinic if birth wt< 1800 gm / GA < 34 wks.
- Schedule the follow up as per corrected age

CARE OF EXTREME PRETERM BABY (<750 g)

Antenatal counseling:

Combined counseling to be done by obstetric and Neonatal consultant together.

- Survival in high and middle income countries –
  - 700-799 g – 50% of treated infants
  - 800-899 g- 66%
  - 900-999 g – 83%
  - 25- 28 weeks – 75%
- Issues to be discussed with obstetrician
  - Betamethasone/dexamethasone. Ideally complete course to be over 24 h prior to delivery.
  - Elective CS is the best for the baby.
  - delivery in morning hours
  - delivery not over weekend
  - each day improves prognosis by 1-4%
- Issues to be discussed with family
  - Care at birth, Surfactant (can be kept ready for prophylactic surfactant administration), few problems , infection control
  - Breastmilk expression, KMC, team effort, build up morale of family
  - Prolonged NICU
  - Encourage to visit NICU if time permits
  - Discuss openly what can be done in our setting

Care at time of delivery:

- Team to consist of – CONSULTANT, fellow, resident and nurse to be present (even if the obstetricians do not ask)
- NICU bed and ventilator/ CPAP to be ready even prior to delivery
- Transport incubator should be ready.
- Ensure delivery room temp is > 25◦C and the warmer is switched on for 20 mins
- Extreme preterm kit – clean polythene bag, (plastic wraps), cap, T piece , nasal prongs, 00 laryngoscope blade, tegaderm, tape
- Arrange for a pulse oximeter and blender if possible.
- Start with 30% O_2 and move up or down if pulse oximeter and blender available. Or else start with 100% O_2.

- Use T piece resuscitator. If positive pressure ventilation is required beyond 30 sec or if no chest rise with T piece / bag and mask, electively intubate the baby with 2.5 sized ET. Beware of "too" much pressure. T piece start with 20 PIP and PEEP of 5. Increase if required
- Fix ET at 6.
- Transfer the baby to NICU ensuring temperature maintenance in transport incubator
- If multiple pregnancy – to shift one more warmer so that each will have a warmer. Two teams.
- Umbilical venous and arterial blood from placental end should be analysed.
- Placenta should be sent for Histopathology Examination.

Transport

- Transport in preheated transport incubator
- 3 personnel required for transport (*1 to ventilate infant, 1 to pull the incubator and 3rd to open multiple doors).*
- *Note admission temperature*

**** 1: 1 nurse – to try to arrange for a personal nurse for the baby in each shift***

NICU care

- Minimal handling protocol
- Clustering of activities
- At least two people to be involved in bed making/shifting of baby
- Nurse in prone position
- Use a humidified incubator - Giraffe
- If in open care system, Cling wrap for the bassinet. Weigh the baby twice a day. .
- Multichannel monitoring
- Prophylactic phototherapy

Infection control

- Most important
- Strict hand washing followed by gloves even for routine handling
- Sterilium use
- Use of mask
- All procedures (including RBS) to be done under strict asepsis – gloves, hand washing
- Restrict use of antibiotics.

Skin care

- Routine handling with sterile gloves(till 7 days)
- Tegaderm over IV sites, Dynaplast to be used on the tegaderm for fixing ET
- Coban use for fixing IV splints

- Areas of skin compromise to be dressed with sofratulle /jelonet
- The betadine to be wiped off after the procedure (to prevent iodine toxicity)

Ventilation

- Prophylactic surfactant if antenatal steroids is inadequate
- May require more than one dose of surfactant
- Prophylactic caffeine
- Gentle patient triggered ventilation. volume guarantee ventilation with TV of 5 ml/kg
- SaO_2 target-90-95% .Beware of oxygen toxicity
- Try to get the baby to non-invasive ventilation as soon as possible
- Analgesia as IV fentanyl as required
- Permissive hypercapnia - provided pH > 7.25

IV access

- Umbilical venous line on admission
- Peripheral / umbilical arterial line for sampling
- Peripherally Inserted Central Catheter(PICC) after 2-3 d (protect an area)
- Ensure care of PICC – heparin if the infusion rate is <7 ml/hr
- Antibiotics to be given slowly through peripheral line
- All injections to be given with infusion pump over 10-15 min
- Fluid ”boluses” to be given over 1 hour

Nutrition

- Restricted fluid regimen 80 ml/kg
- Fluids to be adjusted based on daily weight (twice daily weight), sodium level
- Parental nutrition from day 1 – 10% dextrose and aminoacid solution 2 gm/kg
- Lipids from day 2 at 1 gm/kg
- If losing weight under warmer, shift to double walled incubator with humidification.
- Insulin if RBS >250 mg%
- Multivitamin solution 1 ml/kg from day 1
- Trophic feeding (see feeding protocol)
- Probiotics (<32 wks, < 1250g)
- Fortification of feeds if baby is not gaining adequate weight (15 g/kg/d)

Lactation support to the mother

Monitoring

- Twice daily weight
- Electrolytes at 24 h and followed by as needed twice weekly.
- HCT weekly
- Twice/thrice weekly electrolytes

- Septic profile at least twice weekly and sos
- Neurosonogram on day 3, sos and before discharge
- LFT weekly after 3 weeks of TPN
- Serum Ca, P and ALP for OOP every week after day 14
- Anthropometry Q weekly

ROP screen

Blood transfusion

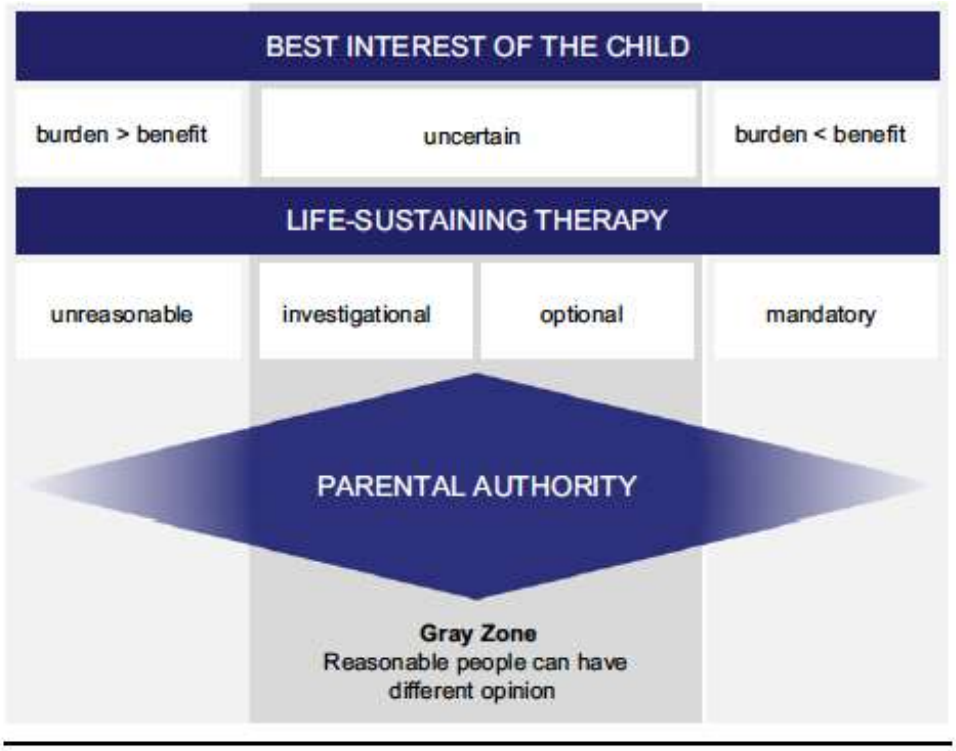
Minimize phlebotomy losses.

St. Paul's Hospital: Protocol for Initiation of Resuscitation for Infants Born at the Ethiopian Margin of Gestational Viability (December 2018)

Background

Review of hospital and regional outcomes for survival and morbidity of extremely preterm infants, suggests that outcomes for infants born at 25 weeks or less remain unacceptably poor, and that in most cases, survival, even with intense resuscitative efforts is exceedingly unlikely. By 28completed weeks, survival is possible and a trial of therapy is worried. Outcomes for infants born at 26-28 weeks remain poor for many infants, although there do appear to be a significant number of survivors in this age group, some without severe disability.

Based on the AAP recommendations that prenatal counseling and recommendations be consistent among caregivers at a given institution, and that resuscitation is at the discretion of parents when the outcome is highly uncertain, we recommend that the following guidelines direct medical decision making for infants born at the margin of viability.



Guidelines

- All infants 28 completed weeks and older (≥ 28 + 0/7) without significant comorbid conditions should be provided with initial resuscitative efforts in the delivery room
- In the antenatal setting, parental "refusal" should prompt immediate notification of the attending neonatologist or pediatrician.
- If there is no time for resolution prior to delivery, resuscitation should be initiated.
- For infants born between 26 +0/7 and 27 +6/7 weeks without complicating comorbid conditions, resuscitation should always be offered. If there has been time to provide appropriate counseling and the parents express a preference that only comfort care be provided, provision of resuscitative efforts and initiation of intensive care may be foregone.
- It may be reasonable to consider other factors (plurality, sex, estimated fetal weight, time to administer antenatal corticosteroids) in deciding whether to recommend resuscitation at this gestational age.
- Infants born at 25 weeks gestation (25 +6/7 or less) are generally not candidates for initiation of resuscitative efforts; in limited circumstances they may be considered selective candidates for resuscitation, such as when other prognostic features (e.g. EFW) are not consistent with the estimated gestational age, or when precise gestational dating is nearing 25 completed weeks.
- In general, if there is no time for extensive antenatal counseling, and there is confidence in the gestational dating, the "default" should be to forego initiation of resuscitative efforts.

- It is nonetheless appropriate to provide antenatal counseling to expectant parents at this gestational age. It may be reasonable to offer NICU attendance at the delivery of 24 week infants, particularly when there is considerable uncertainty about the dating. The NICU service may participate in the provision of palliative care for the infant.

Guiding Principles:

  - Given the inaccuracy of gestational dating and fetal weight estimation, it should be discussed with the parents and delivery team that all plans may be changed based on information gathered after the birth of the infant.
  - Expectant parents of extremely premature infants (or those with EFW <1000 grams at any gestational age) should also be counseled that some infants may be too small in size to accommodate our smallest available equipment, in which case provision of intensive care may not be possible.
  - At any gestational age ≥ 26 + 0/7, if there has been no previously established plan for delivery, resuscitation should be initiated. In any emergent resuscitation scenario in which the obstetric history is incomplete, it is reasonable to initiate a good - faith attempt at resuscitation while more information is gathered about gestational age and parental preferences.
  - In any case in which non-resuscitation is expected, a plan for provision of appropriate palliative care should be made; it should be clarified whether the OB, ALS, or NICU service will be responsible for providing palliative care.
  - The obstetric plan for administration of antenatal corticosteroids, fetal monitoring, and mode of delivery should be reviewed with the OB team prior to the antenatal consultation.
  - Once there is a plan with the family about what kind of care will be provided for the infant, it should be clearly documented as a Neonatology Consult Note and shared verbally with the on-call ALS team and Obstetrics fellow or attending.
  - In the absence of a maternal contraindication the Neonatology Consult should recommend that antenatal steroids be given (given the ratio of potential benefit to risk) for all premature infants for whom resuscitation will be attempted.

- Recommendations for Antenatal Counseling when Pre term Delivery is Expected
- Receiving a request for consultation:
  - Pre-natal consultation by the Neonatology team can be requested by MFM or any obstetric care provider. There is no lower gestational age limit for consultation.
  - Verbal communication between services is required prior to consultation and should include:
- Estimated gestational age (including confidence around the estimate), EFW, gender if known, immediate obstetric history
- Plan for antenatal steroids, fetal monitoring, mode of delivery
- Relevant maternal and family history including previous premature infants, obstetric complications, fetal complications (e.g. oligohydramnios, congenital anomalies)

- Originator of the request (family or medical provider)
- Urgency of the consult
- Nature and content of previous discussions with the family and any unusual psychosocial concerns
- Need for translation services

After reviewing this information, the Neonatology fellow /senior residents should

- Clarify the indication and expectation for the consult and provide a rough timeframe for its completion
- Thank the requestor for the referral and agree to review the result of the consultation with him/her

    - Before doing the consult, population - based outcomes data for infants with similar clinical circumstances should be reviewed as needed.
- Completing the consult:
    - It is helpful to identify the expectant mother's bedside nurse to verify that the timing of the consult is appropriate (i.e. no procedures or off - unit testing is planned) and to extend an invitation to the nurse to be present if able/desired.
    - General principles for conducting a family meeting should be followed. For example:

- Introduce yourself and confirm that timing is acceptable
- Sit, if possible
- Ask the expectant to mother to identify others present in the room and confirm that all will stay for the meeting.
- Set agenda for the meeting

    - While there are multiple appropriate strategies for the subsequent information sharing and decision-making, it is reasonable to allow the discussion to be individualized for parent preferences regarding level of detail and prioritization of information.
    - Providing expectant parents with population-based statistics about outcomes of similar infants, if available may be appropriate for some families. The level of detail should be tailored to a family's individual needs. Whenever specific numbers are provided it is very important to emphasize that these data do not describe the probability of an outcome for the infant in question, and that a number of complicating factors can affect the precision around these estimates.
    - In addition to resuscitation decision-making, prenatal consults should include information for parents about the NICU routines, including: plans for feeding, temperature regulation, glucose monitoring and IV fluids, respiratory distress and

support. Review of all of these items may not be appropriate in a single meeting; repeated visits may be necessary for completion of the consultation.
    - A final plan for delivery is not a necessary outcome of the initial meeting.
    - Parents should be informed that in many cases where the course is complicated or outcomes are uncertain, there will be multiple opportunities after birth to review direction of care and alter the plan if necessary.
- After the consultation:
    - Communicate content of consult with ALS team and Obstetrician (and OB nurse as needed, particularly if the family is distraught).
    - Communicate the plan with the NICU care team, including the charge nurse.
    - Complete appropriate documentation, which serves as a marker that the consult was done, and as an important communication tool for other care providers. At a minimum this should include a description of the kind of prognostic information that was given, which topics were emphasized, specific concerns that were addressed, tentative resuscitation/delivery plan or plan for future discussions if consensus was not reached.
- Include a brief summary of your understanding of the current obstetric situation and reason for the consult at the beginning of the note.
- If the consultation is not complete it is reasonable to post an interim note acknowledging the ongoing consult.
- Multiple formal consult notes are not generally required, but short follow - up notes are encouraged.
- It is appropriate to document the family's apparent reaction to the information given (e.g. tearful, angry, "inappropriately cheerful") as well as your perception of their understanding of what was discussed
- Always reiterate ongoing availability of the NICU team for further questions or clarification

BREASTFEEDING POLICY

Introduction

SPHMMC NICU promotes breast milk and breastfeeding as the optimum nutrition for infants. Benefits apply to both the mother and the infant and include nutritional, immunological, psycho-social and financial components.

The cultural, personal and/or physical factors affecting infant feeding are to be respected and staff is to support and assist women in their choice of infant feeding.

This guideline details the policies and recommended best practices to support breastfeeding the preterm or sick infant within the Newborn Service. It also provides policies and recommended best practice for alternative methods of infant feeding including cup feeding and gastric tube feeding.

Purpose

The purpose of this guideline is to ensure that Newborn Service health professionals protect, promote and support breastfeeding during all stages of the infants association with the service. This policy also seeks to provide information and skills on safe infant feeding regardless of the method used.

Scope

This guideline applies to all Newborn Service health professionals and employees who provide care for, or have contact with, women and infants within Newborn Services. This also applies to both inpatient and outpatient services.This reflects the Global Criteria of WHO/UNICEF to meet accreditation for a Baby Friendly Hospital.

Breastfeeding Policy

Health professionals are to give current, accurate and consistent, non-judgmental breastfeeding information and supportive encouragement to enhance successful breastfeeding. It is essential that feeding of preterm or sick infants is managed in a safe and professional manner that enhances success for the infant, whatever the feeding method.

The respect of, and sensitivity to each woman's personal and psychosexual dignity is to be upheld when assisting her to breastfeed. It is expected that touching the woman's breast will be minimized and the health professional will seek each woman's permission before touching and/or gentle handling of her breasts.

Antenatal clinic

- Inform all pregnant women about benefits of breastfeeding through health education, display of posters, distribution of booklets or pamphlets.
- Obtain detail history of breastfeeding in previous children.
- Examine breast & nipple.
- Identify high risk mothers &mothers with breast & nipple problems.
- Include breast feeding counseling on every ANC visit.

After delivery

- Help mothers to initiate breastfeeding within ½ an hour after birth.
- Practice skin to skin contact immediately after birth.
- Help primi mothers & other high risk mothers for initiating breastfeeding.
- Keep mother and baby together all the time.
- Treat the mothers with breast & nipple problems and reassure them about their ability to breastfeed.

Postnatal ward

- Practice rooming and Bedding in to allow mother and baby to remain together 24 hours a day.
- Reemphasize on importance of breastfeeding through health education.
- Educate the mothers regarding following components of breastfeeding –
    a. Importance of colostrum (mention cultural barriers)
    b. Advantages of breast milk
    c. Exclusive breastfeeding till 6 months of age – no water, no honey, no multivitamin drops
    d. Proper positioning and latching at breast
    e. Demand feeds
    f. Duration of breastfeeding
    g. Night feeds
    h. Expression of breast milk
- The 4 points for ensuring correct position and attachment are:

Positioning:

- Mother and baby should face each other
- Should be very close to each other.
- Body head and neck should be in a straight line
- The baby should be well supported

Attachment:

- Mouth should be wide open
- Chin should be touching the breast
- More areola should be visible above than below.
- Lower lip should be everted.

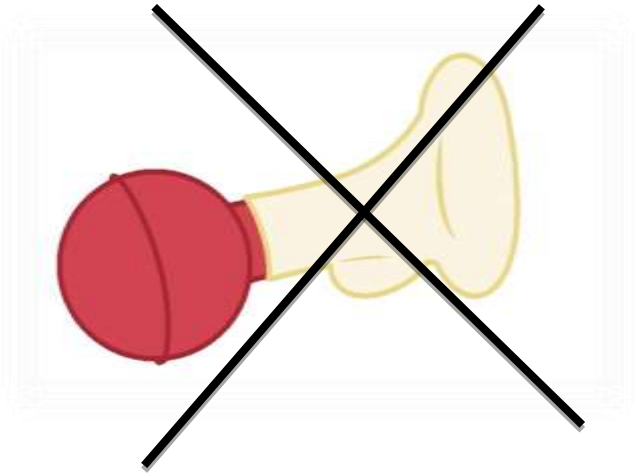
- Assess adequacy of breastfeeding:
  - Observe breastfeeding in each mother baby dyad at least once. Assess position and attachment.
  - Determine LATCH score.

Latch	Grasps breast, tongue down, lips flanged, rhythmic sucking	Repeated attempts, hold nipple in mouth, stimulate to suck	Too sleepy or reluctant; no latch achieved
Audible swallowing	Spontaneous and intermittent < 24 hrs; spontaneous and frequent > 24 hrs	A few with stimulation	None
Type of nipple	Everted	Flat	Inverted
Comfort	Soft, tender	Filling, reddened/small blisters, bruises; mild/moderate discomfort	Engorged, cracked bleeding, large blisters, or bruises severe discomfort
Hold (positioning)	No assist from staff; mother able to position/hold infant	Minimal assist (i.e., elevate head of bed; place pillows for support) teach one side; mother does other; staffs holds and then mother takes over	Full assist (staff holds infant at breast)

  - Trend the weight daily. If > 10% weight loss, intensive lactation support, Labs: Na, total and direct biluribine , glucose monitoring.
  - Examine the mother's breast for cracked nipples, engorged breasts. Provide adequate advice and treatment.
  - Baby should pass urine at least as many times as number of days in the first week.
- Promote KMC for LBW babies and for babies who have difficulty in latch. Distribute pamphlets and booklets for educating mothers regarding importance of mother's milk and newborn care.
- Advise about complementary feeds after 6 months of age and continuation of breastfeeding till 2 years of age.
- Develop confidence in mothers about breastfeeding and newborn care by talking to them before they are discharged from the hospital.
- Focus on mothers who are separated from their babies and encourage them to express breast milk.

Neonatal intensive care unit (NICU)

- Allow mothers in NICU to handle their babies
- Teach all mothers the technique of hand expression of milk. Hand expression is better than machine pumping in the early phase.
- Avoid the manual pumper which is locally purchased



- Ask mothers to express milk Q 2 h at least 8-10 times a day from day 1.
- Keep the EBM in a clean cup near baby's face for stimulation of olfactory sense. Quantify the total milk expressed by the mother every day. Aim at 350 ml/day by day 7.
- Teach mothers the technique of feeding EBM with cup
- Encourage mothers to provide non-nutritive sucking to their babies while on intravenous fluids.
- Practice Kangaroo mother care for premature and low birth weight babies for early and successful establishment of breastfeeding
- NICU mothers are most often stressed, unaware that they have to express milk even if the baby is NPO. Provide emotional support. Promote mother – mother support. Praise mother and empower her.
- Give health education; distribute pamphlets based on importance of breast milk and newborn care before they go home.
- The nurse manager should facilitate health education through video whenever possible

Breast and nipple problems

Treatment of Inverted nipple:

- Teach syringing technique to mother – Cut out the pointed end of syringe (10 ml/20mL) and insert piston through the cut end and apply to the nipple and syringe
- Use of breast pump.
- Use of drip-drop method**.**

Treatment of sore nipple:

- Advise mother to clean breasts only during bath. DO not clean at every feed.
- Application of hind milk to the nipple
- Teach correct position , attachment to mother

Treatment of breast abscess

- Confirm abscess either clinically
- Ensure mother is on antibiotics and abscess is drained.
- Continue expression from the other breast and feed baby.
- As soon as it is convenient, baby can be fed from the abscess side too.
- Continue aiding proper position and attachment

Technique of milk Expression:

Milk expression done in 2 phases

Phase 1 - Establishing Milk supply.

- Begin milk expression as soon after birth as possible (optimally within 6 h, earlier if possible)
- Teach mother hand expression and employ to help with removal of colostrum
- Express frequently (not <8 times in 24 h, up to 12 times)
- Express at least once at night (between 1 am and 4 am)
- When using a mechanical pump, use a full-sized (hospital grade/multiuser) electric breast pump with the ability to pump both breasts simultaneously
- Increase pump suction until milk is flowing and comfort maintained.
- Hold the infant skin to skin prior to and during pumping if possible.
- Use breast massage prior to and during milk expression
- Express for 10-15 min and/or until all milk droplets cease flowing.
- Maximize rest and minimize stress as much as possible

Phase 2 - Maintaining milk supply

- Continue with above regime
- Use a full-sized (hospital grade/multiuser) electric breast pump with the ability to pump both breasts simultaneously and employ hands on pumping technique
- To ensure breasts are emptied, do not pump a specific amount of time, but pump until milk stops flowing, for 2-3 min

Discharge Planning

- Discharge planning is to incorporate written breastfeeding information and referral to appropriate services in the community resources to support continued breastfeeding success.

Follow up clinic

- Foster the establishment of the breastfeeding support groups & refer mothers to them on discharge from hospital or clinic.
- Reinforce about importance and advantages of breast milk and exclusive breastfeeding till 6 months of age.
- Include breast feeding counseling in every follow up clinic as part of the assessment protocol
- Advice regarding introduction of complementary feeds after 6 months of age along with breastfeeds till 2 years and beyond.

Breastfeeding policy for institution – Ten Steps to Successful Breastfeeding

1. Have a written breastfeeding policy that is routinely communicated to all health care staff.
2. Train all health care staff in skills necessary to implement this policy.
3. Inform all pregnant women about the benefits and management of breastfeeding.
4. Help mothers initiate breastfeeding within half hour of birth.
5. Show mothers how to breastfeed and how to maintain lactation even if they should be separated from their infants.
6. Give newborn babies no food or drink other than breast milk unless medically indicated.
7. Practice rooming in : allow mother and baby to remain together 24 hours a day.
8. Encourage breastfeeding on demand.
9. Give no artificial teats or pacifiers to breastfeeding infants.
10. Foster the establishment of the breastfeeding support groups and refer mothers to them on discharge from hospital or clinic.

HYPOGLYCAEMIA

Definition: Blood glucose level < 50 mg/dl in a neonate, irrespective of the gestational age and symptoms. Day one < 40 mg%

Monitor in:-

- low birth weight infants < 2500 g,
- SGA infants
- LGA infants, > 4000 g and infants of diabetic mother
- Infants who are not feeding well with > 10 % weight loss

- Other high risk infants:
  - Infant of a diabetic mother
  - Babies with perinatal asphyxia
  - Polycythemia
  - Hypothermia
  - Sepsis
  - Following exchange transfusion
  - Infants born to mothers on tocolytics and drugs – β sympathomimetic agents - terbutaline, isoxsuprine, chlorpropamide, propranolol
  -

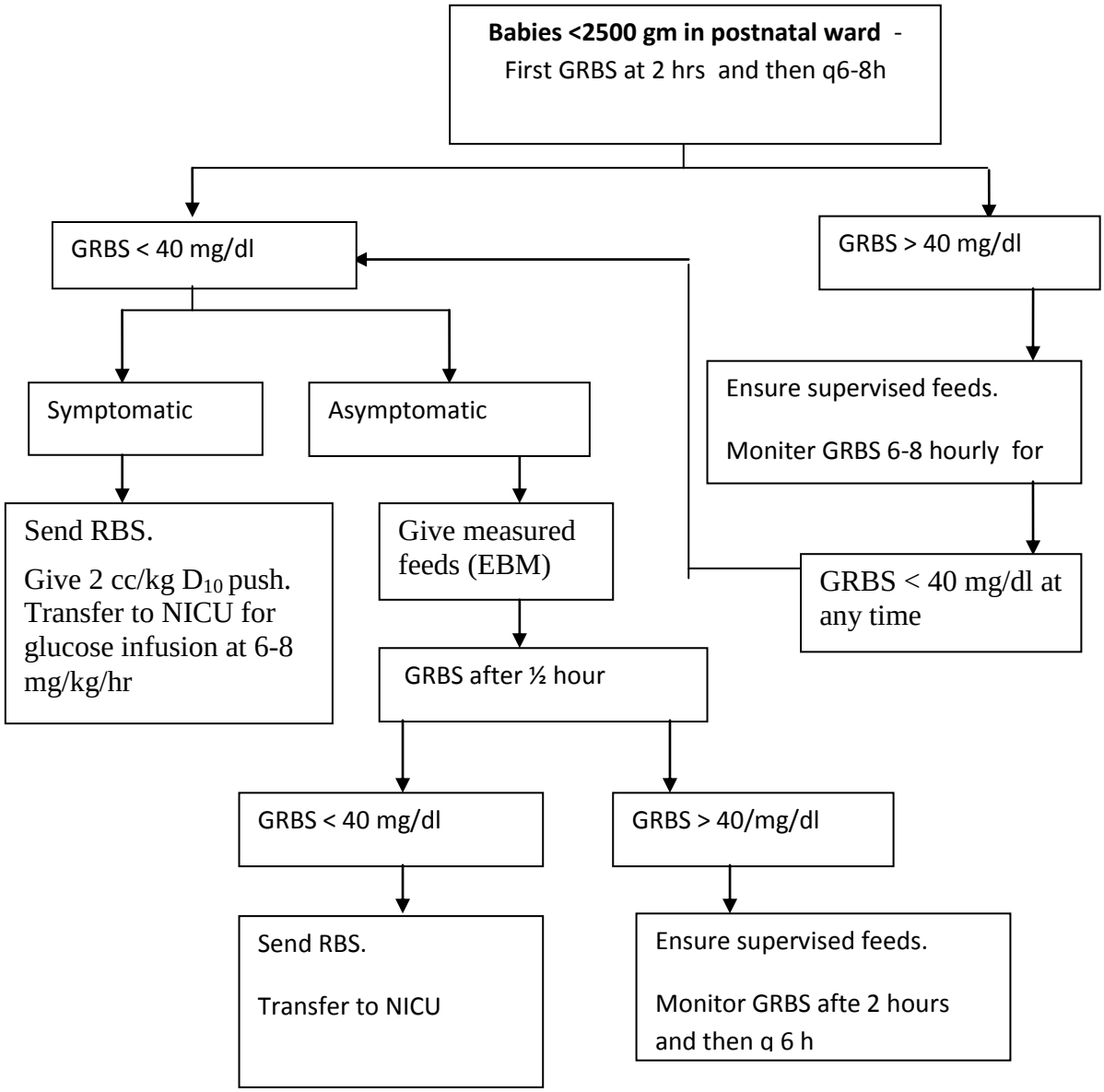
Time of monitoring

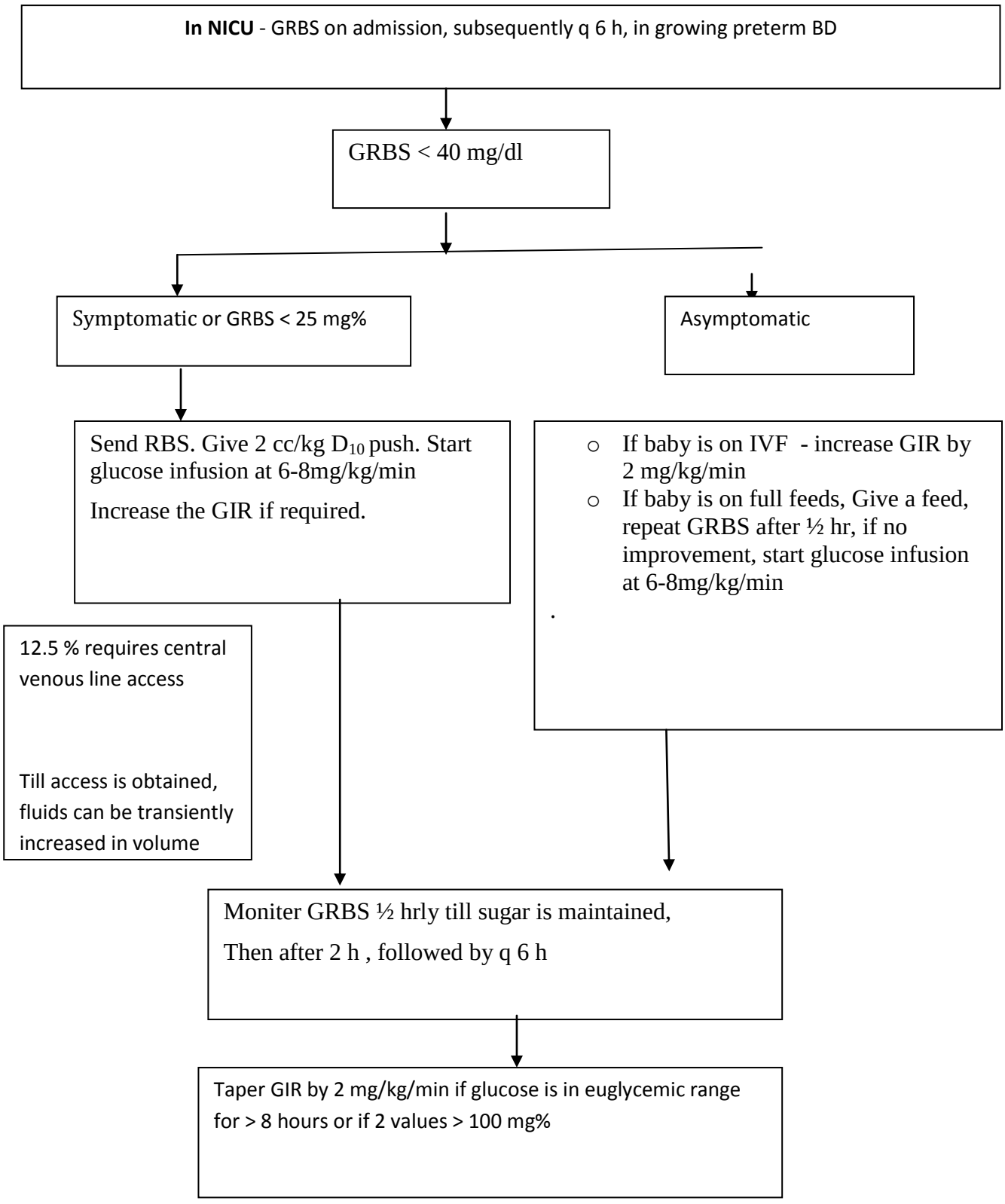
- In Post-natal ward (refer algorism)
- In NICU (refer algorism)
- Infant of diabetic mother (cord blood sugar for hyperglycemia must be sent). Perform Hg stix at 1, 2, 3,6,12, 24, 36 and 48 hours.

Clinical findings

Hypoglycemia is a great mimicker. It can mimic any symptom or can be asymptomatic

- Some infants may be asymptomatic
- Lethargy, apathy
- Poor feeding
- Tremors, jitteriness
- Apnea/ tachypnea
- Hypothermia
- Cyanosis
- Weak or high pitched cry.
- Convulsions


Babies <2500 gm in postnatal ward -
First GRBS at 2 hrs and then q6-8h
GRBS < 40 mg/dl
GRBS > 40 mg/dl
Symptomatic
Asymptomatic
Ensure supervised feeds.
Moniter GRBS 6-8 hourly for
Send RBS.
Give 2 cc/kg D_{10} push.
Transfer to NICU for glucose infusion at 6-8 mg/kg/hr
Give measured feeds (EBM)
GRBS < 40 mg/dl at any time
GRBS after ½ hour
GRBS < 40 mg/dl
GRBS > 40/mg/dl
Send RBS.
Transfer to NICU
Ensure supervised feeds.
Monitor GRBS afte 2 hours and then q 6 h



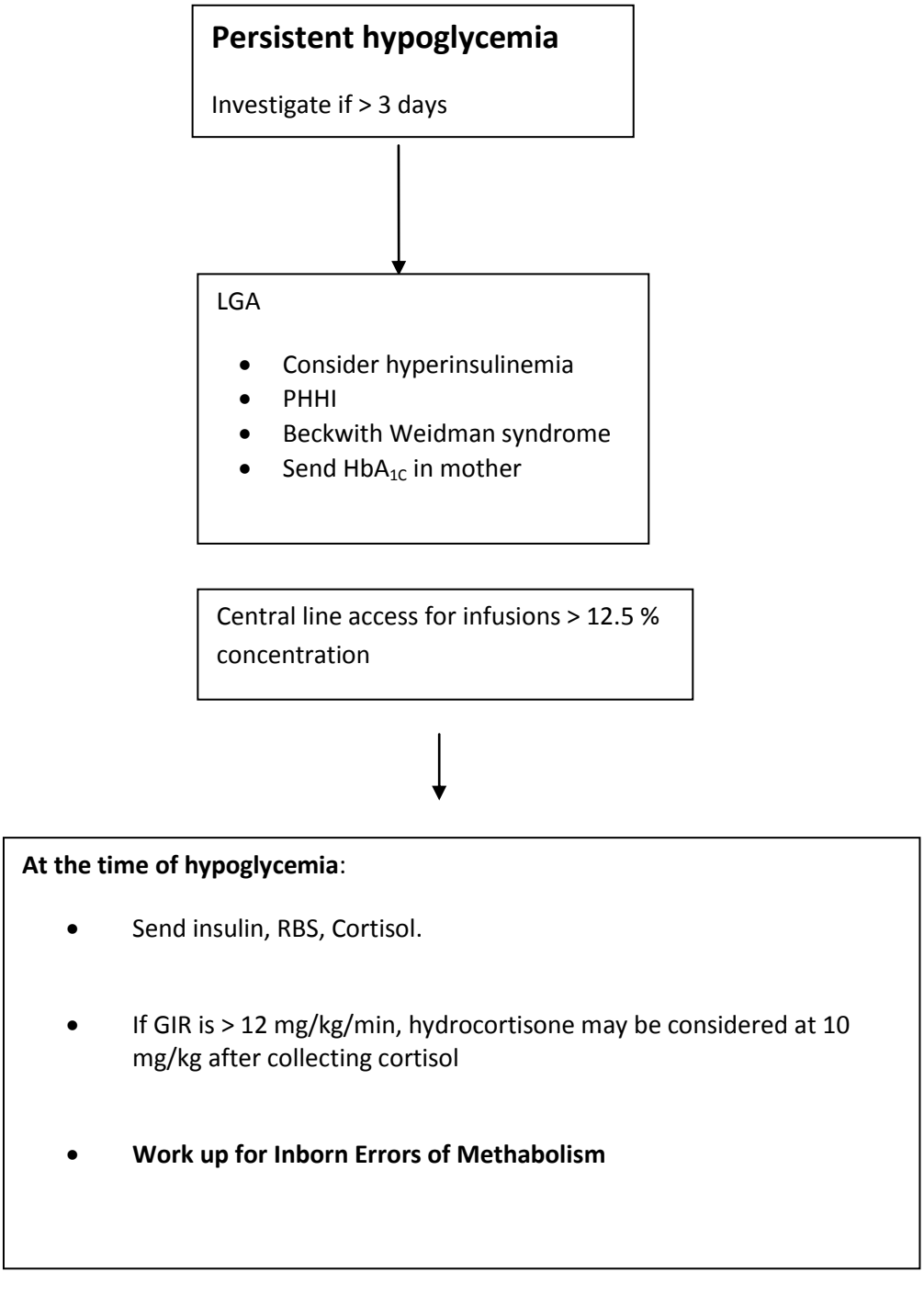
P.S. after 24 hours of life hypoglycemia is defined as < 50 mg%

GRBS= glucose determination using glucometer with whole blood this is what is done in the ward

RBS=glucose determination using plasma which is done in the laboratory

Investigations

- **GRBS using glucometer**: Calibrate glucometer. Give a bold heel prick with lancet. Use the glucometer as per manufacturer's instructions.
- **Blood Sugar estimation**: When hypoglycaemia is detected on the GRBS confirm with random blood sugar estimation. Sample must be processed immediately as delay causes glucose oxidation giving falsely low values.
- Other investigations as indicated. SGA/ Polycythemia - perform hematocrite. At risk for sepsis do septic screen / CSF.
- In case of persistent hypoglycemia or need for large glucose infusion over 72 hours or if persistent GIR > 10mg/kg/min, re-evaluate for other causes.
    - Persistent bacterial or fungal infections.
    - Inborn errors of metabolism.
    - Defects in carbohydrate metabolism - Glycogen storage diseases, Galactosemia.
    - Defects in amino acid metabolism.
    - Endocrinal disorders - Persistent hyperinsulinemichypoglycemia of infancy (PHHI- islet cell hyperplasia,), adrenal insufficiency, hypopituitarism, hypothalamic deficiency, glucagon deficiency, epinephrine deficiency,
- Following investigations must be done in case of persistent hypoglycemia.
    - Serum insulin with simultaneous blood glucose estimation: Insulin > 2 uIU /ml at time of hypoglycemia is suggestive of hyperinsulinemia. Insulin: glucose ratio - > 0.4 is suggestive of hyperinsulinemia.
    - Endocrine Profile: Cortisol.
    - Metabolic Profile



Management of hypoglycemia

- If symptomatic- give 2 ml/ kg of 10% dextrose over 1 minute followed by an infusion of glucose at a rate of 6 – 8 mg/kg/min. by an infusion pump.
- If asymptomatic- increase GIR if the baby is on IV fluids. Give supervised measured feeds if the baby is on full feeds.
- Calculate glucose delivery rate by using (GIR)
- GIR (mg/kg/min) = Concentration X volume ÷ 144
- For e.g. If a baby is receiving 100 cc/kg/day of D_{10} , the glucose infusion rate will be GDR = 10 X 100 ÷ 144 = 6 – 7 mg/kg/min.
- Re-check glucose levels with glucometer/ Dextrostix after 30 minutes, then ½ hrly till stable. Subsequently at 2 hours and then 6 hrly.
- If not maintaining glucose levels, re-ensure adequate infusion rate. Increase drip rate to increase GIR by 1 –2 mg/kg/min. Maximum glucose
- Concentration that can be given through the peripheral vein is 12.5%. Glucose concentration of more than 12.5% has to be given through central venous line.
- Parenteral glucose infusion can be weaned after blood glucose has been in normal range for at least 8 hours or if 2 values is > 100 mg /dl.. The glucose infusion can be reduced by 1-2 mg/kg/min, every 3 –4 hrly, as long as the blood glucose concentration is stable and the enteral feeds are gradually increased. The blood glucose should be monitored with each change in the rate of IV glucose infusion.
- Breastfeeding should be continued.

Persistent hypoglycemia

If the infant requires more than 10 mg/kg/min. of glucose infusion, the appropriate investigation must be sent.

- Consider IV hydrocortisone 10 mg/kg/day in 2 divided doses when the glucose requirement is >12 mg/kg/min.
- Consider injection glucagon 0.1 mg/kg/dose 2-3 hourly IM, maximum upto 1 mg.
- Diazoxide 5 – 20 mg/kg/day in 3 divided doses orally.
- Octreotide 10-40 mg/kg/day, Nifedepine, Epinephrine, Growth hormone.

Special Note

- **Formula for preparing % of dextrose infusion: (5x – 25)**
  x = desired % of dextrose

eg. Desired % 7.5; 5 X 7.5 - 25 = 12.5 ml

12.5 ml of 25% dextrose strength to be added to 87.5 ml of 5% dextrose to

make a total of 100 ml of 7.5 % dextrose.

- Dextrose solutions can be prepared according to the following table:

5% dextrose	Commercially available
7.5% dextrose	Take 1:1 of D_{10} and D_5
10% dextrose	Commercially available
12.5 % dextrose	Take 1:1 of D_{25} and H_2O for injection.
15% dextrose	Take 1:1 of D_{25} and D_5
17.5% dextrose	Take 1:1 of D_{25} and D_{10}
25% dextrose	Commercially available

GIR calculation

Steps in titrating IVF for increasing GIR

- What is the fluid requirement for the baby?
- Calculate the amount of dextrose containing IVF to be given to baby
    - Eg: 1.2 kg baby receiving 30 ml of aminoven, 15 ml of lipid 20% and 20 ml of injections, 1ml MVI, 1 ml KCL @ 150 ml/kg/day
    - Amt of dextrose containing IVF – 113 ml
    - Amt of dextrose containing IVF = 94.16 ml/kg/day
- What is the GIR required for the baby?
    - Eg: 8 mg/kg/min
- Calculate tonicity required
    - Use formula I : Tonicity = GIR X 144 / ml/kg/day
    - 8 X 144 / 94.16 = 12.23%
- Calculate the drip rate of 50 % D
    - Use Formula II :

      $\frac{\text{Required tonicity \%– 10 \%}}{50 - 10}$ X Reqd Rate (ml/hour)

    - 12.23 – 10 / 40 X (113 / 24) = 0.262
    - This is the fluid rate for 50 % D = 0.262 / hour

FLUID AND ELECTROLYTE MANAGEMENT

Initial maintenance fluid therapy

Gestation (Wk)	Dextrose (conc.%)	Fluid volume ml/kg/day			
		< 24 hrs	24 – 48 hrs	48-72 hrs	Max fluids
<28 weeks	10	80	100	110	150
28-34 weeks	10	80	100	110	150
≥34	10	60	80	100	150

Increase of fluids is by 20ml/kg/day. These are guidelines to be used as starting point & fluid requirements require to be revised as per monitoring data

- **Start IVF for any baby < 1500 g or 32 weeks**
- For babies between less than2000 g or 34weeks and for sick newborns, start on IVF if there is a history of perinatal asphyxia, abnormal Doppler, shock, hypoglycemia, no adequate breast milk
- Write fluid orders once in 24 hrs, or once in 12 hours for extreme preterm or per hour requirement in sick babies
- Replace gastric aspirate, ml to ml with RL. If significant volume > 10 ml/kg/day.

Electrolyte requirement

- Add Na^+ after 24 hours, preferably after 5 % weight loss.
- Do not give potassium till urinary flow is established and normal renal function is ensured. Give potassium free fluids if K is > 6 mEq/l. Maintenance K+ is 2 meq/kg/day
- Add maintenance calcium from day one. 2-3 ml/kg/day for all asphyxiated, IDM and preterm babies(less than 1000gm). Measure calcium on day 2 in all babies on IV calcium

Monitoring of fluid and electrolyte status

History

- Enquire particularly about history of use of oxytocin, diuretics, hypotonic fluids as newborn fluid & electrolyte status partially reflects maternal hydration and drug administration.
- Document Input and output. Review Input/output every 6 hours.

Physical examination

- Body weight : Acute changes in weight due to total body water may not reflect intravascular volume. Record weight daily. In sick babies and extreme preterm, weight should be checked twice daily. weight loss can be reach up to – 10% and 15 % of total body weight .React to > 5 % wt loss in a day.
- Failure to lose weight initially suggests fluid retention & is associated with Higher incidence of PDA and NEC in preterm infant
- Tachycardia indicates Congestive cardiac failure(CCF) or hypovolemia.
- Capillary refill time > 3 sec indicates decreased cardiac output.
- Blood pressure changes are late.
- Reduced skin turgor, dry mucous membranes, reduced urine output, depressed anterior fontanel indicate underhydration.
  Increased weight, edema (genital, periorbital, peripheral), hepatomegaly suggest overhydration or CCF
- Measure urine output for ventilated or unstable babies. Normal urine output:1-4 ml/kg/hr. Less than 0.5 ml/kg/hr is significant oliguria.

Laboratory parameters

- Serum electrolytes: Estimate serum Na^+& K^+ on day two, subsequently every alternate day for ventilated and unstable babies. In extreme preterms and neonates with fluid disturbances, serum electrolytes need to be done frequently. Sodium > 145 meq/L is a sign of dehydration. Twice a week for other babies still on IV fluids.
- First S. creatinine to be done at 48 hrs. BUN and serum creatinine twice a week for the first week in sick or ventilated babies. Subsequently once a week.
- Glucose estimation q 4-6 hourly for ventilated and unstable babies. Two times a day for other babies for first 3 days. RBS monitoring to be continued at least once a day in all stable growing babies in the NICU.

Electrolyte content of various body fluids

It is very important to have accurate measurement & composition of abnormal fluid losses to guide appropriate replacement. Measure the volume & composition of abnormal fluid loss & replace volume per volume & mole per mole basis.

Fluid Source	Sodium (meq/l)	Potassium (meq/l)	Chloride (meq/l)
Stomach	20 – 80	5 – 20	100 – 150
Small intestine	100 – 140	5 – 15	90 – 120
Bile	120 – 140	5 – 15	90 – 120
Ileostomy	45 – 135	3 – 15	20 – 120
Diarrheal stool	10 – 90	10 – 80	10 – 110
CSF	130 – 150	2 – 5	110 – 130

- ***Replace GI fluid loss and urine loss (> 4 ml/kg/day) by NS?***
- ***Replace other body fluid losses by RL / full strength NS.***
- ***Fluid losses should be replaced every 6 hours.***

Fluid management in Specific Situations

1. Perinatal asphyxia: Oliguria and anuria is commonly observed. May be due to SIADH or renal injury.

- Restrict fluid intake (two thirds of total) during the period of oliguria.
- Restore intake to normal when urine production is normal.
- If cause of oligo-anuria is unclear, the infant can be given a test dose of up to 20 ml / kg body wt. of normal saline challenge

2. Renal failure: In established oliguria renal failure with fluid overload, give 10 % D fluids at (60 ml/kg) + urine output + other losses. Make sure the GIR should be greater than 4mg/kg/min

3. HS-PDA: Give 2/3 of total fluid requirement.

4. Sick and critically ill babies

Third space losses (no contribution to fluid & circulatory dynamics) are difficult to quantify & replace. Provide fluid & electrolyte replacement as per state of hydration & circulatory status.

Dehydration in non-diarrhea setting

In babies with dehydration as evidenced by very slow skin pinch, treat as moderate dehydration with extra 100 ml/kg of IVF- DNS over 8 hours **till sodium report is available**

Composition of common IV fluids

Solution	**Dextrose g/100 ml**	**Na meq/L**	**K meq/L**	**Cl meq/L**	**Osmolarity mosm/L**
10 % D	10				510
5 % D	5				278
NS	-	154	-	154	308
½ NS	-	77	-	77	154
DNS	5	154	-	154	560
RL (Ca 4, lactate 28)	-	131	4	109	272
3% NaCl	-	513		513	1026
7.5 % $NaHCO_3$	-	900	-	-	1790
KCL	-	-	2000	2000	4000

Electrolyte disturbances

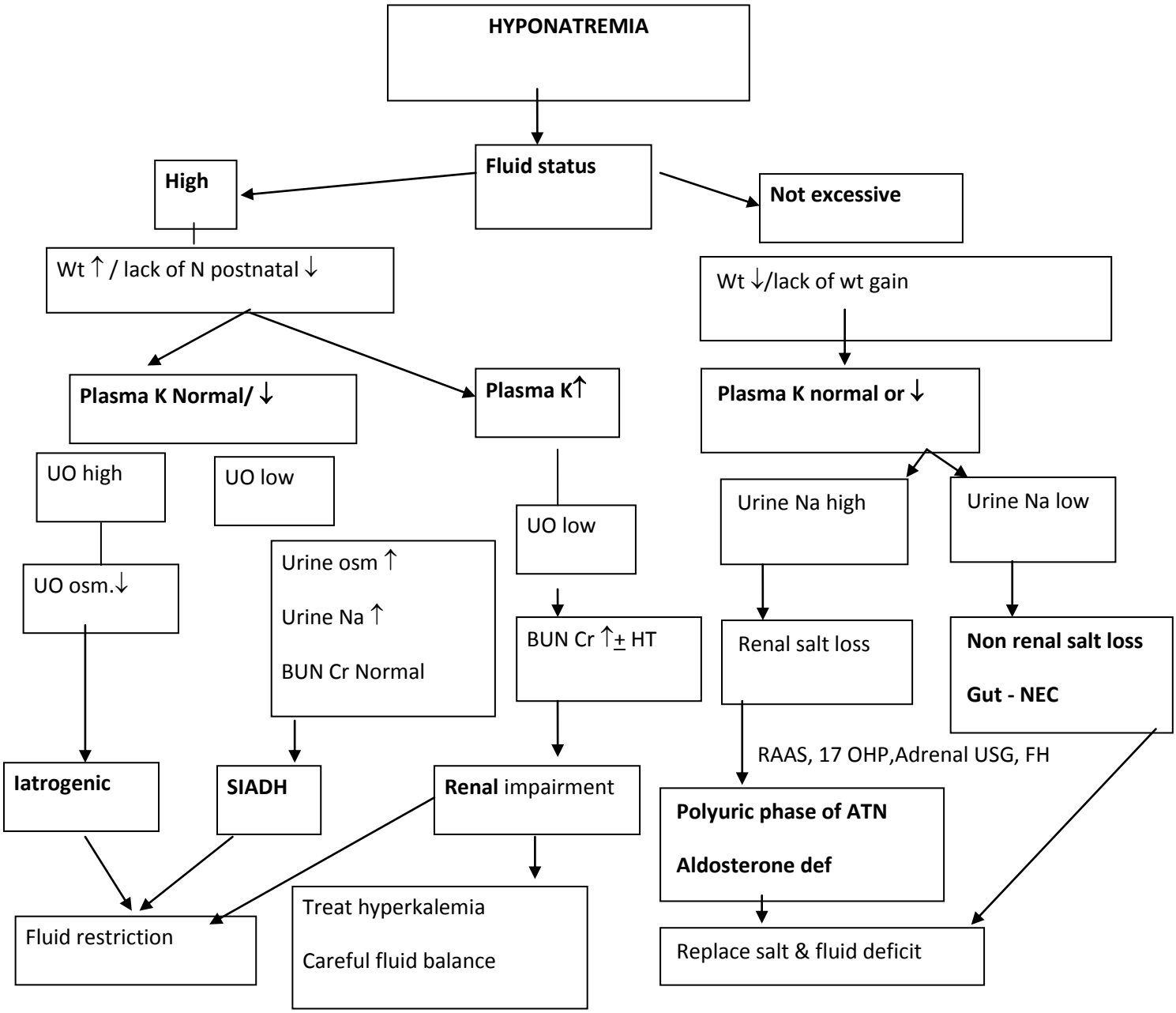
HYPONATREMIA

Approach

- Premature infants with late hyponatremia are generally asymptomatic. Some may develop poor weight gain, apnea, neurological symptoms such as irritability, convulsions.
- Clues: Abnormal change in weight, ambiguous genitalia, renal problems: palpable kidneys, hypertension, hyperkalemia, NEC, failure to thrive and edema.

Management

- If the baby has been on IV fluids and is in the first week of life, the most likely diagnosis is iatrogenic fluid overload. The treatment is fluid restriction. Watch out for hypoglycemia which may necessitate an increase in the concentration of IV dextrose infused.
- Sodium supplementation should start after 24hrs of life
- Urgent measurement of urine sodium will determine if the infant is losing sodium excessively or attempting to conserve sodium,
- Sodium correction = deficit + maintenance + ongoing losses. The deficit correction should not be more than 12 meq/day. Deficit correction = 0.6 X body weight X deficit (max 12 meq)
- Preterms with urinary sodium losses may need upto 3-5 mEq/kg/day.
- For hyponatremia of prematurity in an otherwise normal baby, the deficit is corrected with 3%NaCl with 1:1 dil with maintenance fluid
- Infants can have hyponatremia in oliguric renal failure.
- Hyponatremia is due to dilution secondary to water retention hence has to be corrected with fluid restriction. In most of the cases, there is no sodium deficit.
- If serum sodium is between 120-135 mEq/L, restriction of fluids will suffice. Serum sodium must be monitored at least 12hrly.
- If hyponatremia is associated with symptoms like seizures, or if hyponatremia is less than 120 mEq/L it requires prompt correction with 3% hypertonic saline in a dose of 5 mL/kg over 1 hrs. Be careful on preterm babies
- Hyponatremia unresponsive to above therapy is an indication for dialysis.
- Babies with non-oliguric ARF may have very large urinary sodium losses of up to 10 mmol/kg/day, and these must be replaced.
- Severe hyponatremia may be a risk factor for sensorineural hearing loss, poor cognition and neurodevelopment.


HYPONATREMIA
Fluid status
High
Not excessive
Wt ↑ / lack of N postnatal ↓
Wt ↓/lack of wt gain
Plasma K Normal/ ↓
Plasma K↑
Plasma K normal or ↓
UO high
UO low
UO low
Urine Na high
Urine Na low
UO osm.↓
Urine osm ↑
Urine Na ↑
BUN Cr Normal
BUN Cr ↑± HT
Renal salt loss
Non renal salt loss
Gut - NEC
RAAS, 17 OHP,Adrenal USG, FH
Iatrogenic
SIADH
Renal impairment
Polyuric phase of ATN
Aldosterone def
Fluid restriction
Treat hyperkalemia
Careful fluid balance
Replace salt & fluid deficit

HYPERNATREMIA IN NEONATES

Immediate Emergency Room Management

Mild hypernatrmemia may be corrected by enteral feeding. (eg.Inborn babies with >10% wt loss)

Sick babies presenting to ER with clinical dehydration (weight loss > 10% and skin pinch slow) –

- Assess for shock – if in shock give NS bolus 10ml/kg over 30 min and reassess for another 10 ml/kg
- Collect for serum electrolytes, S Cr, ABG
- Obtain Serum electrolytes as soon as possible.

Management based on serum sodium. Management starts in ER

1. If Na 160 mEq/L – oral correction (unless other indications for IV)
2. If Na >160 mEq/L – IV correction.
3. Start two lines: one for deficit correction, one for maintenance fluid. This aids in titration.
4. If bolus is given, repeat Na after bolus.
5. Estimate the daily maintenance fluid volume in ml (M)
6. Estimate the total deficit in ml (D) . Consider 15 % deficit for all weight loss > 15%.
   - If the serum sodium is 160-169 mEq/l, aim to administer the deficit over 2 days (=2)
   - If the serum sodium is 170-184 mEq/L, aim to administer the deficit over 3 days (T = 3)
   - If the serum sodium is 185-199 mEq/L, aim to administer the deficit over 4 days(T=4)
   - If the serum sodium is > 200 mEq/L – Consider Peritoneal dialysis. PD is indicated in the presence of renal failure/ refractory hyperkalemia/acidosis/fluid overload. PD fluid Na should be 10-15 mEq/L lover than the serum sodium, and change as per drop in serum sodium
7. Calculate the initial infusion rate in ml/h as (M+ D/T) / 24.
8. If serum sodium is > 165 mEq/L, various amounts of 3% normal saline (513 mmol/L sodium) should be added so that the IV fluid sodium concentration is approximately 10 to 15 mEq//L lower than the serum sodium level
9. Check SE and blood glucose 1 hour after starting therapy, and then 4 hourly for 12 hours. Aim for serum sodium to fall at a rate of 0.5 mEq/L/h (maximum 0.6 mEw/L/h or 12-15 mEq/L/day.
   a. If serum sodium is decreasing too rapidly either
   - Increase sodium concentration of IVF
   - Decrease rate of IVF

b. If serum sodium is decreasing too slowly either
   - Decrease serum concentration of IVF
   - Increase rate of IVF

10. Titrate deficit fluid correction based on weight.
11. Maintain a chart (date, time, weight, UO, Serum Na, dehydration deficit, Maintenance, 3 % NaCl, Na in IVF)
12. If the baby has seizures during treatment and the rate of fall has been rapid, give 5 ml/kg 3 % Nacl over 1 hour. Too rapid correction causes cerebral edema, convulsions, and permanent brain injury.
13. Hyperglycemia may occur during treatment. Use Glucose only in maintenance and not in deficit fluid. Do Urine sugar and if positive and > 250 mg/dl, give insulin.
14. Offer neuroimaging especially if the baby has neurological findings for Caverns venous thrombosis VT.

EXAMPLE

- 2.5 kg now 1.6 though 36% wt loss, let us consider as severe dehydration @ 15% (as upto 10% weight loss is normal.)

Maintenance fluid = 2.5 X 150 = 375 m

Deficit fluid = 250 X1.5 = 375 over 4 days

D/ 4 = 93. 75

Rate of fluid needed = 375 + 94 = 469= over 24 hours = 19.5 ml per hour

Now tonicity needed is 170- 175 meq/ L = 90 meq Na

Fluid order for next 24 hours. (Fluids = 60+315+15+81 =470 ml, Na= 89.5)

60 ml is feeds = almost negligible Na

315 ml of GNS =47.25 meq of Na

15 ml of NS = 2.25 meq Na

80 ml 3% NaCl= 40.meq Na

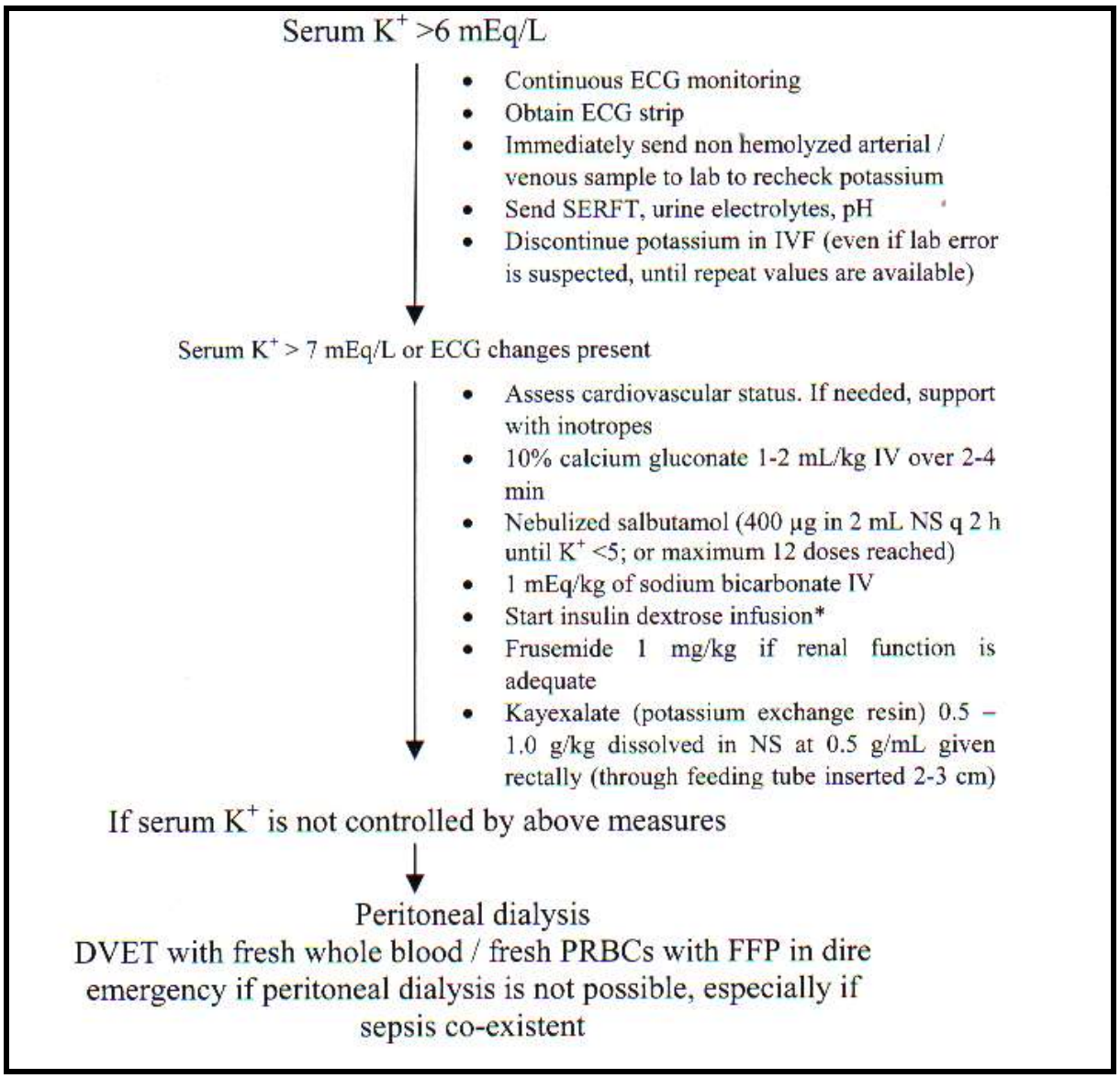
Will need to modify based on next sodium drop.

Potassium

- Newborns are less likely to have hypokalemia (**Serum potassium <3.5 meq/L)** than older infants. ELBW (extremely low birth weight) infants may have life threatening bradycardia

induced by hyperkalemia (**Serum potassium >6.0mEq/L)** in the first few days. A laboratory report of hyperkalemia in a newborn should not be passed off as a result of squeezed / hemolysed sample. An urgent repeat sample should be ordered. Hyperkalemia is commonly seen in a setting of asphyxia, hypothermia, post exchange transfusion or in infants with congenital adrenal hyperplasia.

- Per gavage administration of kayexalate is not recommended in preterm infants because of risk for NEC. Rectal administration is effective. In sick newborns, insulin-glucose infusion has been found to be the most effective in reducing the potassium



RESPIRATORY DISTRESS SYNDROME

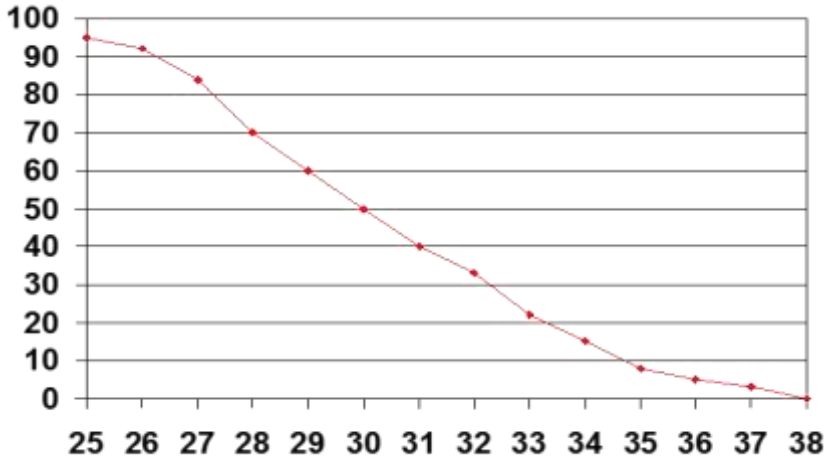
Definition

Pre-term neonate

- Respiratory distress having onset within 6 hours of birth
- Amniotic fluid L/S ratio of <2, or negative gastric aspirate shake test, or
- CXR showing poor expansion with air bronchogram/ reticulogranular pattern/ ground glass opacity.

Incidence

The incidence of RDS increases as the gestational age decreases



Prevention of RDS

Prevention

Prevention of preterm births is not always possible. The single most important intervention to decrease the incidence of RDS is the antenatal administration of corticosteroids. A recent Cochrane meta-analysis has reiterated the magnitude of benefit of antenatal corticosteroids (Table 1) (6):

Table 1: Benefit of Antenatal Corticosteroids

	Relative risk	**95% Confidence interval**	**No. of studies**	**No. of infants**
Neonatal mortality	0.69	0.58 to 0.81	18	3956
RDS	0.66	0.59 to 0.73	21	4038
Cerebroventricular haemorrhage	0.54	0.43 to 0.69	13	2872
Necrotising enterocolitis	0.46	0.29 to 0.74	8	1675
Respiratory support, intensive care admissions	0.80	0.65 to 0.99	2	277
Systemic infections in first 48 h	0.56	0.38 to 0.85	5	1319

- Indicated for 24-34 weeks gestation age.
- Betamethasone or Dexamethasone.
- Dose : 2 doses of betamethasone is administered 12mg IM at an interval of 24 hours or 4 doses of dexamethasone , 6mg each at an interval of 12 hours Effect starts 24 hours (possibly as early as 4 hours) after 1st dose and continues for 7 days.
- A repeat course of steroids is to be considered if it was taken > 7 days ago and gestation is < 34 weeks and delivery is likely.

Evaluation

- Lung maturity can be assessed in a newborn at risk of RDS by the shake test
- For all preterms <34 weeks of gestation perform shake test on the gastric fluid within 1 hour of age by passing a nasogastric tube into the stomach. Take absolute alcohol 0.5ml and add 0.5 ml of gastric aspirate in a 4ml glass test tube. The capped test tube is vigorously shaken for 15 seconds and allowed to stand for 15 minutes.

• **Observation**	• **Interpretation**	• **Risk of RDS**
• Immature	• No bubbles	• High (60%)
• 1+	• Very small bubbles in meniscus extending one-third or less of circumference(magnifying glass may be used)	• Intermediate(20%)
• 2+	• Single rim of bubbles extending one third to all the way around the test tube.	• Moderate
• 3+	• A rim of bubbles all the way around the test tube with double row in some areas	• Low(<1%)
• 4+	• A double row or more of bubbles all the way around the test tube indicate lung maturity	• Nil

- Watch for evidence of respiratory distress (≥2 of the following)
    - RR> 60/min
    - Working of accessory muscle of respiration
    - Cyanosis
    - Grunting
- Document Downes Score every 2 hourly
- Monitor HR, RR, CRT, and NIBP 2 hourly
- Monitor SaO_2 and FiO_2 every ½ hourly
- Take X-ray chest
    - Low volume poorly inflated lungs
    - fine homogeneous reticulogranular pattern (grade 1)
    - widespread air bronchograms become visible (grade 2)
    - Cardio pulmonary differentiation difficult due to alveolar shadowing (grade 3)
    - Complete white-out of the lung fields (grade 4)
- Record intake/output chart strictly
- Watch for apnea , pallor, air entry, liver size, murmur

Management

- Maintain temperature and the vitals
- Give antibiotic if risk factors are present or if septic screen is positive.
- The hallmark of RDS is surfactant deficiency and collapse of the alveoli.

Basic pathophysiology

- Compliance : ↓↓↓

- Resistance : N/ ↑
- Time constant : ↓
- FRC : ↓↓↓, Less commonly N or ↓
- Ventilation : Heterogeneous lung disease
- Perfusion : normal to reduced

CPAP

- Early CPAP is the corner stone of RDS management. If the baby has respiratory distress / labored breathing, initiate CPAP at 5 cm H_2O in the labor room. It is preferred to use blended oxygen. Target SaO_2 90-95 %.

- Start with CPAP of 5 cm H_2O, flow of 5 l/ min and FiO_2 – 0.5.
- In Bubble CPAP the pressure is increased by increasing the depth of the underwater seal. Ensure bubbling.
- **Interface**: should be comfortable, atraumatic to nose, easily cleanable and deliver CPAP effectively. The interface should be fixed well.
- Titrate CPAP pressures based on retractions. It is preferred to increase CPAP rather than FiO_2. Ensure that the stomach is decompressed by keeping the infant feeding tube open.
- Increase CPAP to a maximum of 7 cm H_2O especially if the lungs are low volume. Based on saturations. If the baby requires > 0.4 FiO2, and CXR is suggestive of RDS, give surfactant.
- INSURE - Intubate Surfactant Rapid extubation is preferred.
- Contraindications to CPAP – hemodynamic instability is a relative contraindication CPAP is not possible in cleft palate, TEF, bilateral choanal atresia,, recurrent apnea not responding to CPAP or SIPPV

Surfactant

Surfactant Family	Trade Name	Preparation	Protein	Phospholipd concentration	Dose
Synthetic	Exosurf	DPPC with 9% hexadecanol and 6% tyloxapol	No	13.5 mg/ml	5 ml/kg
	Surfact	DPPC	No	13.5 mg/ml	5 ml/kg
	Pumactant	DPPC, PG	No	40 mg/ml	1.2 ml/kg
Natural	Survanta (bovine)	DPPC, PG	Some SP-B and SP-C	25 mg/ml	4 ml/kg
	Curosurf (porcine)	DPPC, PG	SP-B and SP-C	80 mg/ml	2.5 ml/kg and 1.25 ml/kg
	Neosurf (BLES - bovine lipid extract surfactant)	DPPC, PG	SP-B and SP-C	27 mg/ml	5 ml/kg
	Infasurf (bovine)	DPPC, PG	SP-B and SP-C	35 mg/ml	3 ml/kg
	Alveofact (bovine)	DPPC, PG	SP-B and SP-C	40 mg/ml	1.2 ml/kg
Newer surfactants	Surfaxin	DPPC, POPG,	KL_4 peptide (sinapultide) as SP-B	30 mg/ml	5.8 ml/kg
	Venticute	DPPC, POPG	r SP-C	50 mg/ml	Not studied in neonates

- After surfactant is given, the pressures should be reduced over the next 1 hours. Volume guarantee is a good mode post surfactant to avoid volutrauma.

- Prophylactic surfactant is considered for extreme preterms < 28 weeks) especially if the mother has not received steroids.
- Rescue therapy is considered for all preterms with respiratory distress and FiO_2> 0.4. Early rescue is within 2 hours. Late rescue is > 2 hours.
- Repeat dose: If the baby is still on ventilator and MAP is > 8 and FiO_2 is > 0,4, repeat dose of surfactant may be administered. Repeat dose after 12hrs hours.
- **Precautions :** Adjust the ventilator settings appropriately after administration, as the compliance improves rapidly and may lead to barotrauma.
    - Mechanical blockage of the tube leading to hypoxemia.
    - Hemorrhagic pulmonary edema.

Ventilatory management

- Mechanical Ventilation: Start with patient triggered ventilation.
    - Low PIP - 10-20 cm H_2O
    - Moderate PEEP – 5 – 6 cm H_2O
    - Relatively rapid rate (40-60/min)

**If retractions persists increase PEEP to a maximum of 7 cm H_2O.*

Target SaO_2

- pH 7.25-7.35
- PaO_2 50-70 mm Hg
- $PaCO_2$ 45-55 mm Hg

Further management

- Duration ventilator should be decided by consultant
- Watch for clinical and ABG improvement and gradually wean off the baby.
- Give maintenance fluids and start feeds gradually

MECONIUM ASPIRATION SYNDROME

Management in the delivery room

Note the following points in case of meconium stained amniotic fluid

- The character and colour of meconium
- Approximate estimation of gestational age (preterm vs term)
- Presentation (vertex vs breech)
- Evidence of fetal distress

Keep the appropriate resuscitation equipments ready.

- Resuscitation is same as any normal delivery. The current NRP guidelines 2015 recommends that ET suction in non vigourous baby is NOT needed. However suction of mouth is indicated.
- Examine the placenta
- Collect cord ABG.

If baby develops respiratory distress in the Labor room - start the baby on CPAP with PEEP settings of 5cm of H_2O and shift to NICU.

Management in NICU

- Assess the gestational age of the baby. A preterm < 34 weeks who passes meconium in utero has either infection or is severely hypoxic. Look for the signs of IUGR
- Note whether umbilical cord, nails and skin are stained with meconium.
    - Staining of cord – 1-3 hours
    - Staining of nails – 4-6 hours
    - Staining of skin – 12-24 hours
- Monitor for evidence of respiratory distress suggestive of MAS

Downe-Vidyasagar Score for grading respiratory distress in a term baby

SCORE	Respiratory Rate	Nasal flaring	Cyanosis	Grunt	Auscultation
0	<60	Nil	Absent	Absent	Good air entry
1	60 – 80	Mild	Present on room air	Audible on Stethoscope	Breathing delayed or decreased
2	>80 or apnea	Moderate to Severe	Present on FiO_2 40%	Audible without the stethoscope	Breathing barely audible

Grades of severity according to the total score: 1 – 3 - mild; 4 –6 - moderate, >6 - severe

Monitor closely for deterioration in clinical status or drop in SaO_2 suggestive of air leak syndrome, lung collapse, PPHN.

Meconium aspiration syndrome is defined as at least 2 of the following 3 criteria:

- Meconium stained amniotic fluid
- Respiratory distress
- CXR findings of MAS

MAS infants may be hypoxic but appear well. ALWAYS check the saturations.

Investigations if symptomatic

- Cord ABG
- ABG on admission (if cord ABG not collected or clinically indicated)
- X-ray chest if mod -severe RD or mild RD persisting > 2 hours.
    - Patchy atelectasis
    - Heterogeneous fluffy or nodular opacities

- Dirty lung fields
- Hyperinflation & Air leak

- Asphyxia workup
- Other investigation as indicated.

Management

- Routine gastric lavage with normal saline has not been found to be beneficial.
- Administer IV fluids as required if ventilated or severe asphyxia. For infants with mild RD, give gavage feeds.
- Administer antibiotics if risk for sepsis and symptomatic or if septic screen at 6 -12 hours is + (at least 2 abnormal parameters). Routine antibiotics in MAS are not useful. MAS in preterm neonates may be a sign of infection.
- Prevent hypothermia, hypoxia, hypercarbia, hypoglycemia and acidosis. This could result in PPHN. Supportive care
- Treat the complications (pneumothorax, PPHN and pneumonia, respiratory failure).

Ventilation in MAS

Indications for ventilation

- RDS $\geq$ 6
- ABG: paO_2<50 on 0.8 FiO2 or $paCO_2$>60 or pH<7.25

Basic pathophysiology

- Compliance : N or ↓
- Resistance : ↑↑↑
- Time constant : ↑↑
- FRC : Usually ↑, Less commonly N or ↓
- Ventilation : Inhomogeneous lung disease
- Perfusion : ↑ tonicity/spasm

- CPAP can be tried especially in low volume atelectatic lungs. But the large infant may not tolerate it. Do not use CPAP > 6 cm H_2O, Do not give CPAP if air leak, hyperinflated lungs, or high $PaCO_2$

- Mechanical Ventilation: Start with patient triggered ventilation. HFV as indicated.
    - PIP - 18-20 cm H_2O
    - Low to moderate PEEP – 3-4 cm H_2O
    - Ti = 0.3- 0.5 sec. Adequate Te – 0.5-.7 sec.
    - Relatively rapid rate (40-60/min). If PS available, use rates < 30 /min and PS to support ¾ set Vt
    - If gas trapping occurs, increase Te to 0.7-1.0 sec and decrease PEEP to 3-4 cm H_2O. The findings on the CXR can guide the ventilatory settings. If it shows low volume, higher PEEP can be used. If it shows hyperinflation avoid auto PEEP. Give adequate time for expiration.

- Surfactant – Meconium is a strong surfactant inactivator. **Consider** surfactant if the baby is requiring high ventilatory parameters – FiO_2> 0.6 or PIP > 20 cm H_2O, especially if the CXR shows low volume lungs with atelectasis. . Give 4 ml/kg surfactant.

- Sedation and analgesia.

- iNO in PPHN

Targets in MAS

- Target SaO_2 92-98 %.

- Target ABG : (without PPHN)
    - pH 7.3-7.4,
    - PaO_2 60-80 mm Hg,
    - $PaCO_2$ 35-45 mm Hg

APNEA IN NEWBORN

DEFINITION

Apnea is defined as cessation of breathing for longer than 20 sec or of any duration associated with cyanosis/bradycardia <100/min /poor tone

INCIDENCE

Incidence of apnea increases with decreasing gestational age. Essentially all neonates <28wk have apnea. Seen in 20-25% of babies weighing <1500 gm/<34wks

ONSET: Apnea generally occurs 1 or 2 days after birth, if they do not occur during first 7 days they are unlikely to occur later.

CLASSIFICATION OF APNEA:

Is based on whether absent air flow is accompanied by continued respiratory efforts and upper airway obstruction .Most spells are central or mixed apnea

1. Central apnea(40%) : when inspiratory efforts are absent
2. Obstructive apnea(10%):inspiratory efforts persists in presence of airway obstruction
3. Mixed apnea(50%) :when airway obstruction with inspiratory efforts precedes or follow central apnea

ETIOLOGY OF APNEA:

1. Idiopathic : Apnea of prematurity
2. Temperature: Hypothermia / Hyperthermia
3. CNS: Intracranial hemorrhage, seizures, drugs – depressant, maternal narrcotics and magnesium sulphate,
4. Respiratory: hypoxia, RDS, pneumonia, obstructive airway lesions, laryngeal reflex, pneumothorax, nasal occlusion caused by phototherapy eye patches, tracheal occlusion caused by neck flexion
5. CVS: heart failure, hypotension, hypertension, hypovolemia, PDA
6. GIT: GERD, NEC,
7. Infection: pneumonia, sepsis, meningitis
8. Metabolic: acidosis,hypoglycaemia,hypocalcemia,hyponatremia,hypernatremia,IEM
9. Haematological : anemia, polycythemia

MONITORING

All babies less than 34 weeks gestation should be monitored 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.

Apnea monitors, **Pulse oximeter** is an effective way of monitoring for apnea. Though it does not detect chest wall movement; it detects the most important clinical consequences of apnea i.e. hypoxia and bradycardia.

DIFFERENTIAL DIAGNOSIS:

1. Periodic breathing: About 30-45% of preterm babies' exhibit a periodic breathing pattern characterized by 3or more respiratory pauses of 3-10 seconds. It is not associated with bradycardia or desaturations. Periodic breathing is a normal event; reflective of immaturity of respiratory control system in these infants and does not merit any treatment.

2. Subtle seizures*:* Apnea is an uncommon presentation of a neonatal seizure in preterm infants. Sudden alteration in muscle tone, twitching movements, vacant stare and up rolling of eyes suggests a seizure. Tachycardia preceding/ accompanying an apneic attack usually suggests seizure activity

MANAGEMENT OF APNEA IN NEWBORN:

I. GENERAL MEASURES

1. Avoid reflexes that trigger apnea. Careful suctioning
2. Oral feeding withheld
3. Position of extreme flexion or extension avoided. Prone position reduces apnea
4. Warmth and temperature regulation. Maintain temperature in the lower end of thermoneutral range.
5. Oxygen as needed

II. SPECIFIC MEASURES:

1. Correction of metabolic disturbances like hypoglycemia/hypocalcaemia/acidosis
2. Anemia: Packed cell transfusion if Hematocrite <31 % and recurrent apneas
3. Antibiotics for suspect infection
4. Methyl xanthines is indicated in preterm infants < 34 weeks if recurrent apnea ($\underline{\geq}$ 2 apneas/ h or $\underline{\geq}$ 3 in 2 consecutive hours).

   Caffeine: a methylxanthine reduces apneic spells and need for mechanical ventilation. Survival without neurodevelopmental disability is improved and reduces rate of BPD/CLD. It is prophylactically started in ELBW and extreme preterm neonates and also given periextubation in VLBW infants.

Dose: loading dose 20mg/kg caffeine citrate (10mg/kg of caffeine base) orally or intravenously followed by maintenance doses of 5-8mg/kg of caffeine citrate(2.5-5 mg/kg of caffeine base)in once daily dosing beginning 24hrs after loading dose

If apnea continues give additional loading dose of 10 mg/kg caffeine citrate and increase maintenance dose by 20%. Therapeutic serum levels of caffeine are 5-20mcg/ml.

Caffeine Prophylaxis :< 30 weeks or <1250g

Caffeine is discontinued:

- 48 hours after extubation
- Apnea free for 7 days
- If started empirically in ELBW / extreme preterm, it is generally discontinued at 34-36 wk of corrected age if no apneic spells have occurred in last 7 days .In some ELBW infants caffeine may have to continued even at discharge.
- Effect of caffeine likely remains for approximately 1 week after discontinuation. If caffeine is stopped, the baby should be monitored for apnea for 5-7 days.

Aminophylline can also be used with loading dose of 5 mg/kg , followed by 2 mg/kg /dose TID. However the therapeutic index of aminophylline is narrower.

5. Ventilation : If the apneas are very frequent mandating immediate respiratory support: despite methylxanthines:
    - Nasal CPAP: at 4-6mm of Hg.
    - NIPPV PIP – 12- 15 cm H2O, PEEP - 5 , Rate 20-30 / min, FiO_2 0.21 for normal lungs
    - SIMV with minimal settings if all other interventions unsuccessful PIP – 12- 13 cm H2O, PEEP - 5 , Rate 20-30 / min, FiO_2 0.21

PNEUMOTHORAX

Pneumothorax is a potential emergency in NICU. The possibility of pneumothorax should be entertained in all cases with (**risk factors)**

- Post resuscitation
- RDS with/without surfactant
- MAS
- CDH
- Pulmonary hypoplasia
- High ventilatory parameters for whatever Etiology. (MAP > 10 cm H2O)
- On CPAP in an agitated baby

Clinical presentation

- Sudden and / or unexplained deterioration.
- Asymmetric chest movements, unequal air entry, displaced heart
- Fall in oxygen saturation or increased oxygen requirement.
- Hypotension.
- ABG : hypoxia/ hypercarbia/ respiratory and or metabolic acidosis

Confirmation

- Clinical identification is the gold standard.
- Cold light transillumination
- CXR if available urgently could guide to treatment – common while babies on HFV.
- **USG lung – Absence of sliding sign**

Management

Needle aspiration &Intercoastal Catheter Drainage(ICD) insertion.

Scenarios with air-leaks:

- Scenario 1 – Mildly symptomatic or asymptomatic neonate not on any respiratory support. Close RD monitoring till symptom resolution. RD score atleast Q6H. Once resolved – to watch for any re-accumulation.
- Scenario 2 – symptomatic baby while on respiratory support. If depronging the baby to hood box oxygen is an option, could be tried (term babies). In all other babies – the pneumothorax should be drained and if invasively ventilated to change to rescue high frequency ventilation(HFV)

Needle aspiration

Needle drainage should be used only for diagnostic and prompt symptom relief purposes. Needle drainage.

- 23G or 25G butterfly.

- 10 ml syringe
- 3 way tap?

Neonate should be supine. In the identified side, in 2nd ICS in the mid-clavicular line, the butterfly is inserted while maintaining closed system with syringe, 3 way and syringe. Air is aspirated till there is no further release of air. Urgent preparation should be made to insert ICD.

ICD insertion

- **8 Fr for babies <1500g and 10 Fr for babies >1500g / or Vygon ICD tube**
- Venesction kit
- Mersilk suture 1-0

The procedure is done under the supervision of a SR.

Ensure adequate asepsis during procedure. Sedation – Inj Fentanyl 2microgram/ kg..Titrate oxygen to need.

At 4th / 5th ICS ICD is inserted with a small mosquito after identifying the length to be inserted (2 inch) with the end clamped. This is connected to under-water sealed bottle.

The ICD is secured with purse string sutures around the catheter. The ends of the suture are braided over the tube. The column movement to be documented at the end of procedure.CXR to be taken after the procedure while on HFV.ABG to be taken after 30 mins of change in mode.

ICD is clamped when there is no column movement or air-bubbling, with adequate chest expansion. If baby continues to be stable, the ICD is removed, usually after the baby is off off all positive pressure ventilation.

Trouble shooting:

1. Rapidly accumulating air

- Change position of baby (prone)
- Consult pediatricsurgeons : chance of high airway injury.
- Consider second ICD insertion at higher intercostal space mid axillary line.
- Consider negative suction – 3 bottle technique.

2. When the air column is not moving in ICD –
   - Look for signs of air accumulation :worsening distress, increasing ventilatory requirements, differential air entry, shift of mediastinum, air trapping on pulmonary graphics.
   - Chest x ray to confirm or rule out the same. Consider 2nd ICD
   - Manipulate ??

When to remove ICD

- Output < 10 ml/kg
- Absence of bubbling
- Clamp ICD and repeat xray after 6 hours

If Xray has no re-accumulation of air , ICD may be removed

EXTUBATION PROTOCOL

From the time of initiation of mechanical ventilation, the goal is to wean and then extubate.

Continuation on any form of mechanical ventilation should be a conscious decision everyday along with assessment of readiness to extubate.

Unsuccessful extubations are common especially in VLBW and reintubation adds to the trauma and hemodynamic compromise. Hence all extubations must be well planned and done under optimal conditions.

Criteria

There is no single reliable physiologic parameter or pulmonary function test in neonates that determines readiness for extubation. However the following are generally considered.

1. Baby on minimal ventilatory parameters
    a. for a term baby PIP≤14, PEEP≤4, FiO_2 ≤0.4 Set rates≤20/min
    b. for a preterm baby PIP≤13, PEEP≤5, FiO_2 ≤0.4 Set rates≤25/min
2. Blood gases within normal range on these minimal parameters
3. Consistently maintaining target saturations on the pulse oximeter for the past 6 hours
4. Spontaneous respiratory effort above the set ventilator rate or when the neonate is disconnected from the ventilator for suctioning etc
5. Hemodynamically and metabolically stable. Not in shock, no contraindication for CPAP in VLBW, anemia and dyselectrolytemia are corrected.
6. For VLBW infants a loading dose of caffeine citrate should be to be given 4 hours prior to extubation
7. Sedation needs to be discontinued at least 12 hours prior. Follow gradual weaning if used for more than 7 days.
8. Spontaneous minute ventilation of >50% on Dragger ventilator (optional)
9. Spontaneous tidal volume of 3ml/kg
10. Improvement or resolution of the underlying cause of respiratory failure

Equipment Required

- A T-piece resuscitator / Ambu bag must be at the bedside for delivering oxygen, CPAP, or manual breaths (with pre set pressures) if necessary post extubation with appropriate size face mask
- Stocked and checked resuscitation trolley
- Wall suction unit working and appropriate size suction catheters for suctioning the oropharynx and ETT

- Wall oxygen is connected and an appropriate hood is ready
- If extubating to CPAP, the interphase should be ready.
- Multiparameter monitors should already be in situ and should remain so during and after extubation
- Prepare sterile container and sterile scissors.

Post extubation respiratory support

1. in VLBW or less than 32 weeks : extubate to CPAP.NIPPV can be optional if the baby is assessed to be at high risk for unsuccessful extubation.
2. all other babies: extubate to room air/ hood oxygen if FiO2 on ventilation was more than0.21

Risk for extubation failure

- ELBW /extreme preterm
- Prolonged ventilation > 7 days
- Pre extubation AaDO2 > 50, Pre extubation OI > 2/ FiO2 pre extubation > 0.3 in preterm
- Nutritionally compromised (NPO > 7 days)
- HsPDA / Unresolved pneumonia/ Unresolved sepsis

Personnel

- Extubation is a 2 person job.
- Explain to parents that there is a risk of reintubation.
- Time extubation away from changes of shifts or after 8 PM .
- Ensure a senior nurse and fellow are available to perform reintubation, is available at the time of extubation.

Procedure

- Place infant in supine position –head midline and slightly extended to ensure a clear airway.
- Ensure vital signs stable before proceeding.
- If infant on milk feeds keep NPO for 4hrs prior to the procedure or consider aspirating contents of the stomach.
- Decontaminate hands as per unit policy. Using oil remove tape securing ETT in place carefully
- Perform ET suction followed by oral suction.

- Apply positive pressure with Ambu bag and extubate the baby
- It may be beneficial for the infant to be nursed prone following extubation.
- Send ET tube tip for microscopy(Gram stain), culture and sensitivity.
- Hold free flow oxygen close to baby's nose throughout the procedure
- Blood gas should be taken 1 hour following extubation, and subsequently assessed on an individual basis.
- Observe the infants response to extubation and continue to monitor for any signs of respiratory distress tachypnoea, increased work of breathing, color changes, decreasing oxygen saturations requiring an increase in oxygen or CPAP or stridor which may indicate upper airway obstruction
- Feeds may be restarted four hours after extubation
- Document the time of extubation on the neonate's observation chart and in the neonate's progress notes indicating whether the extubation was to room air, oxygen or CPAP +/- oxygen and how it was tolerated
- Post extubation care – nebulization with adrenaline 0.5ml in NS can be given if there are signs of upper airway obstruction or baby was on ventilation for more than 5 day.
- Chest physiotherapy on individual basis if there is collapse or secretions

Criteria for Reintubation:

Clinical

1. Recurrent apneic spells
2. Recurrent desaturation
3. Preterm babies: requirement of FiO_2>0.6 with significant retractions
4. Term babies : Respiratory Distress Score >5/10

ABG :-PaCO2 > 65 mm Hg, respiratory acidosis with pH <7.25, (arterial oxygen saturation <88% and/or PaO2 55 mm Hg)

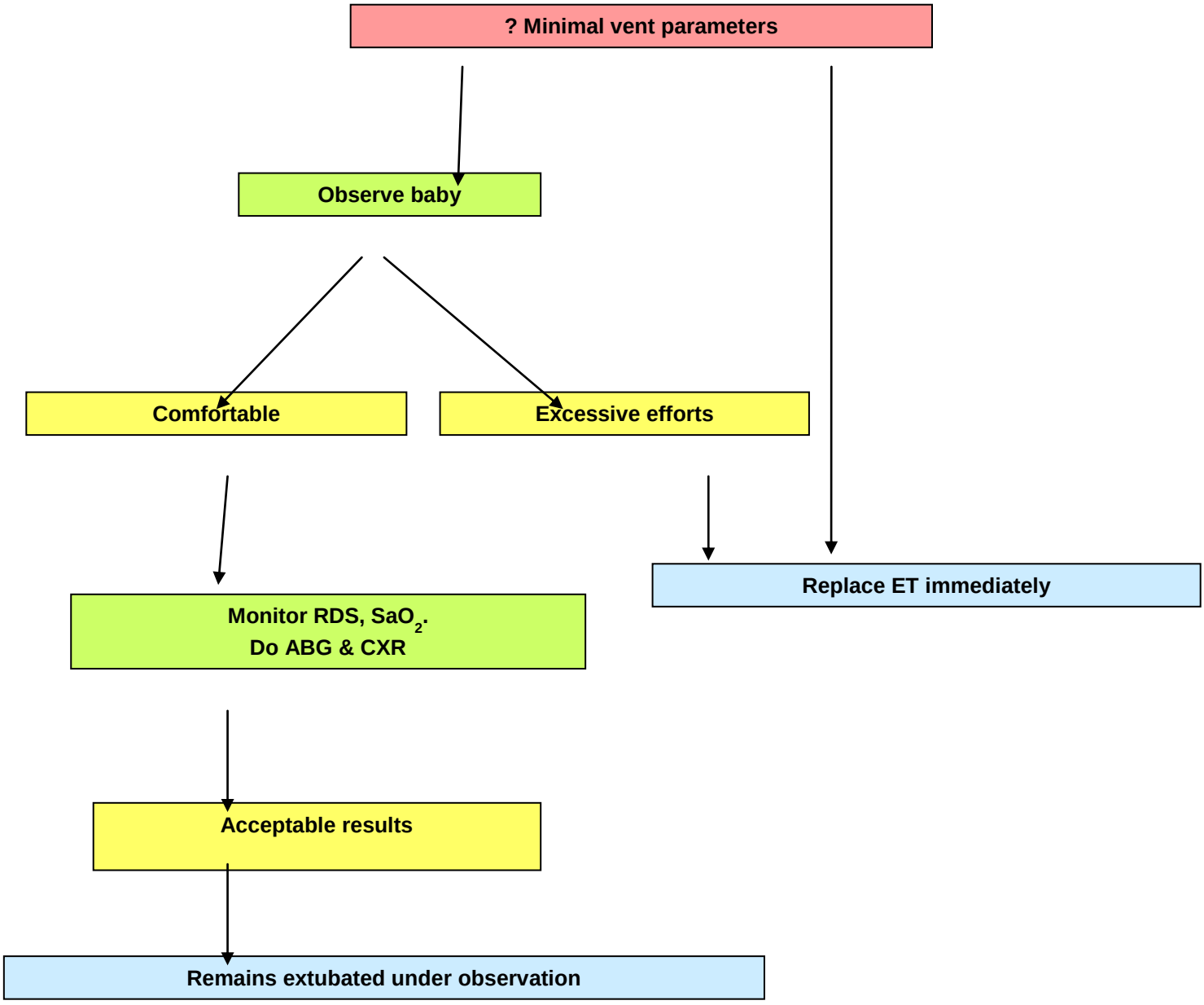
Use of Steroids

- 2 failed extubations
- Bronchoscopy normal
- Several days of ventilation(at least 7 days)

What to give ?

- Short course Dexamethasone 0.5 mg/kg/d in 2 divided doses beginning 24 hours before extubation Continue 24 hours after extubation

Accidental Extubation



Monitor By Apnea monitor /Pulse oximeter

1. Preterm <34 weeks gestation.
2. Sick neonates

NEONATAL SEPSIS

Definitions

Systemic Inflammatory Response Syndrome:

The presence of at least 2 of the following 4 criteria, 1 of which must be abnormal temperature or leukocyte count:

1. Core temperature of >38.5°C (38°C in preterms) or <36°°C (could be need for increased heater output for maintaining temperature)
2. Tachycardia, defined as a mean heart rate >2SD more than normal for age in the absence of external stimulus OR bradycardia, defined as a mean heart rate <10th percentile for age in the absence of β-blocker drugs, or congenital heart disease; or otherwise unexplained persistent depression in a 0.5-h time period
3. Mean respiratory rate >60 more than normal for age or mechanical ventilation for an acute process not related to underlying neuromusculardisease or the receipt of general anesthesia
4. Leukocyte count increased or decreased for age

Sepsis : SIRS in the presence of or as a result of suspected or proven infection.

Severe sepsis: Sepsis plus 1 of the following: cardiovascular organ dysfunction OR ARDS

OR 2 or more other organ dysfunctions

Definite sepsis- bacteremia (culture positive) with clinical features

Probable sepsis- clinical suspicion with positive screen tests

Suspect sepsis- clinical suspicion only

Early onset sepsis (EOS) – onset < 72 hrs.

Late onset sepsis (LOS)- onset >72 hrs

Health care-associated infection (HCAI), also referred to as "nosocomial" or "hospital" infection, is an infection occurring in a patient during the process of care in a hospital or other health care facility which was not present or incubating at the time of admission. Any new blood culture positive sepsis after 48 hours of hospital stay is considered nosocomial sepsis.

Symptoms and Signs of Sepsis Clinical features of neonatal sepsis are non-specific and any unexplained clinical deterioration should be investigated for sepsis unless proven otherwise.

Symptoms : fever , lethargy, difficulty in feeding*, fast breathing, apnea, respiratory distress, retractions, grunting, cyanosis, abdominal distension, vomiting, diarrhea, convulsions*, umbilical discharge, pustules.

Signs:

- General: Hypothermia<35.5C / hyperthermia >37..5 C*, abnormal skin color, pallor, jaundice,
- Cardiovascular: tachycardia / bradycardia, shock, hypotension/delayed capillary refill, oliguria, metabolic acidosis,
- Respiratory: apnea, tachypnea (≥60 / min*), severe chest indrawing *, respiratory distress, cyanosis / desaturations, grunt, increased ventilator requirements
- Gastrointestinal: abdominal distension, increased aspirates, bleeding
- Neurological: lethargy/hypotonia, stupor . coma, reduced activity(movement only when stimulated*), seizures,
- Late clinical signs are indicative of severe septicemia: sclerema, shock, features of disseminated intravascular coagulation, pulmonary hemorrhage, collapse.

* WHO Young Infants Clinical Signs Study Group found these 7 clinical symptoms and signs to be useful for diagnosing sepsis.

Risk factors for Early Onset Sepsis are as follows:

- Repeated per vaginal examinations
- Clinical chorioamnionitis: maternal fever of greater than 38°C (100.4°F) and at least two of the following criteria:
    - maternal leukocytosis (greater than 15 000 cells/ mm3),
    - maternal tachycardia (greater than 100 beats/minute),
    - fetal tachycardia (greater than 160 beats/minute),
    - uterine tenderness,
    - foul odor of the amniotic fluid)
- Very low birth weight (<1500 grams) or very preterm
- Febrile illness in the mother with evidence of bacterial infection / UTI within 2 weeks prior to delivery.
- Perinatal asphyxia (Apgar score <4 at 1 minute)
- Rupture of membranes >18 hours.
- PPROM / Spontaneous preterm labor

Management (EOS)

- Every newborn at risk for sepsis should be evaluated (clinically and by laboratory tests) for sepsis.
- If the baby is symptomatic with risk factors – Collect blood culture and start on antibiotics.
- If the baby is asymptomatic with risk factors – Collect blood culture at birth, monitor the baby and perform septic screen at 6-12 hours. If the septic screen is positive, start on antibiotics . If septic screen is negative, continue to monitor the baby and repeat septic screen after 24 hours..
- If the baby is symptomatic without risk factors and CXR is suggestive of pneumonia OR have no alternate reasons for the symptoms must be started on antibiotics after blood culture.

Neonates with extreme risk factors must be started on empirical antibiotics

- Very prolonged rupture of membranes (≥72 hours), GA<35weeks/spontaneous preterm labor
- Very prolonged labor (≥24 hours),
- Foul smelling liquor,
- Maternal septicemia or other systemic infections

Management (LOS)

- If the neonate is symptomatic after 72 hours of life, evaluate for LOS.
- The risk factors for LOS are VLBW, mechanical ventilation, Central lines, TPN, use of antibiotics > 5 days, multiple interventions, inability to feed with EBM, use of H2 blockers, steroids.
- Categorize the neonates into low probability or high probability of sepsis.
- If low probability for sepsis, perform a septic screen. If all the parameters of the screen are negative, antibiotics may not be started and the neonate must be monitored clinically. However Repeat screen after 24 hours. A negative repeat screen strongly indicates against starting antibiotics whereas a positive repeat screen with persistence of symptoms may warrant antibiotics.
- If high probability of sepsis, start on antibiotics pending blood culture and septic screen.
- A CSF examination must be performed in all neonates with a high probability of sepsis as well as in those neonates with a low probability of sepsis with a positive sepsis screen.
- Monitor the baby with sepsis for clinical deterioration, respiratory worsening, shock, coagulopathy, cholestasis.

Blood culture

Under strict aseptic precautions 5-cm in diameter area should be cleansed thoroughly with alcohol, allow to dry, followed by povidone iodine, allow to dry and followed again by alcohol. Povidone-iodine should be applied in concentric circles moving outward from the centre.The skin should be allowed to dry for at least 1 minute before the sample is collected. One-mL sample of blood for a blood culture bottle containing 5-10 ml of culture media.Bactec culture reports should be available in 48 hours.

Sepsis screen

More valuable in a low probability situation to exclude sepsis than to start antibiotics in a suspect sepsis. A sepsis screen is not warranted in neonates with a high probability for sepsis. Instead these neonates should be directly started on antibiotics pending blood culture. If two (or more) parameters are abnormal, it should be considered as a positive screen and the neonate should be started on antibiotics. If the screen is negative but clinical suspicion persists, it should be repeated after 12-24 hours. Two consecutive completely negative screens are suggestive of no sepsis

1. **Total leukocyte count**<5000/mm^3
2. **Absolute neutrophil count**abnormal counts as per **Monroe chart** for term **a**nd **Mouzinho's chart** for VLBW infants.
3. **Immature/total neutrophil** > 0.2. Immature neutrophils (band forms, metamyelocytes, myelocytes) / Mature + immature neutrophils
4. **Micro-ESR** more than 3+ age in days in the first week of life or more than 10 thereafter.
5. **C reactive protein (CRP)** >1 mg/dl Or Positive

Fig : Monroe s chart of Absolute neutrophil count

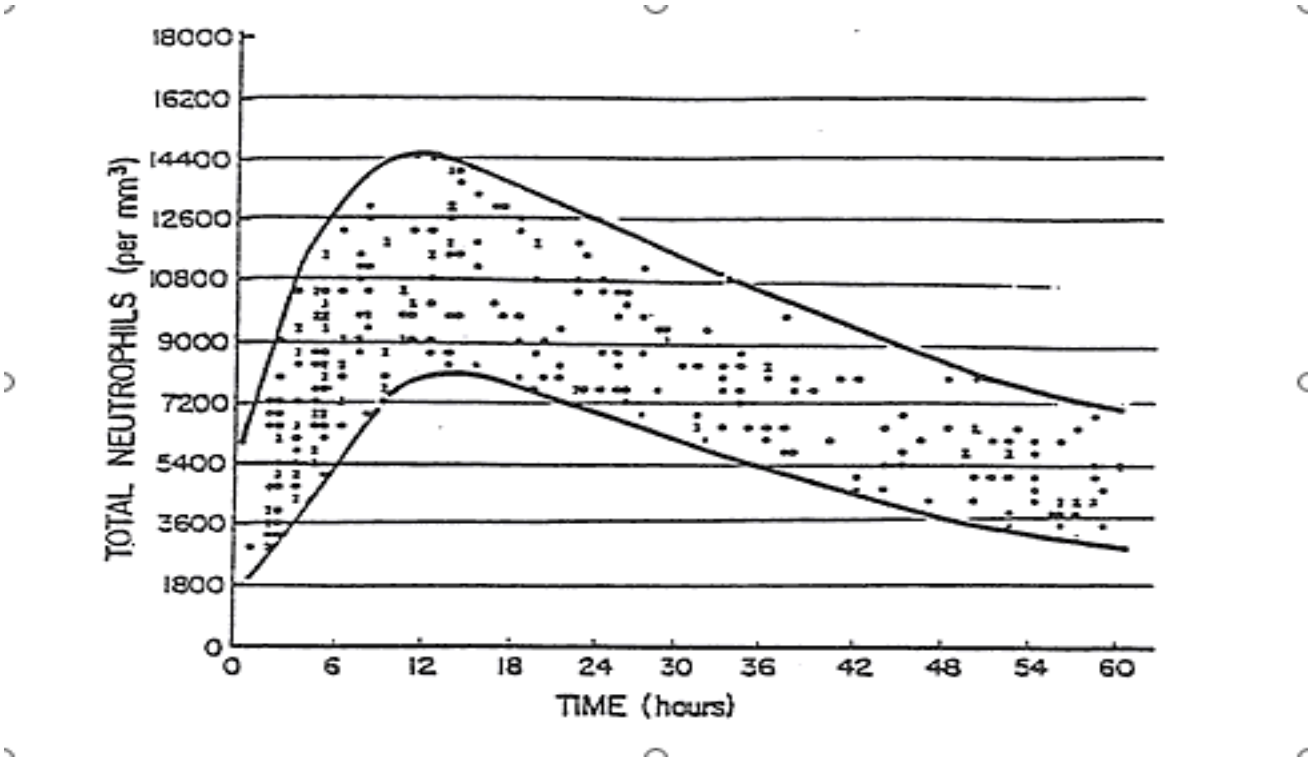
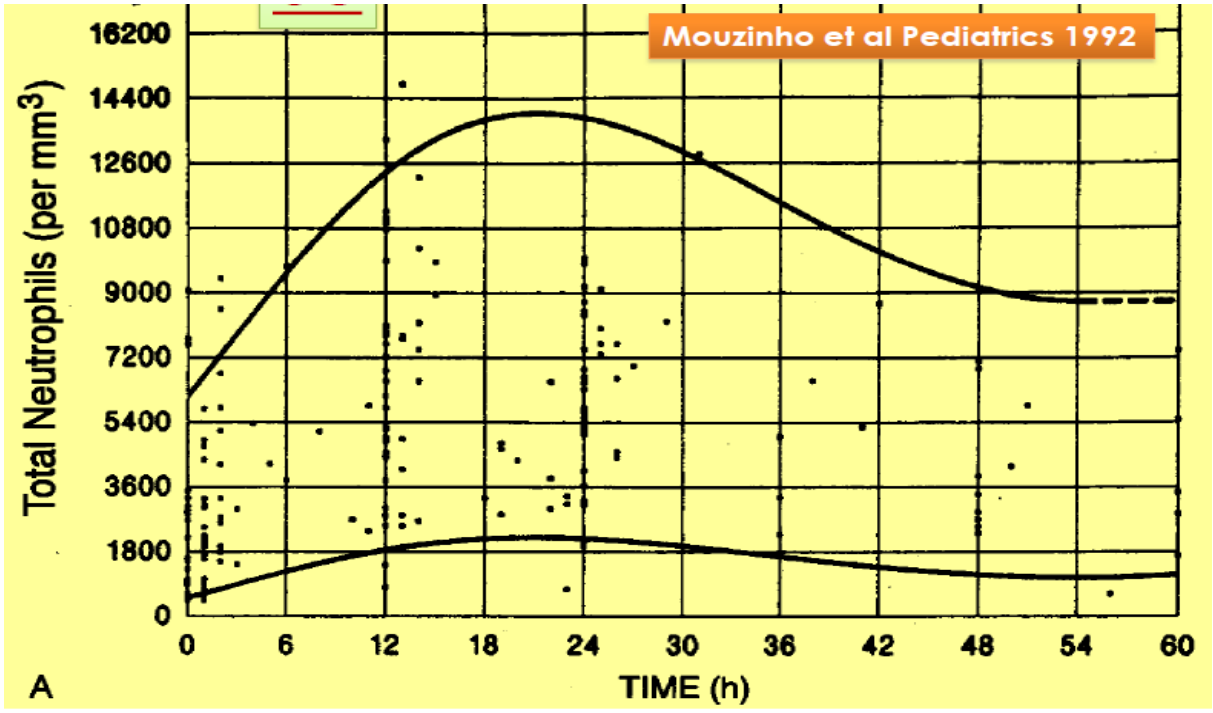
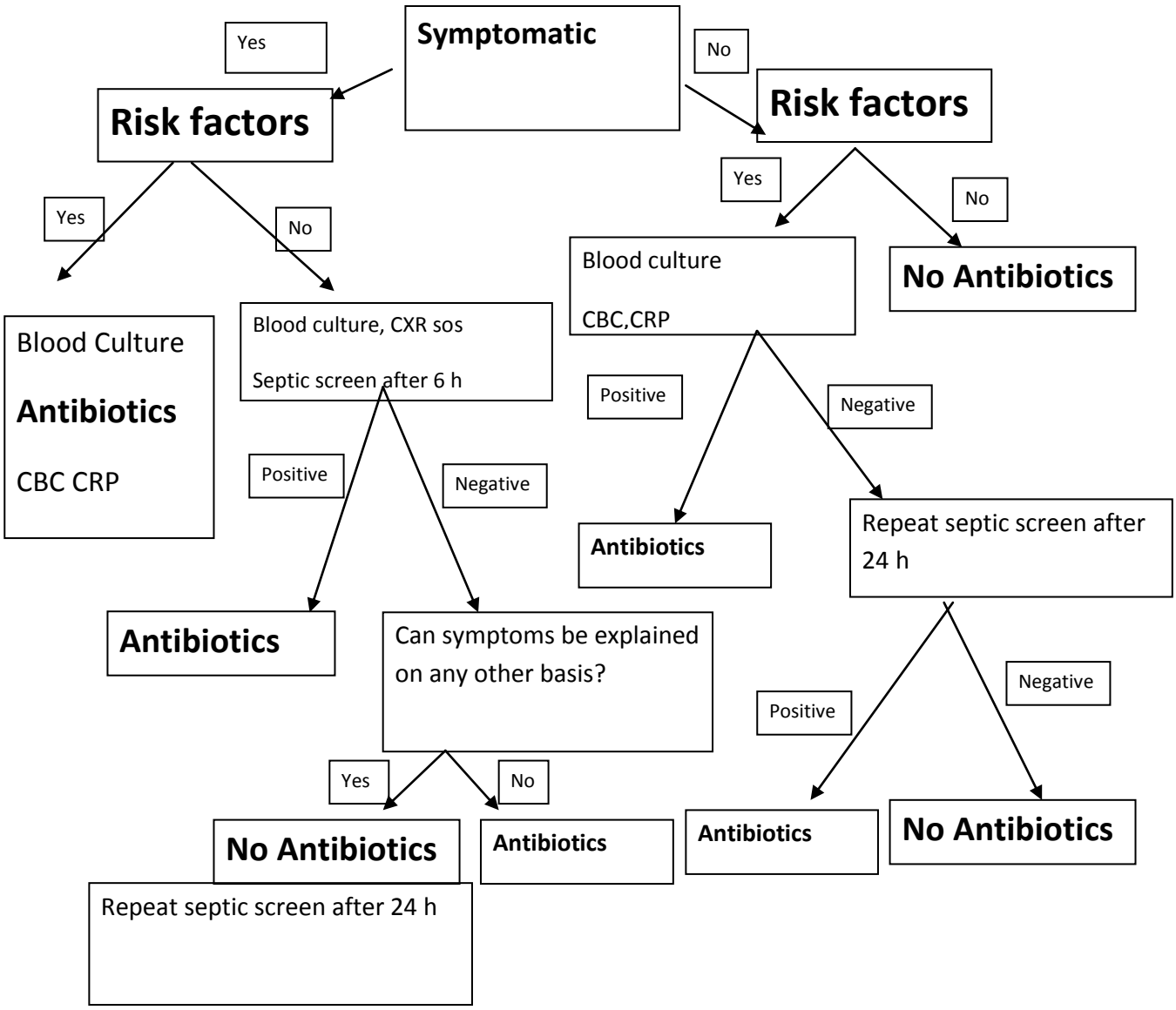


Fig: Mouzinho s chart for ANC in preterms.



Approach to EOS



Lumbar Puncture

- In EOS, lumbar puncture is indicated in the presence of a positive blood culture or if the clinical picture is consistent with septicemia. In situations of late onset sepsis, LP should be done in all infants **prior t**o starting antibiotics (high probability of sepsis). Lumbar puncture could be postponed in a critically sick neonate under cover of antimeningitic dose of antibiotics.
- In a neonate with meningitis not showing clinical recovery after institution of antibiotics, LP should be repeated after 48 hours.
- If the LP is traumatic, the CSF should be sent for gram stain and culture & CSF glucose. Repeat after 24 hours. Pending culture reports, the neonate may be started on meningitis dose of antibiotics. If culture is negative and repeat CSF is normal, neonate should not be labeled or treated for meningitis.

- WBC cell count must be performed within **30 minutes.**

- Preterm infants: Treat if CSF WBC count ≥10 OR glucose <24 OR protein >170. Do not treat if CSF WBC count <25 AND glucose ≥25 AND protein <170". For in-between results, clinical judgment will have to be used, keeping in mind clinical features (seizures, degree of altered sensorium, fullness of fontanels) and prematurity (the lower the gestation, lower should be the threshold for diagnosis).

- Term infants: Treat if CSF WBC count >8 OR glucose <20 OR protein >120. Do not treat if CSF WBC count <20 AND glucose ≥20 AND protein <120".
- **Urine culture**
- In early onset sepsis, urine cultures have a low yield and are not indicated. Urine cultures obtained by supra pubic puncture or bladder catheterization recommended in all cases of LOS.
- Neonates at risk for fungal sepsis and very low birth weight infants with poor weight gain should have a urine examination done to exclude urinary tract infection (UTI).
- UTI may be diagnosed in the presence of one of the following: (a) >10 WBC/mm^3 in a 10 mL centrifuged sample (b) $>10^3$ organisms /mL in urine obtained by catheterization and (c) any organism in urine obtained by suprapubic aspiration.

Antibiotic therapy

Both for out born & inborn

1st line:Ampcilline and Gentamycin –

2nd line: Cefotaxime/ceftazidime/ with ampcilline OR

: ciprofloxacilin

3rd line: Meropenem- single drug

Scenarios after starting 1st line (After a minimum of 24 hours of firstline Antibiotics)

1. Worsening clinical condition: add Cefotaxime/ceftazidime (± lab or Xray worsening).
2. Static / no significant improvement in a sick baby: Worsening septic screen-add Cefotaxime/ceftazidime
3. Clinical improvement: continue 1st line till culture reports are available.

Scenarios after starting 2nd line (After a minimum duration of 48 to 72 hours)

1. Worsening clinical condition: Change to 3rd line (± lab or Xray worsening).
2. Static / no significant improvement in a sick baby: Worsening septic screen-replace ceftazidime/meropeneum
3. Clinical improvement: continue 2nd line till culture reports are available.

After culture report

- If the organism is sensitive to an antibiotic with a narrower spectrum, therapy must be changed to such an antibiotic, even if the neonate was improving with the empirical antibiotics and/or the empirical antibiotics are reported sensitive.
- If the empirical antibiotics are reported sensitive, but the neonate has worsened on these antibiotics, it may be a case of *in vitro* resistance. Antibiotics may be changed to an alternate sensitive antibiotic with the narrowest spectrum and lowest cost.
- If no antibiotic has been reported sensitive, but one or more has been reported 'moderately sensitive', therapy must be changed to such antibiotics at the highest permissible dose.
- After treatment of UTI, all cases must be started on cephalexin (15 mg/kg HS) oral prophylaxis, till such time that a renal ultrasound, MCU and DMSA scan are performed to exclude VUR or malformation.

For suspect bone and joint infections, cover for Gram + (cloxacillin / vancomycin and gram negative organsism (aminoglycosides)

Table: Duration of Antibiotics

	Duration of Antibiotics
Culture negative	
Asymptomatic at risk	Stop antibiotics
Suspect screen Negative asymptomatic	Stop antibiotics
Probable EOS or LOS screen +, and the neonate becomes completely asymptomatic by day 5	Antibiotics X 5 days
Suspected/probable EOS or LOS and the neonate improves but does not become asymptomatic by day 5	repeat a CRP If CRP + ve: continue antibiotics If CRP –ve: stop antibiotics
Suspected/probable EOS or LOS and the neonate have not improved or have worsened	Upgrade
Culture-proven	
CONS sepsis	5-7 days
Sepsis	7 - 14 days
Meningitis	21-day
Pneumonia	7 -10 days
UTI	7-14 days
Bone or joint infections	6 weeks(4 weeks IV, 2 weeks oral)
Ventriculitis	6 weeks

Adjunctive therapies

- **Intravenous immunoglobulins (IVIG)**: no evidence. May be considered in sick infants < 34 weeks. 1 g/kg
- **Colony stimulating factors)**: no evidence. May be considered in sick newborns with neutropenia <1000 / mm^3 and not improving with antibiotics. 10 mcg/kg SC BD X 3 days

Double volume Exchange Transfusion : may be performed in a case of deteriorating sepsis with sclerema, DIC provided the general condition of the baby allows the procedure. Use fresh whole blood compatible with baby and mother.

Indications for shifting to isolation

- Blood/urine/CSF culture positive other than CONS
- Open skin lesions / Sclerema
- Colonization with MDR organism
- Clinical certainty of sepsis.
- Clinical + lab deterioration with suspicion of MDR organism

After sterilization of cultures, infants from isolation could be shifted out after surface cleaning with chlorhexidine2 %, and surface and stool culture sterile.

INFECTION CONTROL BUNDLES

CLABSI BUNDLE

- **Hand hygiene**
- **Central line register**
- **Central line protocol**
- **Central line kits**
- **Health personnel education& feedback – Measure by Questionnaire**
- **Central line insertion bundle – Measure by checklist**
- **Central line maintenance bundle – Measure by audit tool**

The WHO 5 moments of hand hygiene are:

1. Before patient contact
2. Before aseptic task
3. Any body fluid exposure
4. After patient contact
5. After patient contact surroundings.

When to hand wash? (Soap and water (+chlorhexidine / betadine)

- Before entering patient care area
- After touching patients if there is chance of coming in contact with body fluids
- After handling objects which come in direct contact with body fluids
- Before invasive procedures.
- When hands are dirty
- When hands are visibly contaminated with proteinaceous material, blood or body fluids.
- After using restroom
- After waste handling
- Before giving food or medicine to patients.

When to use hand rub? (60 -70% alcohol with or without chlorhexidine)

- Before and after touching patients
- Before handling an invasive device for patient care despite glove use.
- If moving from a contaminated site to another body site.
- After contact with inanimate surfaces and objects in the immediate vicinity of patients.
- After removing gloves.

Ensure:

- Sleeves are rolled 2 inches above elbow, all jewellery, watch are removed.
- Take at least 3 ml of hand rub. Do not touch the hand rub dispenser with hands/ fingers. Use your elbow instead.
- All 6 core steps are done : back of hands, palm to palm, knuckles, thumb, finger tips
- Duration
    - Before entering NICU – 2 minutes
    - Hand wash – 1 min
    - Hand rub – 30 seconds
- Dry hands

What is a central line?

Any venous and are arterial access into a central large blood vessel is a central line. They can be of different types:

- Percutaneously inserted central lines
- Umbilical venous catheters
- Umbilical arterial catheters
- Femoral venous access

Who should put it?

- Fellow or Residents with an experience of having assisted / put under supervision 5 central lines (umbilical / PICC) is privileged to put a central line.
- Central lines are put with the help of the staff nurse of the baby.
- A senior nurse/ another doctor should supervise the procedure.

Who should certify the procedure?

- After having assisted 5 central lines successfully and having cross signed by the consultant, the fellow/ Resident/ is privileged to put the central lines independently.

When should you put?

- All cases of hypoglycemia requiring central access should be put without delay.
- Any baby where central line is elective:
    - Preterm baby for prolonged access.
    - Therapeutic hypothermia. Etc should be postponed to morning working hours.
- All lines should be assisted and supervised exactly with the same set of people as required, despite the time of the day.

How is it put?

- The primary person inserting should be identified at the beginning of the procedure.
- The nurse assisting should also scrub up for the procedure
- Another senior nurse/ doctor should supervise the procedure and use the check list in real time.
- Any member of the team has the RIGHT to suspend the procedure.
- The needed kit is opened and the procedure prescription is cross checked before the beginning of the procedure.
- A rescue site is identified before the beginning of the procedure and used in case of need(PICC line).

Precautions/ pre-requisites for the procedure

- A central line prescription (to make sure all needed things are made ready before the beginning of the procedure.)
- A central line kit.
- Consent
- Checklist

Central Line Insertion Bundle

1. Hand hygiene – Hand wash
2. Maximum sterile barriers – sterile gown, sterile gloves, cap, mask, large sterile drape (the drape should be large enough to cover the sides of the baby trolley)
3. Chlorhexidine skin antisepsis - 2 % chlorhexidine gluconate in 70% isopropyl alcohol and is used to dry for 30 seconds. If spirit and povidone –iodine is used – a new bottle should be opened.
4. Optimal catheter selection –minimum number of ports or lumens in the catheter and in the extension tubes.
5. Sterile dressing - Tegaderm (transparent semi permeable dressing)with sterile gauze if there is oozing or tegaderm. Ensure no blood at site of insertion.
6. Securing the central line: Loop the external catheter under the transparent dressing. Cover the exposed catheter so that no part of the catheter chateter is free to be accidentally caught and pulled. Loop the IV tubing so that no stress pull.
7. Check position of catheter tip by USG before fixing.
8. Details of insertion to be documented.
9. Take a Xray to confirm position.

Central line Maintenance Bundle

1. A daily review of need for the line to be done during morning rounds with documentation in daily notes and in central line card.
2. **Catheter injection ports** –
   - Open lumens are covered with needless connectors
   - Caps are changed every 72hourly
3. Inspect catheter insertion site every day for signs of infection and dressing integrity. Do not use creams or ointment at site of insertion.
4. Catheter site dressing change – Gauze dressing can be used immediately after insertion to stop the ooze. But change it within 2 days and replace by transparent tegaderm dressing. The dressing is changed is undertaken when visibly soiled / loose/damp. For surgically inserted central lines, change gauze dressing every 3 days, clear dressings every 7 days. For PICC do not change dressing electively.
   Use chlorhexidine/povidion Iodine for antisepsis during dressing change.
5. **Catheter access / manipulation :**
   - Hand hygiene – hand wash, rub &sterile glove usage at the time of accessing the port.
   - Do not break the circuit unless inevitable.
     - Minor adjustments to avoid break of circuit are accepted …Eg: increasing drip rate rather than change of concentration.
     - Alterations with peripheral access is an alternative to increase or decrease GIR while handling hypoglycemia in the setting of central access.
     - Mix all fluids in 10% dextrose when compatible (eg inotropes).
     - Document number of break of circuit on central line card.
   - **SCRUB THE HUB PROTOCOL** – If available access ports are sanitized by scrub the hub with 2% chlorhexidine for 15 secs. Follow scrub by 30 sec of air drying – 15 second scrub , 30 second air dry
   - Any manipulation of central line should be a **two person job** to maintain strict asepsis.

6. **Administration set**:
   - Sets are replaced every 72hrs if only IV fluids (dextrose and proteins) are used.
   - Set is replaced if visible soiled or if changing form peripheral access to central access. If handling > 3 times sets are replaced
   - In ELBW , sets and dorsifix to be replaced Q24H
   - Blood transfusion sets are replaced immediately
   - Fat or fat mixed solutions are replaced every 24 hrs.
   - Needleless ports are changed every time the set is changed. (* For ELBW the sets are changed every 24 hrly.)

7. **Infusate preparation**:
   a. Infusate is prepared by 2 people

b. The primary person wears sterile gloves
c. The second person wears paper gloves.
d. If heparin is used – take a new vial.

8. Removal of central lines

The central line should be removed as soon as possible. Send the tip for culture. Document removal, date time and sign in case file on removal.

In the presence of definite CLABSI, the central line should be ideally removed. However it may be the only life line…first stabilize the baby, get a new access and remove the older central line.

a. PICC – As long as it is functional
b. UAC – Maximum 5 days
c. UVC – Maximum 7 days
d. Femoral – As long as it is functional

In the presence of a blood stream infection, labeled as CLABSI, it is prudent to remove the central line. However the vital need for the central line, the possibility of putting another one if needed has to be assessed. If the same bug is grown twice from blood, the central line has to be removed

VAP BUNDLE

Along with the standard infection control precautions of the hospital – Hand wash (Audit)

Endotracheal Tube Care -

a. During Intubation, asepsis to be maintained, mask and gloves to be worn.
b. Oral Intubation is preferred over nasal
c. Inspection of the ET security 4^{th} hourly to avoid unplanned extubation (Document in ventilator chart)

Humidification

1. Heated humidifier is a must
2. Inspired gas At 37^0C and 100% Relative Humidity
3. Use distilled water in the humidifier.
4. The auto-fill technique is preferred for the humidifier to fill water.
5. No condensation in inspiratory limb
6. Drain condensate in water trap Q 4 hours (document in ventilator chart)
7. Consider condensate as an infectious waste and discard accordingly.

8. Change circuit only when visibly soiled or malfunctioning.

Respiratory Equipment Care

d. Ventilator circuits and oxygen therapy equipment should be readily available
e. CPAP Systems allowed to remain on stand-by for no longer than 12 hrs
f. Resuscitation bags not to be laid on bed, to be placed in a sterile cover.
g. Resuscitation bags should be replaced once a week.
h. The circuit to be positioned parallel to the baby and in dependent position to avoid condensate ET and ventilator tubes being placed horizontally to avoid trickling of condensate into patient end. (Audit)
i. Change circuit only when visibly soiled or malfunctioning – (Document in HICC sheet)

Suctioning

- Wearing gloves during suctioning (Audit)
- Paper gloves for inline suctioning and sterile gloves for suctioning
- No routine use of normal saline (Audit) .If NS is needed for suction, to indicate in order sheet
  - Protected suction
  - Sterile procedure – Hand wash, gloves, and sterility maintained during procedure.
- Prevent gastric distension (if NPO) (Audit). Feeding is not a contra indication.
- Head end elevation - 30° (Audit). Lateral decubitus preferred

Oral hygiene

j. Oral suction to prevent pooling of secretions
k. Always suction mouth before the nose
l. Moisten the lips with saline / expressed breast milk.
m. Colostrum should be applied as oral care.

- Assess extubation readiness daily and minimize days of invasive ventilation (Audit of compliance to extubation criteria for every invasively ventilated infant using extubation tool) to be assessed for all ventilated infants post extubation.
- Measurement of processes is mentioned in brackets
- Use of ET card and document in all ventilated infants

Intubation Checklist

Equipment and medications

- Large sterile towel
- Endotracheal tube (ET tube) – appropriate size, at least two
- 3 pairs of gloves of appropriate size (No. 61/2 and 7)
- Laryngoscope (neonatal) – 0 for preterm , 1 for term
- Suction apparatus with suction catheter size 8 or 10
- Oxygen tubing
- Resuscitation bag with mask, reservoir
- Cut Adhesive tape – tegaderm , dynaplast
- Sterile blade
- Stillette
- Timer
- Inj Fentanyl 1 microgram/kg

Role of the Assisstant

- Provide free flow oxygen while intubation is being undertaken
- Provide suction
- Ensure correct position, with neck slightly extended.
- Mild cricoid pressure may be required to visualize the glottis
- Give ET
- Check HR
- Auscultate for correct position of tube
- Help in fixing the tube
- Remind about time : Limit attempt to 20 seconds.
- Maintain strict asepsis

Points of Emphasis

- Maintain strict asepsis
- Be gentle

One should always observe tube going into trachea during the procedure

NICU INFECTION CONTROL (ENVIRONMENT) PRACTICES

ENVIRONMENTAL CLEANING

Floor cleaning

- Done by the cleaners, 3 times in a 24 hour period

Patient care area (high, low dependency and isolation)

- Only wet mopping
- Separate mop used for each area, solution to be changed for each area
- Bucket same , cleaned after use
- Isolation will be done last

Non patient care area (nursing station outwards till entrance area)

- Broom sweeping followed by wet mopping
- Single mop, same solution
- Entrance area to be done last

Cleaning Spills of Blood and Other Body Fluids

Clean spills of blood, body fluids and other potentially infectious fluids immediately:

- For small spills, while wearing utility or examination gloves, remove visible materials using a cloth soaked in 0.5% chlorine solution.
- For large spills, flood the area with a 0.5% chlorine solution, mop up the solution and then clean as usual with detergent and water.

Solution: 50 ml phenyl in 5 litres of water (bleach)…see the protocol

Utility room and toilet area

- Toilet cleaned 3 times a day after floor cleaning done by cleaner
- Utility room cleaned once a day and fumigated once a week by helper

Sinks including taps

- Cleaned by cleaners
- Once per shift using vim and brush
- Brush cleaned after use and kept in the utility room

Glass panes

- Cleaned by cleaners once a day using glass cleaner and piece of clothe
- piece of cloth thrown after use

Doors

- cleaned once a day

- Door handles should be cleaned once per shift using bleach solution

Bedside cabinet

- to be cleaned once a day by cleaners/ nurses
- Using 0.5% bleach solution
- Separate duster per room

Patient care area

- Bed making once in 24 hrs
- Cleaning done by nurses using 0.5% bleach solution
- Separate duster for each baby care area
- Wet and dry mops
- Starting from bed area outwards
- Solution changed after each baby
- All equipment used cleaned as part of patient care area
- All trolleys cleaned as part of patient care area
- Equipment trolley cleaned once per shift

Others

- Plastic files washed with soap and water after each baby is discharged
- Files should be cleaned every day by nurses
- Stethoscope, tapes cleaned with alcholo everyday
- Chairs cleaned once a day with 0.5% bleach solution
- Plastic chairs washed once a week
- Fridge cleaned once a week
- AC airvent cleaned once a week by maintenance personnel

Medications and IV fluids

- Ampoules discarded after single use
- Vials inexpensive discarded after single use
- Vials with expensive medication discarded after 24 hrs
- Surfactant discarded after single use
- Antibiotics in bottles discarded after 24 hrs
- IV fluids will be discarded after 24 hrs
- Parenteral nutrition solutions will be discarded after 24 hr

Changing of tubing

- Oxygen tubing Q 24 hrs

- Oxygen humidifier container Q 24 hrs
- Suction bottle cleaned Q 24 hrs
- Suction tubing changed Q 24 hrs
- ET suction single use
- Oral suction single use
- IV sets/ Dorsifix- 24 hours in VLBW babies. In others use may be prolonged till 72 hours if the closed system in not broken.
- Syringes for use in infusion pump Q 24 hrs
- Blood set single use
- IV cannulas single use
- Needles and syringes single use

Feeding articles

- Feeding tube Q 72 hrs
- Feeding syringes gas sterilized after use
- Cup , steel utensils washed , autoclaved after use

HAND HYGIENE

Hand wash

- before entering NICU for 2 minutes up to elbow using soap and water or chlorhexidine solution
- Dry using air

BEFORE **AND AFTER** HANDLING NEONATE

- 30 second hand wash using soap/ chlorhexidine
- DRY using air
- 20 second alcohol rub

BEFORE AND AFTER TOUCHING INANIMATE OBJECT

- 20 second alcohol rub using 3 ml solution (2 pumps)
- ALWAYS USE ELBOW OPERATED TAPS USING ELBOW
- ALWAYS DRY HANDS THOROUGHLY
- DO NOT KEEP TOUCHING YOUR FACE HAIR etc. WHILE TAKING CARE OF PATIENTS
- CHECK EACH OTHER FOR COMPLIANCE !!!
- BEFORE INVASIVE PROCEDURE 2 MINUTE HAND WASH

Personal Protection

USE OF GLOVES, MASK, GOWNS, CAPS

GOWNS

- Though there is no recommendation that gowns decrease infection, it certainly decreases the number of visitors!!
- Any HCP or parent entering the NICU should wear a gown after hand wash
- Single use autoclaved gowns for all HCP
- Parents gowns changed per day
- Gowns are washed and autoclaved
- For procedures wear full sleeved gowns

MASKS

- Should be worn in the following situations
- Prior to performing or assisting in any invasive procedure
- If HCP has an URTI
- Prior to entering isolation room
- Special circumstances (outbreak)

GLOVES

- Surgical gloves for all invasive procedures
- Plastic gloves for less invasive procedures – GRBS, handling ELBW < 750 gm or Gest age< 28 wks (first week of life)
- Clean gloves as personal protection (handling waste, contaminated material)

Remember Gowns, Masks, Gloves can be a source of infection

Respiratory management

- Gas sterilized ventilator tubing
- 2 persons to connect ventilator or CPAP tubing wearing sterile gloves to ensure asepsis
- To ensure the water trap is always in the dependent position
- Frequent emptying of water trap and removal of any rain out water from the circuit.
- CPAP prongs to be kept in a sterile tray for < 24 hours if baby is tried off CPAP
- Ventilator tubing to be changed every week
- Asepsis during endotracheal tube suction, endotracheal intubation and surfactant administration
- Sterile nebulization chamber to be changed daily and kept in a sterile tray after use.

Aseptic precautions during invasive procedures

- 2 persons are required for all invasive procedures
- Cap and mask for both the health personnel
- 2 minute hand wash
- Sterile gown / disposable sterile procedure gown
- Sterile gloves.
- The assistant to open the procedure set in a sterile manner. The assistant to ensure that asepsis is maintained throughout the procedure.
- The sterile cloth to cover the procedure trolley completely
- Clear concept of sterile and non sterile equipment. The covers of the ET or the syringe etc should NOT be placed on the sterile towel

NEONATAL SEIZURE

- Record the type and duration of convulsions
  - **Subtle**: horizontal deviation of eyes, staring, fluttering, chewing, tongue, thrusting, lip smacking, cycling, peddling, rowing, apnea.
  - **Clonic**: focal or multifocal.
  - **Tonic** : focal or generalized Myoclonic : focal, multifocal or generalized
- Nurse the baby in thermo- neutral environment and ensure airway, breathing and circulation.
- Confirm hemodynamic stability of the infant.
- If stable, secure an IV line
- If unstable, take appropriate resuscitative measures.
- Perform RBS with glucometer.
- If less than 40 mg/dl, administer 10% dextrose, 2 ml/kg followed by glucose infusion drip at a rate of 6-8 mg/kg/min. For further
- Management of hypoglycemia (see hypoglycemia protocol)
- If RBS > 40 mg/dl and if convulsions continue then give anticonvulsants Once convulsions stops, collect blood for serum electrolytes , RBS, calcium, phosphorus and alkaline phosphatase, magnesium.

Etiology:

- Asphyxia
- Intracranial bleeds
- Metabolic – hypoglycemia, hypocalcaemia, hypomagnesaemia, electrolyte disturbances, IEM
- Infection – Meningitis
- Cranial malformations
- Miscellaneous – Benign sleep myoclonus, Fifth day seizures

Investigations

- RBS , calcium, magnesium, serum electrolytes
- Septic profile
- Cranial USG, MRI / CT Scan if indicated
- aEEG/EEG

- Other investigation indicated as per the history, eg. Inborn errors of metabolism, drug levels.

Treatment

- Treat the seizures as per the protocol given below.
- Treat the underlying cause of the convulsion eg. Pyogenic meningitis, hypocalcemia, hypomagnesemia.
- Connect all infants with seizures to a-EEG

ALGORITHM FOR MANAGEMENT OF NEONATAL SEIZURE

Seizure

↓

Airway ,breathing ,circulation,RBS,sendcalcium,NPO,IV fluids

↓

If RBS normal,give Inj. phenobarbitone 20mg/kg loading over 15-20min

↓

If seizure persists give additional loading phenobarbitone at 10mg/kg over 10-15min

↓

Inj phenobarbitone 10mg/kg over 15 min (Do not give 2nd half loading in asphyxia)

↓

Inj. Phenytoin 20mg/kg over 15-20 min

↓

Inj. Phenytoin 10mg/kg over 15-20min

↓

Inj. Lorazepam/diazepam 0.1mg/kg one dose

- Inj. Midazolam 0.15mg/kg followed by Inj Midazolam infusion at 1-18mcg/kg/min
- Inj. Thiopentone sodium 4mg/kg bolus; followed by 4mg/kg/hr
- Inj Lidocaine

If seizure is not controlled with the above medications consider pyridoxine dependency and challenge with Tab.

- Pyridoxine (30-50mg/kg), folinic acid(3-5mg/kg/day),pyridoxal Phosphate (30mg/kg/day)

In cases of perinatal asphyxia and preterm babies send serum calcium and give single dose of calcium 2-3meq/kg. Then if seizure continue load with phenobarbitone.

- IF Leveteracitm IV is available it is the current recommendation next to phenobarbitone.
- Leveracitam loading 20-50mg/kg
- Maintainace 20-60mg/kg per day

Refer manual of neonatal care for further reading

Maintenance dose:

- Start after 24 hrs
- Inj phenobarbitone 3-8 mg/kg/day Divided BD
- Inj Levetiracetam 10-30mg/kg/dose BD
- Inj phenytoin 5mg/kg/day divided BD

Algorithm for tapering anticonvulsants

Seizure free for 48 hrs

↓

Taper in following order

First -Thiopentone /Midazolam

↓

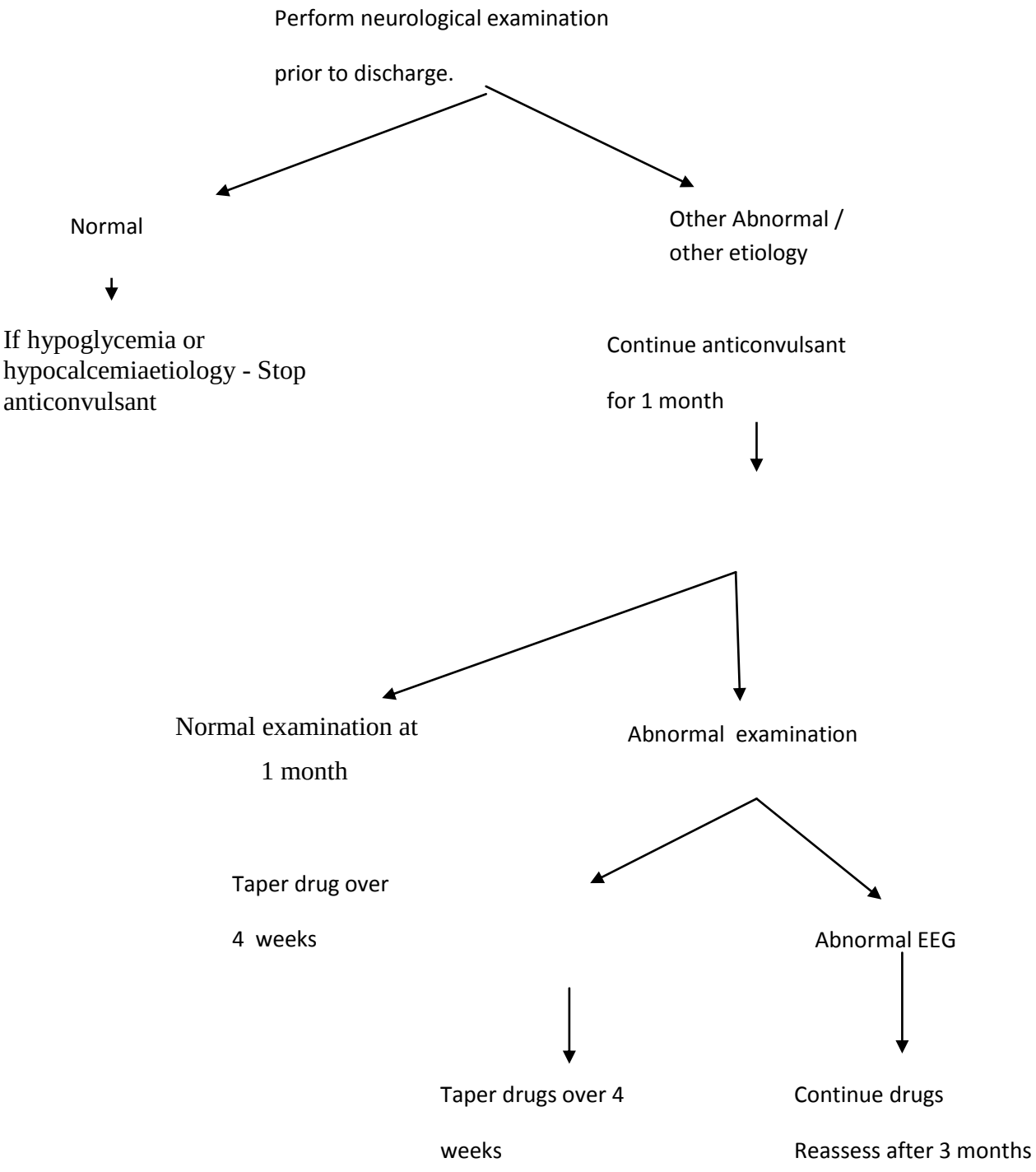
Second -Phenytoin

↙ ↘

If seizures controlled by phenobarbitone alone continue oral phenobarbitone at 3mg/kg/day

If baby required levetiracetam , continue it and next line of drugs ,stop others all anticonvulsants except levetiracetam

Algorithm for tapering Anti-seizure drugs



NEONATAL JAUNDICE

- Approximately, 60% term newborns and higher percentage of preterms develop clinical jaundice.
- Newborns appear jaundiced when serum bilirubin level is greater than 5-7 mg/dl.

Evaluation of jaundice

Physiologic jaundice

- Term neonate:
  - Onset of jaundice on day 2-3 of life.
  - Reaches a peak of 10-12 mg/dl by 2-3 days.
  - Disappears by 4-5 days.
  - Usually does not exceed 15 – 17mg/dl
- Preterm neonate:
  - Onset of jaundice on day 3-4 of life.
  - Reaches a peak of 15 mg/dl by 6-8 days.
  - Disappears by 7-10 days.

Pathologic jaundice

- Onset of jaundice before 24 hrs of age.
- Total serum bilirubin (TSB) concentration increasing > 0.2 mg/dl/hour Or >5 mg /dl /day.
- TSB > 95th percentile on age specific nomograms.
- Signs of bilirubin encephalopathy / Kernicterus
- Jaundice persisting for more than >2 weeks in term and 3 weeks in preterm
- Direct serum bilirubin concentration >2 mg/dl or > 20% of total bilirubin.

History

- Record the hours of onset of jaundice and birth weight.
- Family history - jaundice, anemia, splenectomy, liver disease.
  - jaundice in previous sibling (blood group incompatibility).
- Maternal history – diabetes, intrauterine infection, utero-placental insufficiency.
- Labor and delivery history - oxytocin administration, delayed cord clamping, perinatal asphyxia.

- Feeding history – initiation, type and frequency of feeding
- History of delayed meconium passage, high colored urine and pale stools.

Risk factors for development of severe hyperbilirubinemia in infants of 35 or more weeks gestation

Major risk factors (Acronym Jaundice)

- Jaundice TSB in high risk zone on hour specific nomogram
- **Jaundice observed in first 24 hours**
- **A**sian (east) race /North Indian race
- **U**nder 37 weeks
- **N**ursing – Exclusive breastfeeding esp if not doing well or excessive weight loss
- **D**eficiency of G6PD
- **I**ncompatibility – Rh or ABO is immunization
- **C**ephalhematoma or significant bruising
- **E**lder sibling received phototherapy

Minor risk factors

- Predischarge TSB in high intermediate risk zone
- Gestational age 37-38 weeks
- Jaundice observed before discharge
- Previous sibling with jaundice
- Macrosomic IDM
- Maternal age > 25 years
- Male gender

Physical examination

- Age in hours, weight, gestational age – SGA/AGA/LGA.
- Visual assessment of jaundice – in natural light without a yellow background has reasonable accuracy at TSB < 12-14 mg/dl. All newborns should be assessed

  every 12 hours in the first 3-5 days.

- Dermal level of jaundice (see figure)

Kramer's rule – cephalocaudal progression of dermal icterus

- Pallor, plethora, petechiae.
- Bruise, cephalhematoma, subgaleal bleed.
- Hepatosplenomegaly.
- Signs of sepsis.
- Adequacy of breastfeeding
- CNS examination: poor Moro's reflex, poor feeding, lethargy, tone abnormality , altered cry (signs of acute bilirubin encephalopathy).

Investigations

1. Mother`s and baby`s blood group & Rh typing.

2. Direct Coomb's test (DCT).

3. Serum bilirubin (Total and direct).

4. Hb, PCV, reticulocyte count, and peripheral smear for RBC morphology.

5. Other investigations to be done as per clinical indication

* *BIND Bilirubin induced neurological dysfunction*

* *ABE – acute bilirubin encephalopathy*

BIND Score

Clinical signs	***BIND score***	***ABE***
Mental status		
Normal	0	None
Sleepy but arousable; decreased feeding	1	Subtle
Lethargy, poor suck and/or irritable/jittery with strong suck	2	Moderate
Semi-coma, apnea, unable to feed, seizures, coma	3	Advanced
Muscle tone		
Normal	0	None
Persistent mild to moderate hypotonia	1	Subtle
Mild to moderate hypertonia alternating with hypotonia, beginning arching of neck and trunk on stimulation	2	Moderate
Persistent retrocollis and opisthotonos—bicycling or twitching of hands and feet	3	Advanced
Cry pattern		
Normal	0	None
High pitched when aroused	1	Subtle
Shrill, difficult to console	2	Moderate
Inconsolable crying or cry weak or absent	3	Advanced
	Total BIND score	

Management of Hyperbilirubinemia

- Send cord blood for group and type for all babies
- Mother O group – send also DCT
- Mother Rh negative – send DCT, Hb, Retic count cord TB, CB

Follow up the blood group in 2 hours.

Prophylactic phototherapy

- DCT +
- Birth weight <1000 g
- Severely bruised preterm infant

- Monitor babies with risk factors twice a day in natural light for jaundice

Empirical phototherapy

- Jaundice < 24 hours
- Icterus beyond thighs 24-72 h
- Palms and soles vellow anytime

- Obtain TB/CB if jaundice is seen< 36 h age
- Obtain TB/CB ifjaundice till the lower abdomen
- Obtain TB/CB if baby is being discharged <72 h
- Obtain TB/CB by 48 hours in presence of major risk factor (other than Asian race)

- Decide on **need of phototherapy** by plotting on AAP phototherapy chart
- Do Retic count if phototherapy is needed

Bilirubin monitoring frequency

- Term non hemolytic – once in 24 hrs
- Preterm once in 12 hrs
- Hemolytic jaundice once in 6 to 8 hrs

Moniter PCV in hemolytic jaundice OD

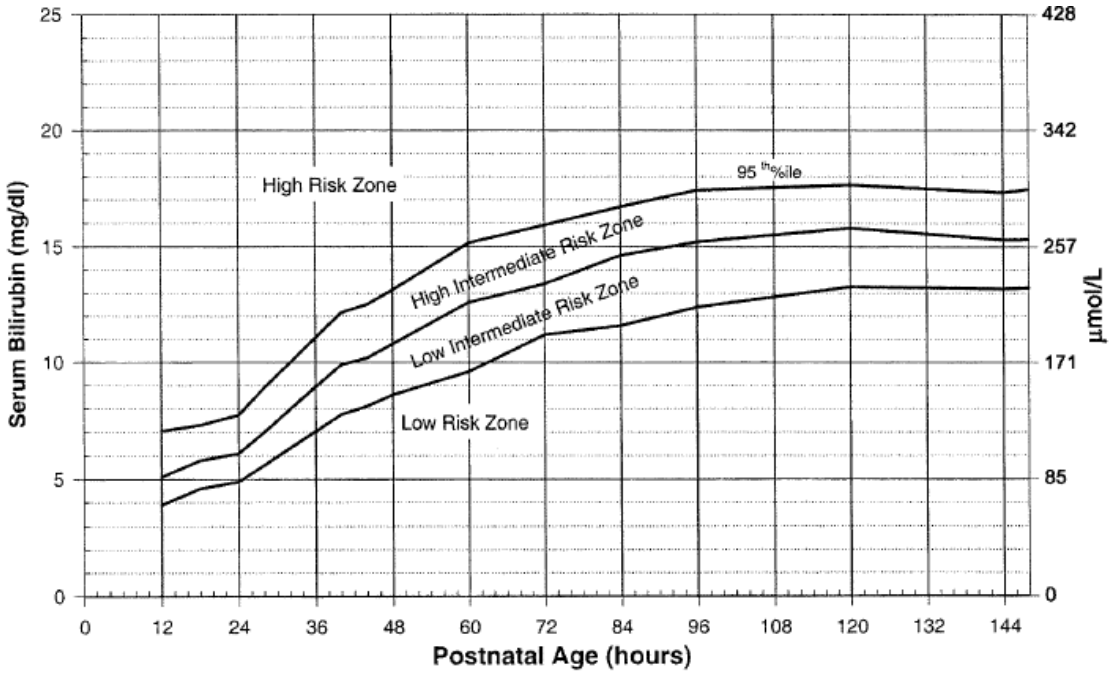
- If below phototherapy range plot on Predischarge hour specific nomogram

- Shift the baby to NICU for Double surface phototherapy if the bilirubin level is approaching 20 mg% / exchange level
- Observe the baby for rebound .hyperbilirubinemia after stopping phototherapy

Follow up

- TSB > 75 %ile – Repeat TSB within 8-24 hours
- TSB > 40%ile – TSB follow-up within 48 hours
- TSB < 40 %ile – Clinical follow up within 48 hours and optional TSB on follow up

Bhutani's Hour specific bilirubin normogram for term and near term healthy neonates

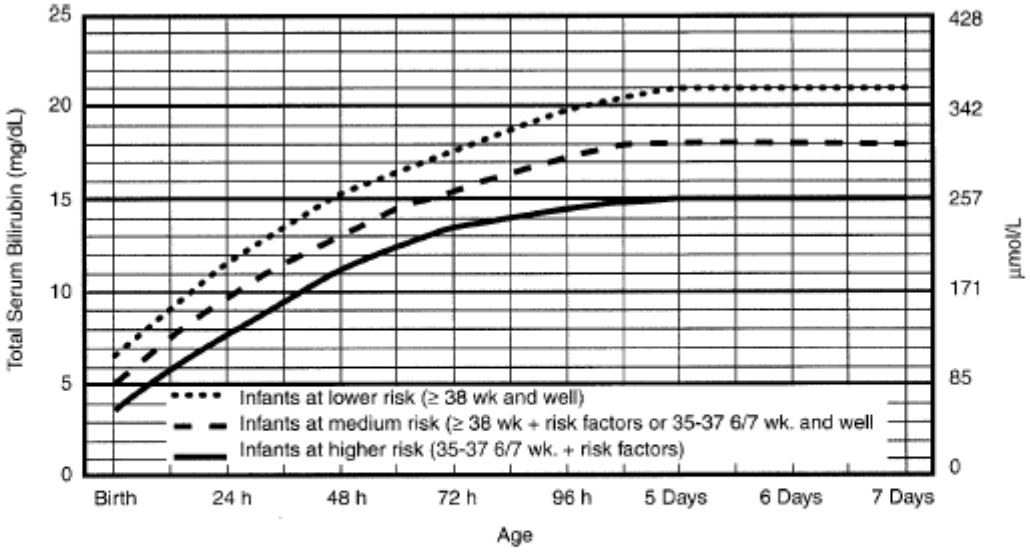


Designated Risk Status	**Evaluation**	*Follow-up*
High	For hemolysis and risk factors	In 6-12 hours; decide on intervention strategy
High-intermediate	For risk factors	May repeat TSB in 24 hours
Low-intermediate	For risk factors	May repeat in 48 hours
Low	Assess well-being	May not need TSB follow-up

* AAP provides two age-specic nomograms- one each for phototherapy and exchange transfusion. The nomograms have lines for three different risk categories of neonates (Fig A & C).
    - **Lower curve** - For lower risk babies (38 wk or more AND no risk factors),
    - **Middle curve** – For medium risk babies (38 wk or more WITH risk factors, or 35 wk to 37 wk AND WITHOUT any risk factors) **Upper curve** – For higher risk (35 wk to 37 wk and WITH risk factors).

Risk factors include presence of isoimmune hemolytic anemia, G6PD deficiency, asphyxia, temperature instability, hypothermia, sepsis, significant lethargy, acidosis and hypoalbuminemia.

A.Guidelines for phototherapy in infants of 35 or more weeks



- Use total bilirubin. Do not subtract direct reacting or conjugated bilirubin.
- Risk factors = isoimmune hemolytic disease, G6PD deficiency, asphyxia, significant lethargy, temperature instability, sepsis, acidosis, or albumin < 3.0g/dL (if measured)
- For well infants 35-37 6/7 wk can adjust TSB levels for intervention around the medium risk line. It is an option to intervene at lower TSB levels for infants closer to 35 wks and at higher TSB levels for those closer to 37 6/7 wk.
- It is an option to provide conventional phototherapy in hospital or at home at TSB levels 2-3 mg/dL (35-50mmol/L) below those shown but home phototherapy should not be used in any infant with risk factors.

B. Guidelines for phototherapy in preterm LBW babies

There are no evidence based cut offs for preterm babies. The following table gives weight based day specific guidelines

Birth Wt (g)	**Day 1**	**2**	**3**	**4**	**5**	**6**	**7**
<1000	**Proph.**	**3**	**3**	**5**	**5**	**7**	**7**
1000-1249	**5**	**5**	**5**	**7**	**8**	**10**	**12**
1250-1499	**8**	**8**	**8**	**10**	**12**	**12**	**12**
1500-1749	**10**	**10**	**10**	**12**	**12**	**13**	**13**
1750-1999	**10**	**10**	**12**	**13**	**13**	**13**	**13**
2000-2499	**10**	**12**	**12**	**15**	**15**	**15**	**15**

Maisels et al (2012) have suggested the following cut offs for preterms:

Phototherapy		**Exchange transfusion**
Gestational age (week)	**Initiate phototherapy total serum bilirubin (mg/ dl)**	**Total serum bilirubin (mg /dl)**
$<28^{0/7}$	5–6	11–14
$28^{0/7}$–$29^{6/7}$	6–8	12–14
$30^{0/7}$–$31^{6/7}$	8–10	13–16
$32^{0/7}$–$33^{6/7}$	10–12	15–18
$34^{0/7}$–$34^{6/7}$	12–14	17–19

Use BILIAP- for preterm jaundice < 35 weeks (NICE guidelines)

Phototherapy: the phototherapy equipment available in our unit are:

- Conventional blue / white fluorescent tubes.
- Light emitting diode

Practical

- Check all lights are on .
- To increase the efficacy :
    1. Shorten the distance to as close as possible and maintain euthermia.
    2. Change position 2 hourly.
    3. Use double unit phototherapy.
    4. Use the phototherapy unit with highest flux.
    5. Cover the phototherapy unit with white sheet to increase reflection
- Monitor temperature every 2 hourly.
- Monitor weight daily
- Record intake and output chart.
- Give frequent breastfeeding. Ensure baby is passing stools daily.
- Shield eyes from light source with appropriate sized eye pads.
- Give continuous phototherapy (except for feeding)
- Monitor side effects (dehydration, hypo/hyperthermia increased stool frequency, hypocalcemia, tanning).

- Measure irradiance with use of flux meter monthly (intensive phototherapy - > 30 $\mu w/cm^2/nm$) & preferably use a chronometer to measure time of use of phototherapy lights.
- If flux meter is not available , change tubes of phototherapy every 3 months or after 1000 hours of use.

- **Watch for danger signs - Vomiting , lethargy, poor feeding , fever , high pitched cry, dark urine, light stools.**
- **Stop phototherapy when bilirubin is <13 mg% in term / or two consecutive values are lower than age specific cut offs and <10 mg% in preterm infants.**

- Assess clinically for rebound after discontinuing phototherapy and do TB , CB if required especially in hemolytic jaundice.

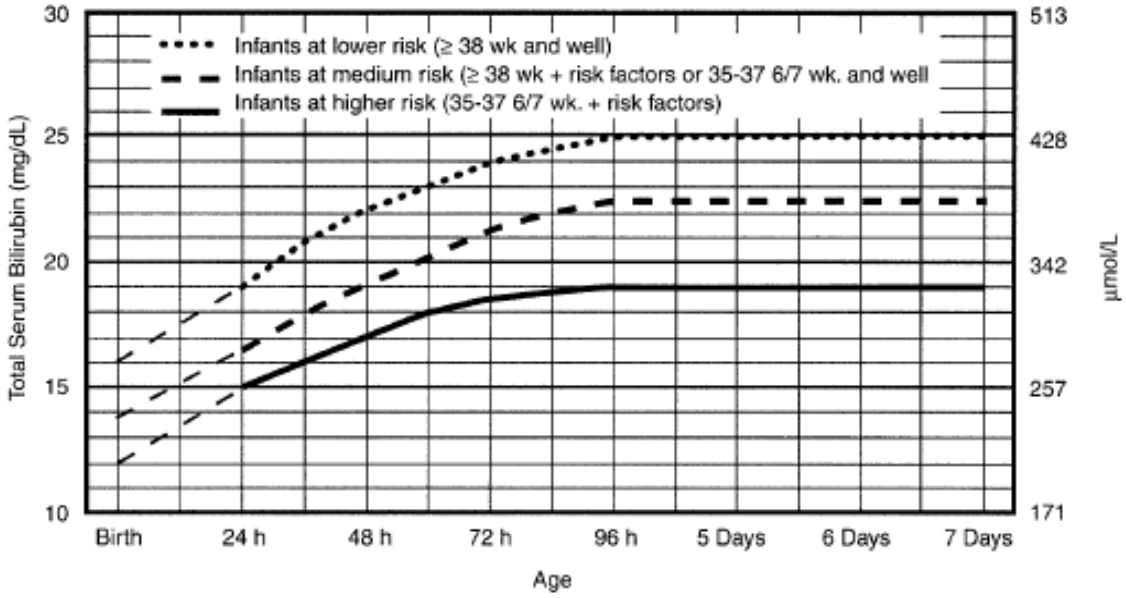
EXCHANGE TRANSFUSION

Definition: Simultaneous (isovolumetric type) or cyclical (discontinuous type) withdrawal of the recipient's blood and transfusion with the donor's blood. When a recipient's blood is replaced with crystalloids or colloids, it is partial exchange

Indications:

- Severe hyperbilirubinemia based on normograms.

Guidelines for Exchange Transfusion in infants of 35 or more weeks



- If the TSB is above exchange level, exchange transfusion is indicated if baby has received intensive phototherapy**.**
- If the value is above exchange cut off and baby has not received phototherapy previously, **start intensive phototherapy. A**rrange everything including blood for exchange, but repeat bilirubin in 4-6 hours and do exchange if there is no significant reduction in bilirubin (at least 2 mg.dl).
- ***Immediate exchange transfusion is indicated if baby shows features of BIND (hypertonia, arching, retrocollis, opisthotonus, fever, high pitched cry) or TSB is > 5 mg/dl than exchange level***
- Use total bilirubin. Do not minus direct fraction unless > 50%.

Measure serum albumin

Risk category	**B/ A ratio at which exchange transfusion should be considered**
38 0/7 and well	8
35-37 6/7 and well or 380/7 and risk	7.2
35 -37 6/7 and risk	6.8

Guidelines for Exchange Transfusion in Preterm LBW babies without risk factors for Kernicterus or hemolysis

Birth Wt (g)	**Day 1**	**2**	**3**	**4**	**5**	**6**	**7**
<1000	**10**	**10**	**10**	**12**	**12**	**12**	**12**
1000-1249	**12**	**12**	**12**	**12**	**15**	**15**	**15**
1250-1499	**15**	**15**	**15**	**15**	**16**	**16**	**16**
1500-1749	**15**	**17**	**17**	**17**	**18**	**18**	**18**
1750-1999	**17**	**17**	**18**	**18**	**19**	**19**	**19**
2000-2499	**18**	**18**	**19**	**19**	**19**	**20**	**20**

As a rough guide, phototherapy should be started at a bilirubin level of 1% of the birth weight (in gm) in healthy low birth weight infants. An exchange transfusion should be considered at a value of 5 mg/dl higher than that for phototherapy (1% of birth weight + 5 mg/dl).

All babies born to Rh-ve or O+ve blood group should have their cord blood group done and collected asap

Other indications:

- Hyperbilirubinemia with BIND.
- Severe sepsis with sclerema or refractory metabolic problems. to be a consultant decision
- An exchange transfusion soon after birth is indicated in haemolytic jaundice if
  - Cord bilirubin is $\geq$ 4.5 mg/dl
  - Cord Hb is $\leq$11 mg/dl, hematocrite<30
  - The bilirubin is rising >1 mg/dl/hour despite phototherapy
  - The hemoglobin level is between 11 and 13 mg/dl and bilirubin level is rising >0.5 mg/dl /hour despite phototherapy
  - The bilrubin level is 20 mg/dl or it appears that it will reach 20 mg/dl

Exchange transfusion achieves:

(1) removal of antibody-coated red blood cells (a source of "potential" bilirubin),

(2) correction of anemia (if present), and

(3) Removal of maternal antibody.

Single volume removes 63% of total patients blood volume. Double volume removes 86% and triple volume 95% of total patients blood volume. Post exchange bilirubin reduces to ½ of original value but again increases to 70-80% of previous level

Choice of blood

- Fresh whole blood (preferably < 72 hrs, upto 5 days acceptable). It may also be reconstituted from packed cell and plasma (hematocrit 45-50% . 2/3 whole blood and 1/3 plasma).
- In Rh isoimmunisation –ABO compatible Rh –ve blood is always used. However in emergency situations O –ve blood can be used without cross matching. For the first exchange blood cross matched against mother's serum should be used. For subsequent exchanges irrespective of baby's ABO blood group, O –ve blood cross matched against baby's serum should be used.
- In ABO incompatibility – O Rh negative blood group or Rh compatible blood group with baby.
- In other situations – fresh ABO and Rh compatible blood should be used.

- Blood should be cross matched with baby. The blood should be warmed to 37°C with a blood warmer.
- If the hematocrit is < 35 %, partial exchange transfusion with 80 ml/kg PRBC (hematocrit 70%) should be first performed and the exchange completed with another 80 ml/kg of whole blood.

Volume

Usually involves double the volume of the infant's blood (160ml/kg) and is known as double volume exchange transfusion (DVET). This replaces 87% of the infant's blood volume with new blood. In preterms, the blood volume should be calculated from the nomogram.

Preparation

- Obtain informed consent,
- Equipments for umbilical catheterization. It is preferable to have vital signs or saturation or apnea monitor attached to baby.
- Use blood warmer
- Ideally irradiation needed ,but not feasible in emergency
- Check potassium if blood is >7days old
- Keep Oro-Gastric tube in situ. Do not feed during the procedure.
- Equipment: Cap , mask,Sterile gown, Surgical gloves, extension tubing Set, Blood & Infusion Warmer , vaccutainers for biochemistry & haematology, Exchange Transfusion Record Chart, Cardiorespiratory monitor, Consent form for parents , antiseptic solution for Line insertion

Method

- Push-pull technique - Umbilical exchange through UVC, the tip should be in the IVC to get a good backflow few cm. Do not perform Exchange Transfusion through a UVC if the tip is in the portal circulation. This may cause NEC by reducing bowel blood flow. Avoid umbilical exchange in SGA and preterm babies who are more prone to develop NEC**. A large central vein like femoral vein may also be used if vascular access difficult esp in an older newborn**

4. Peripheral exchange – Withdraw from artery and infuse through vein.
5. Isovolumetric exchange (simultaneous pulling blood from umbilical artery and pushing blood through the umbilical vein). Continuous infusion of blood into the UVC balanced by controlled removal of blood from the UAC.

Aliquots<3-5% of blood volume, the sicker and smaller baby the smaller is aliquot

- 5 ml for infants under 1500 gm.
- 10 ml for infants 1500 to 2500 gm.
- 15 ml for infants 2500 to 3500 gm.

Each aliquot should take 3-5 minutes.

- Keep moving the bag intermittently to prevent RBC s from settling
- Keep the syringe vertical with nozzle facing down to prevent air embolism. Never leave umbilical catheter end open.
- Use the 3 way/4 way stopcock
- Flush the withdrawal catheter with heparinised saline every 10-15 min to prevent clotting,
- During the procedure, the operator(s) must call out the volume in and out with each infusion and withdrawal (eg ten in ten out). A 2nd person must keep a written timed running record of each infusion and withdrawal and of cumulative volumes to be sure that the volumes infused and withdrawal are equal.
- FiO2 may have to be increased in a ventilated newborn.
- Take 45-60 min for a double volume ET in a vigorous baby and longer in a sick one. The rate is 1-2 ml/kg/min.
- If there is a risk of thrombocytopenia in a sick child esp if the exchange is done with PRBC and FFP reconstituted, consider platelet transfusion at mid point and at end of ET
- Routine calcium injections during exchange transfusion is not indicated. But if unexplained tachycardia or arrhythmia give slow IV calcium.
- Continue phototherapy during the procedure.
- No routine antibiotics after DVET unless umbilicus looks unhealthy /breach of asepsis
- Mention on the bradma sheet and OPD card of baby the blood group with which exchange transfusion is done (to avoid confusion of blood group on future admissions)
- BERA to be fixed

Blood Samples To Be Taken During Transfusion

First : Ensure that blood for TSH, DCT, PCV, Retic Count, PS, and filter paper sample for G6 PD have already been collected.

In a sick ventilated infant, Serum electrolytes and ABG at the beginning and frequently (eg q 100 ml). In the middle of the procedure: Test GRBS, ABG and calcium

At the end: serum bilirubin, electrolytes, calcium, RBS, Hb, PCV should be tested.
After 4-6 horus – send a repeat serum bilirubin.

Monitoring during transfusion: every 10 min during the procedure, check and document HR(vital monitor), respiratory rate, temperature, color, SaO2 probe.

Monitor vitals and abdominal girth ½ hrly for 2 hours. If constant, start feeds. Check blood sugar at end of procedure , 30 min, 1 hour and 2 hours.

Complications related to procedure and blood

- Hypocalcemia and hypomagnesemia.
- Hypoglycemia.
- Acid base imbalance.
- Hyperkalemia.
- Infection.
- Bleeding.
- Thrombocytopenia
- Thrombosis, embolisation.
- Perforation of vessel, vasospasm.
- Volume overload.
- Cardiac arrhythmias and arrest.
- Hemloysis(hemoglobinuria,hyperkelemia)
- GVHD
- Hypo/hyperthermia

NECROTIZING ENTEROCOLITIS

Anticipate NEC in the following conditions

- Prematurity< 32 weeks,
- Hypoxia – perinatal asphyxia, in utero hypoxia (SGA with reverse end diastolic flow), postnatal recurrent apnea and hypoxia, PDA (ductal steal)
- Rapid increase in feeds (>20-35 ml/kg/d), Formula feeds (6 times more common than if only breast milk fed)
- Sepsis
- Polycythemia
- Umbilical catheterization
- Inappropriate weight gain

Investigations

- CBC with platelet count (for sepsis and thrombocytopenia)
- ABG (for metabolic acidosis)
- S. Electrolytes (refractory hyponatremia)
- Septic work-up
- Stool for occult blood
- Xray abdomen- lat. decubitus / cross table lateral view (pneumotosis intestinalis. Portal venous gas, perforation)
- Gas under diaphragm, rigler's sign, cupola sign, football sign, ligamentem teres sign are signs of PERFORATION.
- **Enlarge the Xray and carefully look for signs of perforation**
- USG - for pneumatosis, pneumoperitoneum

Management

- **Medical management**
  - NPO (TPN when NPO >3 days)
  - Continuous oro-gastric aspiration
  - Abdominal Girth 2 hrly
  - ***Consider trans illumination Q12H in NEC > 2a***

- Maintenance fluid, electrolyte and acid base balance
- Replace gastric aspirate by 1/2 NS/RL every 8 hourly if > 10 ml/kg/day
- Broad spectrum antibiotics
- IV metronidazole in definite NEC (≥Stage II)

Surgical management

- Refer to pediatric surgery when stage IIa is documented
- Primary peritoneal drainage (PPD) is indicated in sick newborns with perforation or stage II B or III A and not improving
- Laparatomy

Initiation of feeding

- Initiation of enteral feeds by expressed breastmilk.
- Start EBM in suspected NEC after 3-5 days
- Start EBM in proven and advanced NEC after 10 d- 2 or more weeks

Walsh and Kliegman's modification of Bell's Staging Criteria for Necrotizing Enterocolitis

Stage	Systemic Signs	Intestinal signs	Radiologic Signs	Treatment
I. Suspected				
A	Temperature instability, apnea, bradycardia, lethargy	Elevated pregavage residuals, mild abdominal distension, emesis, occult blood in stool	Normal or intestinal dilatation, mild ileus	NPO, antibiotics x 48hrs Ampicillin and gentamycine
B	Same as IA	Same as IA, plus bright red blood per rectum	Same as IA	Same as IA
II. Definite				
A: Mildly ill	Same as IA	Same as I, plus diminished or absent bowel sounds ± abdominal tenderness	Intestinal dilatation, ileus, pneumatosis intestinalis	NPO for 48hrs, antibiotics x 7 to 10 days. Ampiciline, gentamycine and metronidazol
B: Moderately ill	Same as IIA, plus mild metabolic acidosis, mild thrombocytopenia	Same as IIA, plus absent bowel sounds, definite abdominal tenderness, abdominal cellulitis, right lower quadrant mass	Same as IIA ± portal vein gas ± ascites	NPO, antibiotics x 14 days Ampiciline, gentamycine and metronidazol
III Advanced				
A: Severely ill, bowel intact	Same as IIB, plus hypotension, bradycardia, severe apnea, combined respiratory & metabolic acidosis, DIC, neutropenia, anuria	Same as IIB plus signs of generalized peritonitis, marked tenderness, distension & abdomen wall erythema.	Same as IIB, definite ascites	NPO, antibiotics x 14 days, fluid resuscitation, inotropic support, ventilator therapy, paracentesis
B: Severely ill: bowel perforated	Same as IIIA, sudden perforation	Same as IIIA, sudden increased distension	Same as IIB, plus pneumo-peritoneum	Same as IIIA, plus surgery

Spontaneous intestinal Perforation:

	SpontaneousIntestinal Perforation	NEC
Age of onset	0-14 days	2-6 weeks
Enteral feeds	No	Yes
Pneumatosis intestinalis	No	Yes
Histology of villous necrosis	No	Yes
Mortality	Lower	Higher

Prevention of NEC.

1. Use of human milk
2. Probiotics in infants < 32 weeks, < 1200g
3. Hand hygiene
4. KMC
5. Antenatal Steroid

ANEMIA IN A NEONATE

In preterm infants, anemia of prematurity is common occurrence between 4- 8 weeks. However a nadir could be seen as early as 2 weeks. Hence weekly hematocrite screen till discharge is important for all infants < 1500g

Diagnostic approach

- Family history – anemia, gallstones, splenectomy
- Evaluate Obstetric history
- Physical exam for acute blood loss, shock
- CBC, Retic count(see annexure for normal values)
- Blood smear
- DCT
- Apt test of gastric aspirate
- KB test – 50 ml fetal blood loss = 1% fetal cells
- USG abdomen
- Parental testing – Hb, PS,
- MS – G6PD screen
- TORCH
- RBC indices
- Rarely – Bone marrow

Reticulocytes	Bilirubin	Test	Morphology	Diagnostic Possibilities
Normal or ↓	Normal	Negative	Normal	Physiologic anemia of infancy or prematurity; congenital hypoplastic anemia; other causes of decreased production
Normal or ↑	Normal	Negative	Normal	Acute hemorrhage (fetomaternal, placental, umbilical cord, or internal hemorrhage)
↑	↑	Positive	Hypochromic microcytes	Chronic fetomaternal hemorrhage
			Spherocytes	Immune hemolysis (blood group incompatibility or maternal autoantibody)
Normal or ↑	↑	Negative	Spherocytes	Hereditary spherocytosis
			Elliptocytes	Hereditary elliptocytosis
			Hypochromic microcytes	α- or γ-Thalassemia syndrome
			Spiculated RBCs	Pyruvate-kinase deficiency
			Schistocytes and RBC fragments	Disseminated intravascular coagulation; other microangiopathic processes

Tr

Indications for transfusion:

Suggested Hemoglobin threshold for transfusion:

Post-natal age	Respiratory support	No respiratory support
Week 1	**11.5(35)**	**10(30)**
Week 2	**10(30)**	**8.5(25)**
Week 3 & older	**8.5(25)**	**7.5 (23)**

Infants with significant respiratory disease or congenital heart disease (e.g., large left-to-right shunt) , acute blood loss may need their Hct maintained above **40%.**

Transfusion Guidelines for Premature Infants

1. Asymptomatic infants with **Hct ≤23% (hemoglobin 7.5 g/dL)**

2. Infants with **Hct ≤20% (hemoglobin ≤7 g/dL)** on supplemental oxygen who are not requiring ventilation but have any one of the following
a. ≥24 hours of tachycardia (heart rate >180 bpm) or tachypnea (respiratory rate >80 breaths per minut

b. A doubling oxygen requirement from the previous 48 hours

c. Acute metabolic acidosis (pH <7.20) or lactate ≥2.5 mEq/L

d. Weight gain of <10 g/kg/day for 4 days while receiving ≥120 kcal/kg/day

e. If the infant will undergo major surgery within 72 hours

3. Infants with **Hct ≤25%** (hemoglobin ≤8 g/dL) requiring minimal mechanical ventilation, defined as MAP ≤8 cm H2O by CPAP or conventional ventilation, or MAP <14 on high-frequency ventilation, and/or FiO2 ≤0.40

4. Infants with **Hct ≤30%** (hemoglobin ≤10 g/dL) requiring moderate or significant mechanical ventilation, defined as MAP >8 cm H2O on conventional ventilation, or MAP >14 on high-frequency ventilation,

and/or **FiO2 >0.40**

5. A transfusion should be considered if **acute blood loss of ≥10%** associated with symptoms of decreased oxygen delivery occurs, or if significant hemorrhage of **≥20% totalblood** volume occurs.

Volume of transfusion:

The average newborn blood volume is 80 mL/kg; the Hct of packed RBCs is 60% to 80% and should be checked before transfusion. We generally transfuse 15 to 20 mL/kg; larger volumes may need to be dividedin more than one aliquots.

$$\frac{\text{Weight in kilogram} \times \text{blood volume per kilogram} \times (\text{Hct desired} - \text{Hct observed})}{\text{Hct of blood to be given}} = \text{volume of transfusion}$$

- Irradiated RBCs are recommended in premature infants weighing <1,200 g. Premature infants may be unable to reject foreign lymphocytes in transfused blood
- All neonates must be given leucoreduced blood
- Avoid transfusion from relatives (Directed donor transfusion)
- Reduce multiple donor exposures esp. to ELBW
- In case of large volume transfusions for a severely anemic or hydropic infant partial exchange must be done.
- Transfusions of 10 ml/kg increase hb by 2g/dl. (assuming PC hct to be 60%)

Partial Exchange

In case of severe anemia , the above mentioned formula needs to used. Isovolumetric partial exchange

Complications of transfusion

1. **Acute Hemolytic reaction:**

- Due to incompatibility of donor RBC with patient plasma
- Rare in neonates
- Tachycardia, hypotension, fever, hematuria
- Management : - Stop transfusion
- Notify blood bank and send the bag
- Fluids and frusemide as necessary
- Vasopressors for hypotension

2. Volume overload – Monitor vitals, stop transfusion . Fluid restriction , Frusemide Partial exchange
3. Hypocalcemia
4. Hypothermia
5. Transfusion-associated acute lung injury (TRALI).
6. Hyperkalemia – In exchange transfusion use fresh RBC < 5 days
7. NEC – anemia itself rather than transfusion is a reported cause of NEC

Iron prophylaxis

Must be given to all preterm infants (see feeding protocol)

BLEEDING NEONATE

History and examination

- Family history
- Maternal- collagen vascular diseases, ITP, pre eclampsia, medications – aspirin, anticonvulsants, anticoagulants
- Baby- Mode of delivery- (Birth trauma- subgaleal hemorrhage
- Vitamin K administration

Determine whether the baby is

Investigations

- Apt test
- Blood grouping, cross matching
- CBC with reticulocyte count.
- PT, APTT, Platelet count
- Septic profile
- Liver Function Tests
- Specific clotting factor assay
- USG skull and abdomen for IVH and

APTT should be sent in special tubes for neonates and the normal values compared with neonatal charts

Apt test:

The Apt test is used to rule out swallowed maternal blood.

a. Procedure. Mix one part bloody stool or vomits with five parts water; centrifuge it and separate the clear pink supernatant (hemolysate); add 1 mL of sodium hydroxide 1% (0.25 M) to 4 mL of hemolysate.

b. Result. Hemoglobin A (HbA) changes from pink to yellow brown (maternal blood); hemoglobin F (HbF) stays pink (fetal blood).

PT APTT altered

- Inj Vit K 1 mg stat X 3 d
- FFP 10 ml/kg if bleeding persists for 4-6 hours after Vit K

Platelet Transfusion 10-20 ml/kg if

- Platelet count < 50,000 and bleeding
- Platelet count < 30,000

Supportive Treatment

Treatment of underlying cause

Packed cell transfusion if blood loss is significant (hematocrit less 40%)

Guidelines for platelet transfusion in neonates

Platelet count	Action
< 30,000/ cu mm	Transfuse all
30000-49000/cumm	**Transfuse if**: ▪ BW <1,500 g and ≤7 days old ▪ Clinically unstable ▪ Recent diagnosis of NEC ▪ Concurrent coagulopathy ▪ Previous major hemorrhage (i.e., grade 3 or 4 IVH) ▪ Prior to surgical procedure ▪ Postoperative period (72 hours)
50,000- 100.000/mm3	**Transfuse if:** ▪ Active bleeding ▪ NAIT with intracranial bleed ▪ Before or after neurosurgical procedures

	Preterm recd Vit K	**Term recd Vit K**	**Child 1-2 mo**
PT seconds	14-22	13-20	12-14
APTT seconds	35-55	30-45	25-35

**5- 10 ml/kg increases platelet count by 50,000- 100,000/mm*

	Laboratory studies			
Clinical evaluation	Platelets	PT	PTT	Likely diagnosis
Sick	D	I	I	DIC
	D	N	N	Platelet consumption (infection, NEC, renal vein thrombosis)
	N	I	I	Liver disease
	N	N	N	Compromised vascular integrity (associated with hypoxia, prematurity, acidosis, hyperosmolality)
Healthy	D	N	N	Immune thrombocytopenia, occult infection, thrombosis, bone marrow hypoplasia (rare) or bone marrow infiltrative disease
	N	I	I	VKDB
	N	N	I	Hereditary clotting factor deficiencies
	N	N	N	Bleeding due to local factors (trauma, anatomic abnormalities, qualitative platelet abnormalities (rare), factor XIII deficiency (rare)

POLYCYTHEMIA

Definition: Polycythemia is defined as a peripheral venous blood of HCT > 65 %. Capillary blood sample is higher by 10 - 15 % than venous blood.
Management: Partial exchange transfusion

The procedure should be done under strict aseptic technique after umbilical catheterization (LOOK NEONATL PROCEDURES for detail)

- Partial exchange transfusion in symptomatic patients if venous HCT is > 65%.
- Increase fluid intake(10-20ml/kg/day) and repeat HCT in 4 to 6 hrs in asymptomatic infants with venous HCT between 65% - 70%.
- Partial volume exchange transfusion when the peripheral venous HCT is >70% even in the absence of symptoms.
- Partial volume exchange transfusion is done by withdrawing blood from umbilical vein and replacing it with Normal saline using the formula as shown below.
- The amount of blood to be removed at a time is 5ml to 20 ml depending on the gestational age, birth weight and of the infant. The lower range is used for preterm, VLBW, and critically ill infants. The higher amount of aliquot should be utilized in stable newborns that are term with normal birth weight.
- Determine post transfusion hematocrit after 4-6 hours after the procedure
- Monitor RBS every 2-4 hours for the first 24 hours after procedure.
- Keep baby NPO for 4 hours before and after procedure for prevention of NEC and put him on maintaince fluids.

  - Volume of exchange in ml =
    blood volume of newborn x $\frac{\text{observed HCT- Desired HCT [55\%])}}{\text{Observed HCT}}$

  - Example: What is the amount exchanged in a newborn weighing 3kg infant and hematocrit of 75 % the amount of blood to be exchanged is calculated as follows. Volume of blood for term baby is 85ml/kg and for a preterm to bring HCT to 55 %

    Volume of exchange in ml = $\frac{85\text{ml}X3\text{kg}X75-55}{75}$

    $= \frac{255X\ 22}{75}$

    = 68 ml blood will be exchanged with equal amount of normal

NEONATAL SHOCK

Definition

- Acute state of circulatory dysfunction resulting in insufficient O_2 and nutrient delivery to satisfy tissue requirements.

Types of shock

	PRELOAD	**AFTERLOAD**	**CONTRACTILITY**
Cardiogenic	↑	↑	↓
Hypovolemic	↓	↑	No change
Distributive	↓	↓	↑
Septic early	↓	↓	↑
Septic late	↑	↑	↓

Clinical features

- Tachycardia- one of the earliest manifestations of shock
- **Tachypnea/ apnea**
- **Capillary refill time (CRT) is prolonged (> 3 sec).**
- Cold extremities with tummy-toe difference.
- **Blood pressure- Hypotension - late sign. Wide pulse pressure - in early septic shock.**
- **Oliguria.**
- **ABG changes: Shows** following changes in the same sequence as shock progresses :
- Respiratory alkalosis (as a compensation to overcome hypoxia)
- Metabolic acidosis (due to anaerobic metabolism leading to lactic acidosis).
- Mixed acidosis (late stage due to respiratory suppression).

Organ specific indicators of shock

Organ	Effect of shock
Brain	Irritability, lethargy, seizures
Heart	Tachycardia, thready pulse, cardiomegaly
Lungs	Shock lung
GIT	Mucosal ulceration
Kidney	Acute tubular necrosis
Hematological	DIC
Liver	Jaundice , elevated liver enzymes

Blood pressure

Shock is not synonymous with hypotension as is commonly believed. Hypotension is a late feature of shock.

Measurement of BP in newborn:

II. Invasive BP – in UAC, radial, posterior tibial
III. NIBP – Oscillometric method
    a. Cuff width to arm circumference ratio – 0.4-0.55

What is low BP?

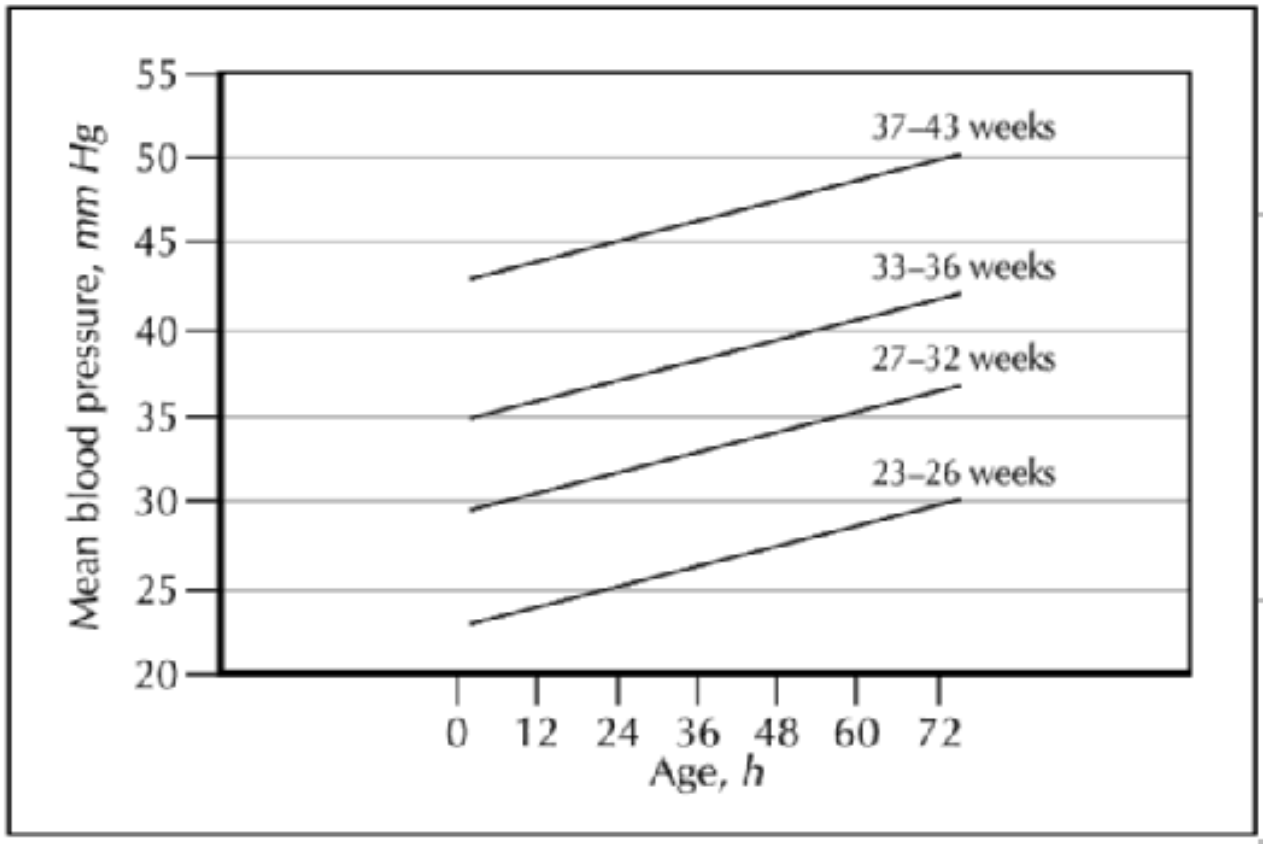
- Refer to Zubrow 's blood pressure chart
- Rule of thumb- Mean blood pressure less than GA in wks or < 10^{th} centile for GA (Watkins criteria)
- MAP<30mmhg , narrow pulse pressure
- The plethysmograph on the pulse oximeter gives an early clue. Waveform indicates indicates perfusion
- PPI – Peripheral perfusion index gives a clue – continuous monitor

Shock is not synonymous with hypotension as is commonly believed. Hypotension is a late feature of shock.

I. MAP<30mmhg , narrow pulse pressure

1. The plethysmograph on the pulse oximeter gives an early clue. Waveform indicates indicates perfusion
2. PPI – Peripheral perfusion index gives a clue – continuous monitor

Mean arterial pressure based on gestational age.



Approach

History

- Antepartum haemorrhage - Note the duration & quantity of bleed- Placenta & vasa Praevia, abruption.
- Trauma, recent aminocentesis, external cephalic version.- Feto maternal bleed.
- Difficult / prolonged labour/ Vacuum/Forceps delivery - Birth injuries,
- Maternal fever, tachycardia, PROM ,foul liquor - Septic Shock.

- H /O bleeding disorder in the family - Factor deficiencies.
- Resuscitation required – perinatal asphyxia.
- Drug administration - Barbiturates, muscle relaxants.
- H/O not taking Vitamin K – Haemorrhagic disease of newborn.

Treatment

- Maintain airway & breathing. Optimise perfusion. Start oxygen, if saturation (<90%); low threshold for invasive ventilation

- Establish iv access(central line preferred if requiring inotropes)
- Preload augmentation- Intravascular volume is increased by using crystalloids Normal saline 10cc / kg given over 20 minutes in term; 1 hr in ELBW. Consider repeat fluid bolus of 10 ml/kg after 20 minutes in septic or hypovolemic shock. (Maximum 60 ml/kg in term)
- **Augmentation of Myocardial contractility**.
    - Dopamine (3-15 µg/kg/min) - first line of inotrope in septic shock. Maximum 20 µg/kg/min
    - Dobutamine start at 3mcg/kg/min. First line of inotrope in cardiac dysfunction, perinatal asphyxia or unexplained shock in ELBW. When baby is on dopamine esp> 10 µg/kg/min, to consider adding dobutamine if blood pressure is normal but perfusion is poor. Dopamine and dobutamine can be increased upto a maximum dose of 20 mcg/kg/min
    - Epinephrine (0.1-1.5 µg/kg/min) – if no adequate response to Dopamine and Dobutamine. Reduce and wean off dobutamine after starting epinephrine
    - Drip formula –
        - Dopa/dobutamine-6 X body weight mg dissolved in 10 ml NS / D5. 0.1 ml/hr. gives 1 mcg/kg/min
        - Adrenaline and milrinone maintenance- 0.6 X body weight mg dissolved in 10 ml NS/ D5. 0.1 ml/hr. gives 0.1 mcg/kg/min
    - Titrate inotropes fast – remember half-life is only 2 minutes!
    - While tapering- taper the one which is least likely to be effective.
    - Avoid combination of 3 or inotropes- difficult to titrate
    - Other inotropes- milrinone, vasopressin, noradrenaline, levosimendan- after discussion with consultant

- ***Other agents***
    - Steroids – indications - Congenital adrenal hyperplasia (Drug of choice)
    - **Dose – Hydrocortisone** 1 mg / kg every 12 hourly for 2-3 days. Hydrocortisone is indicated if requiring >1 inotrope in very preterm and >2 in >32 wk 1–2 mg/kg every 8 hrs till normal cortisol report or resolving shock
    - In presence of persistent acidosis with pH < 7.2 or pH < 7.25 with base deficit > -10 mm Hg, consider use of sodabicarbonate. 0.3 X body weight X base deficit given very slowly over at least 1 hour.

- Preventing and correcting metabolic abnormalities

- **Maintain normal blood glucose, electrolytes, calcium and pH.**
- Supportive therapy for multi organ dysfunction. Monitor renal function.

- Correction of a significant coagulopathy and anemia (PCV < 36%).

- NPO if > 1 inotrope or dopamine >10
- Consider urinary catheterization
- Treatment of underlying cause. Consider starting or changing antibiotics

Types of Shock – Clues & management

1. **Hypovolemic:**

- Pallor , dehydration,
- H/ o - Placental hemorrhage, cord accidents , fetal to maternal hemorrhage (send KB test), twin to twin transfusion,
- Evident / occult blood loss– ICH, massive pulmonary hemorrhage, DIC
- Insensible water loss, diarrhea
- Choice of initial treatment- Fluid / Blood.
- If blood loss- cross matched PRBC/ whole blood 15ml/kg over2hours . Urgent need to be communicated to blood bank officer. Repeat boluses may be given

2. **Cardiogenic:**

- Signs - Absent femoral pulses, murmur, differential pulses, signs of heart failure, hepatomegaly, cardiomegaly, pulmonary edema
- H/o - Perinatal insults – asphyxia, antenatal diagnosis of heart disease, PPHN ,VLBW with Hemodynamically significant PDA or initial 48 hrs

- Structural abnormal heart - congenital abnormalities
- Arrhythmias
- Choice of initial treatment- dobutamine starts at 3 mcg/kg.min and titrate. Avoid fluid boluses.

3. Septic/ distributive:

- All risk factors for sepsis-(refer to protocol)
- Choice of initial treatment- Upto 60 ml/kg of NS as 20 ml/kg aliquots if no signs of fluid overload followed by dopamine start at 5 mcg/kg.min and titrate

Therapeutic Endpoints

- capillary refill time of < 2 seconds
- normal pulses without differential between peripheral and central pulses
- warm extremities
- urine output greater than 1ml/kg/hr, low serum lactate, and
- mixed venous saturation of >70%

Indicator	0	1	2	3
GA	≥36	32-35	28-31	<28
State	Active Awake	Quiet Awake	Active Sleep	Quiet Sleep
HR increase	0-4	5-14	15-24	25
SaO_2 decrease	0-2.4%	2.5-4.9%	5-7.4%	≥7.5%
Brow bulge	0-9% of time	10-39% of time	40-69% of time	≥70% of time
Eye squeeze				
Nasolabial furrow				

Estimated relative cardiovascular receptor stimulatory effects of inotropes, lusitropes, and vasopressors

	Adrenergic, Dopaminergic, and Vasopressin Receptors					
	α_1/α_2	β_2	α_1	β_1/β_2	DA_1/DA_2	V_{1a}
	Vascular	Vascular	Cardiac	Cardiac	Vascular/Cardiac	Vascular
Phenylephrine	++++	0	+	0	0	0
Norepinephrine	++++	0/+	++	++++	0	0
Epinephrine	++++	++++	++	++++	0	0
Dopamine[a]	++++	++	++	+++	++++	0
Dobutamine[b]	+/0	++	++	++++	0	0
Isoprenaline	0	+++	0	++++	0	0
Vasopressin	0	0	0	0	0	++++
PDE-III inhibitors	0	0	0	0	0	0
PDE-V inhibitors	0	0	0	0	0	0

PAIN MANAGEMENT IN NEWBORN

A newborn including a preterm **FEELS, RESPONDS TO and REMEMBERS pain**!

- Monitor babies for pain using the PIPP score or monitoring the baby's face for pain by neonatal facial coding system (NFCS).

A. Premature Infant Pain Profile

<6-no/minimal pain, > 12- mod/severe pain

B. NFCS scale (neonatal facial coding system)

A ten point scale with the following facial actions been monitored

* An addition tenth activity been monitored only for preterm infants

	Facial Expressions	**Actions & points**	
		Did not occur	**Occurred**
1.	Brow lowering (lowering and drawing together of the brow can result in brow bulge)	0	1
2.	Eyes squeezed shut	0	1
3.	Deepening of the naso- labial furrow(fold)	0	1
4.	Open lips (any separation of the lips is an occurrence)	0	1
5.	Vertical mouth stretch	0	1
6.	Horizontal mouth stretch	0	1
7.	Taut tongue(cupping of the tongue)	0	1
8.	Chin quiver(high frequency vibration of the chin and lower jaw)	0	1
9.	Lip pursing(tightening the muscle around the lips to form an "oo")	0	1
*10.	Tongue protrusion(this is a "no pain" response in full term infants)	0	1

General measures to reduce pain

1. Limit number of procedures.
2. Cluster care.
3. Reduce “routine” tests. Do tests if they are going to modify management.
4. Do only necessary procedures - Eg – Endotracheal suctioning only when there are secretions and not as a routine.
5. Plan invasive procedures when the baby is awake. Protect sleep
6. Once a procedure is over, do not plan another procedure for at least two hours
7. Minimize the number of attempts per procedure.
8. Use a lancet instead of needle for heel pricks.
9. Use the smallest G needle.
10. Avoid IM / SC injections when the same can be given through an existing IV cannula.
11. Removal of plasters: Use saline/ sterile water /oil for wetting the plasters before removal. Do not apply traction perpendicular to the skin.

Environmental modifications / Sensorial saturation

1. Nesting / Swaddling / Facilitated tucking during painful procedures.
2. Kangaroo mother care reduces pain. If a baby is in KMC position, painful procedures can be done in KMC.
3. Non-nutritive sucking.
4. Sensorial saturation by using multiple pain limit measures.

Pharmacological treatment

1. Expressed breast milk (if not available, 25% Dextrose) Give 2 ml of EBM 2 minutes before the painful procedure.
2. EBM can be used only on a baby who is receiving at least 2 ml of milk.
3. Local anesthetic 0.5 % 1 ml/kg forintercostals tube drain.
4. Oral / Rectal paracetamolpost surgery. Dose: 10 – 15 PO mg/kg or 20-25 mg/kg PR.
5. IV fentanyl – 1-3 ug /kg/dose is used for pain relief for babies on invasive ventilation. It should be given slowly over 3-5 minutes as it can cause chest rigidity on rapid infusion.
6. IV fentanyl (1 ug/kg/hour) infusion is used only for
    - ventilated infants who are very agitated despite intermittent fentanyl especially in PPHN and CDH
    - post-operative pain relief in a ventilated infant.

Specific procedures

Procedure	Non intubated neonates	Intubated neonates
Venipuncture	2 ml EBM 2 min prior	2 ml EBM 2 min prior
Heel stick	2 ml EBM 2 min prior	2 ml EBM 2 min prior
Arterial puncture /line placement	2 ml EBM 2 min prior	2 ml EBM 2 min prior
Lumbar puncture	2 ml EBM 2 min prior	2 ml EBM 2 min prior or 1-3 ug/kg fentanyl IV
Elective intubation		1-3 ug/kg fentanyl IV
Endotracheal suction	N/A	2 ml EBM 2 min prior or 1-3 ug/kg fentanyl IV
Suprapubic aspiration	2 ml EBM 2 min prior	2 ml EBM 2 min prior or 1-3 ug/kg fentanyl IV
Immunization	Breastfeeding or 2 ml EBM 2 min prior	
UAC /UVC placement	2 ml EBM 2 min prior	1-3 ug/kg fentanyl IV
Mechanical ventilation	NA	1-3 ug/kg fentanyl IV sos or 4-6 hourly 1 ug/kg/hour if severe agitation
Chest tube drainage	Local anesthesia 0.5 % - 1 ml/kg SC 2 ml EBM 2 min prior 1-3 ug/kg fentanyl IV*	Local anesthesia 0.5 %1 ml/kg SC 1-3 ug/kg fentanyl IV
ROP screening	2 ml EBM 2 min prior 0.5 % proparacaine	1-3 ug/kg fentanyl IV 0.5 % proparacaine
Laser	Paracetamol 2 hours prior and after Q 6 h till 24 h 1-3 ug/kg fentanyl*	Paracetamol 2 hours prior and after Q 6 h till 24 h 1-3 ug/kg fentanyl
Post operative	Paracetamol	Paracetamol / IV fentanyl

*In non ventilated babies while using opioids- Watch for apnea/ respiratory depression; IV Naloxone should be kept ready and used in case of respiratory depression or apnea (0·1 mg/kg or 0·25 ml/kg IV);
** Even ventilated patients on opioid infusion during procedures needs additional analgesic measures

Withdrawal of Opioid

- No need to wean if use < 3-4 d or sporadic
- Short term 3-8 d – reduce by 25-50% /d (10% every 6-8 hr)
- Long term >8-10 d –
    - reduce by 20% over 24 h and then 10% every 12 h as tolerated
- If required, treat withdrawal by Phenobarbitone

Annexes

Annex 1 - Common NICU Drug dosage

Drug Name	Route						
		≤29 WEEKS			**30-34 WEEKS**		**>35 WEEKS**
		0-7 D	**8-28 D**	**≥ 29 D**	**0-7 D**	**≥8 D**	
AMIKACIN	IV	18Q48H	15Q36H	15Q24H	18Q36H	15Q24H	15 Q 24H
		≤29 WEEKS		**30-36 WEEKS**		**37-44 WEEKS**	
		0-28 D	**>28 D**	**0-14 D**	**>14 D**	**0-7 D**	**>7 D**
AMPICILLIN	IV	25-50 Q12 H	25-50 Q8H	25-50 Q12H	25-50Q8H	25-50Q12H	25-50 Q8H
		≤29 WEEKS		**30-36 WEEKS**		**37-44 WEEKS**	
		0-28 D	**>28 D**	**0-14 D**	**>14 D**	**0-7 D**	**>7 D**
AZTREONAM	IV	30 Q12H	30 Q8 H	30 Q12H	30 Q 8 H	30Q12H	30Q8H
Amox-clavulanate (dose for amox)	IV	**Wt<1200**		**1200-2000**		**>2000**	
				0-7 D	**>7 D**	**0-7 D**	**>7 D**
		25 q12 h		25 q 12 h	25 q8h	25 q 12h	25 q 8h
Ampicillin-sulbactum (dose for	IV	**Wt<1200**		**1200-2000**		**>2000**	
				0-7 D	**>7 D**	**0-7 D**	**>7 D**
		25q12h		25q12h	25q8h	25q12h	25q8h

ampicillin)						
Cefoperazone-Sulbactum (dose for cefoperazone)	IV	**Wt<1200**		**1200-2000**		**>2000**
				0-7 D	**>7 D**	**0-7 D**	**>7 D**
		50q12h		50q12h	50q8h	50q12h	50q8h
CEFIPIME	IV/ IM	**<28 DAYS**		**> 28 DAYS**		**MENINGITIS/ SEVERE INFECTION**
		50 Q 12 H		30Q12H		50 Q12H
CEFOTAXIME 50mg/kg/day	IV	**≤29 WEEKS**		**30-36 WEEKS**		**37-44 WEEKS**	
		0-28 D	**>28 D**	**0-14 D**	**>14D**	**0-7 D**	**>7 D**
		50 Q12H	50 Q8H	50 Q12H	50 Q8H	50Q12H	50 Q8H
CEFTAZIDIME 30mg/kg/day	IV	**≤29 WEEKS**		**30-36 WEEKS**		**37-44 WEEKS**	
		0-28 D	**>28 D**	**0-14 D**	**>14D**	**0-7 D**	**>7 D**
		30 Q 12	30 Q 8	30 Q 12	30 Q 8	30 Q 12	30 Q 8

CEFTRIAXONE	IV	50 mg/kg/day Q 2 H
		Meningitis 100 mg/kg → 80 mg/kg Q 2 H

Chloramphenicol	IV	20 mg/kg infusion loading dose Preterm < 1 mo – 2.5q6h FT <1 wk, PT > 1 mo – 5q6h FT >1 wk – 12.5q6h				
		Wt<1200	**1200-2000**		**>2000**	
			0-7 D	**>7 D**	**0-7 D**	**>7 D**
CIPROFLOXACIN	IV	10q12h	10q12h	10q12h	10q12h	20q12h
CLOXACILLIN	IV	30q12h	30q12h	30q8h	30q12h	30q8h
CLINDAMYCIN	IV	5q12h	5q12h	5q8h	5q8h	5q6h
COLISTIN	IV	2.5-5mg/kg/dayQ6-12H		Inhaled 4mg/kg/dose Q12h		

GENTAMICIN	IV	**≤29 WEEKS**			**30-34 WEEKS**		**>35 WEEKS**
		0-7 D	**8-28 D**	**≥ 29 D**	**0-7 D**	**≥8 D**	4 Q 24 H
		5Q48 H	4Q36 H	4Q24 H	4-5 Q36H	4Q24H	
LINEZOLID	IV/ PO	**PRETERM <1 WEEK**			**PRETERM>1 WEEK OR TERM**		
		10 mg/kg/dose Q12H			10 mg/kg/dose Q8H		

LEVOFLOXACIN	IV	10 mg/kg Q 24H					
MEROPENEM	IV	**< 32 WEEKS**		**>32 WEEKS**			
		<14 DAYS	**>14 DAYS**	**<14 DAYS**	**>14 DAYS**		
		20 Q 12 H	20 Q 8 H	20 Q 8 H	30 Q 8 H		
(MENINGITIS)		40 Q 12 H	40 Q 8 H	40 Q 8 H			
Metronidazole Loading dose 15mg/kg→7.5mg /kg/dose	IV/ PO	**< 29 WEEKS**		**30-36 WEEKS**		**37-44 WEEKS**	
		0-28 D	**>28 D**	**0-14 D**	**>14 D**	**0-7 D**	**>7 D**
		7.5Q48H	7.5Q24H	7.5Q24H	7.5Q12H	7.5Q24H	7.5Q12H
NETILMYCIN	IV	**< 29 WEEKS**			**30-34 WEEKS**		**>35 WEEKS**
		0-7 D	**8-28 D**	**>29 D**	**0-7 D**	**≥ 8 D**	4Q24H
		5Q48H	4Q36H	4Q24H	4.5Q36 H	4Q24H	
PENICILLIN PROCAINE	IM	**Wt<1200**		**1200-2000**		**>2000**	
		0-7 D	**>7 D**	**0-7 D**	**0-7 D**	**>7 D**	**0-7 D**
		50000 Q12H	50000 Q8H	50000 Q24H	50000 Q12H	50000 Q8H	50000 Q24H
BENZATHINE PENICILLIN	IM	50000 single dose					
		< 29 WEEKS		**30-36 WEEKS**		**37-44 WEEKS**	

PIPERACILLIN	IV	**0-28 D**	**>28 D**	**0-14 D**	**>14 D**	**0-7 D**	**>7 D**
		50-100 Q12H	50-100 Q8H	50-100 Q12H	50-100 Q8H	50-100 Q12H	50-100 Q8H
PIPERACILLIN + TAZOBACTAM		**< 29 WEEKS**		**30-36 WEEKS**		**37-44 WEEKS**	
		0-28 D	**>28 D**	**0-14 D**	**>14 D**	**0-7 D**	**>7 D**
		50-100 Q12H	50-100 Q8H	50-100 Q12H	50-100 Q8H	50-100 Q12H	50-100 Q8H
VANCOMYCIN	IV	**< 29 WEEKS**		**30-36 WEEKS**		**37-44 WEEKS**	
		0-14 D	**>14 D**	**0-14 D**	**>14 D**	**0-7 D**	**>7 D**
		10 Q18H	10Q12 H	10Q12H	10Q8H	10Q12H	10Q8H
(Meningitis)		15Q18H	15Q12H	15Q12H	15Q8H	15Q12H	15Q8H
FLUCONAZOLE Loading Dose 12-25mg/kg→ 6-12 mg/kg	IV/ PO	**<29 WEEKS**		**≥30 WEEKS**			
		0-14 DAYS	**>14 DAYS**	**0-7 DAYS**	**>7 DAYS**		
		6-12 Q 48 H	6-12 Q 24 H	6-12 Q 48 H	6-12 Q 24 H		
Amphotericin B	**IV**	1-1.5 mg/kg Q 24 H					
Amphotericin B Liposome / Lipid complex	IV	5 q 24 h over 2 h					

<table>
<tr><td colspan="5"></td></tr>
<tr><td>ACYCLOVIR</td><td>IV</td><td colspan="3">10-15 mg/kg/dose Q8H
(<33 weeks Q12H)</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td rowspan="3">ZIDOVUDINE</td><td rowspan="3">PO</td><td colspan="2">30-35 WEEKS</td><td>≥ 35 WEEKS</td></tr>
<tr><td>0-14 DAYS</td><td>>14 DAYS</td><td rowspan="2">4 mg/kg/dose Q12H</td></tr>
<tr><td>2 mg/kg/dose Q12H</td><td>3 mg/kg/dose Q12H</td></tr>
<tr><td rowspan="2">NEVIRAPINE</td><td rowspan="2">PO</td><td>BW <2 KG</td><td>2- 2.5 KG</td><td>➢ 2.5 kg</td></tr>
<tr><td>0.2ml/kg -6-12 weeks</td><td>10 mg od (1ml)</td><td>15 mg od(1.5ml)</td></tr>
</table>

1. **Prostaglandin E1**

Initial dose – 0.05 to 0.1 mcg/kg/min. start at 0.05 and titrate up or down based on response)

* Maintenance dose may be as low as 0.005 mcg/kg/min

2. **Captopril** 0. 01 to 0.05 mg/kg/dose PO q 8 to 12 h
3. **Enalapril** 0.04 to 0.15 mg/kg/dose PO q 6-12 h
4. **Digoxin**

	Total loading dose		Maintenance dose		
PMA wks	**IV mcg/kg**	**PO mcg/kg**	**IV mcg/kg**	**PO mcg/kg**	**Interval**
<29	15	20	4	5	24
30-36	20	25	5	6	24
37-48	30	40	4	5	12
>49	40	50	5	6	12
Divide into 3 do (½ + ¼ + ¼ over 24 h)					

5. **Dobutamine** 2-25 mcg/kg/min Initial dose then titrate to maximum of 20mcg/kg/min. as IV infusion(12mg/kg in 10 ml 5%D or NS @ 1ml/hour = 10 mcg/kg/mt)
6. **Dopamine** 2-20 mcg/kg/min Initial dose then titrate to maximum of 20mcg/kg/min as IV infusion
7. **Epinephrine** 0.05 to 0.1 mcg/kg/min Initial dose then titrate to maximum of 1 mcg/kg/min as IV infusion
8. **Ibuprofen**- 10mg/kg/dose followed by 2 doses of 5mg/kg/dose PO at 24 h interval. Monitor for adv effect prior to each dose
9. **Sildenafil-**IV Loading dose 0.4 mg/kg over 3 hrs→1.6 mg/kg/day(0.067mg/kg/hr)
   ORAL- 0.5-2 mg/kg/dose Q 6-12 H
10. **Nitroglycerine**-0.5-3mcg/kg/min as IV infusion Max 10 mcg/kg/min
11. **Milrinone-** Loading dose 135 mcg/kg over 60 min (3 h in **Preterms**), followed by 0.5 to 0.75 mcg/kg/min (0.2 mcg/kg/min in **Preterms**) as IV infusion

CNS drugs

1. **Phenobarbitone** – 20 mg/kg loading dose as IV infusion over 10-15 min. Repeat at 10 mg/kg/dose as infusion if seizures not controlled in 20-30 min.Maintenance after 12 hours at 2.5 mg/kg /dose q 12 h. If toxicity, withhold for 5 days and restart at 3 mg/kg/dose HS q 24 h
2. **Phenytoin** – 20 mg/kg loading dose dissolved in 20 ml NS over 20 min as IV infusion. Maintenance after 12 hours at 2.5 mg/kg /dose q 12 h.
3. **Fosphenytoin** – Always expressed as phenytoin equivalent PE IM/IV
   Fosphenytoin 1.5 mg = Fosphenytoin 1 mg PE= Phenytoin 1 mg
4. **Lorazepam**- 0.05-0.1mg/kg/dose over at least 5 min.
5. **Midazolam –**
   a. IV infusion – 0.2 to 1 mcg/kg/min (10-60 mcg/kg/hour)
   b. Stat dose - IV 0.05 to 0.15 mg/kg over at least 5 min
   c. Intranasal- 0.2 to 0.3 mg/kg/dose
6. **Fentanyl** -0.5-4 mcg/kg/ dose q 2-4h OR as 1-5 mcg/kg/hour as infusion
7. **Morphine** - 0.05-0.2mg/kg/dose over at least 5 min q 4 -6 h OR IV infusion 10-20 mcg/kg/hour after loading with 100-150 mcg/kg over 1 hour

Respiratory Drugs

1. **Aminophylline:** Loading dose 8 mg/kg IV Infusion over 30 mins /ORAL Maintenance dose –1.5-3 mg/kg/dose **ORAL or SLOW IV** Q8-12H
2. **Caffeine Citrate:** Loading dose- 20 mg/kg (10mg/kg of caffeine base**) PO or IV** over 30 min.
   Maintenance dose- 5-10 mg/kg Q24H. **IV/ORAL**
3. **Salbutamol (Albuterol) nebulisation:** Bronchodilataion: 0.1 to 0.5 mg/kg/dose Q 2 to 6 h. To make a concentration of 0.1 mg/ml in NS
4. **Adrenaline nebulisation** : 0.5 ml/kg/dose in 3 ml NS
5. **Terbutaline**: Nebulisation: 0.1 mg/kg in 2 ml NS
   a. 0.01 mg/kg SC for a/c bronchospasm.
   b. Infusion: loading dose 2-5 mcg/kg. Maintenance dose 2-12mcg/kg/hr.
6. **Dexamethasone:** For Severe BPD **:**
   DART PROTOCOL for Chronic Lung Disease- IV/ORAL

   0.075 mg/kg/dose Q12H × 3 DAYS

   0.05 mg/kg/dose Q12H × 3 DAYS

   0.025 mg/kg/dose Q12H × 2 DAYS

0.01mg/kg/dose Q12H × 2 DAYS

Miscellaneous

1. **VZIG** : 125 Units as IV infusion . Start at 0.1 ml/kg/hr and increase to maximum of 1 ml/kg/hr
2. **IVIG:** 1 g/kg total dose. Start at 0.01 ml/kg/min. Double every Q 15 min to maximum of 0.08 ml/kg/min
3. **Octreotide** initial dose 1 mcg/kg/dose q 6 h, titrate to max of 10 mcg/kg/dose q 6 h
4. **Ranitidine:** PO 2 mg/kg/dose Q 8h. IV 1.5 mg/kg/dose Q 8 h slow push. Preterm 0.5 mg/kg dose Q 12 h.
5. **Domperidone:** 0.1 to 0.3 mg/kg/dose Q 8 h
6. **Insulin :** 0.05 U/kg of human regular insulin with 2 ml/kg of 10%D bolus. Infusion of 0.1 U/kg/hour with 2-4 ml/kg/hour of 10% D (conc of 0.1 U/ml.
7. **Kayexelate:** 1 g/kg at 0.5 g/ml of NS only per rectal in term babies. Retention time 30 min
8. **Frusemide:** 1-2 mg/kg/dose Q 12 h in term infants & Q 24 h in preterm infants. IV slow push or PO.
9. **Hydrocortisone:**
   For Hypoglycemia (GIR > 12 mg/kg/min): 5 mg/kg /dose IV Q 12h

   For Shock in preterm: IV

   Day 1: 1 mg/kg/dose Q 8 h X 3 doses

   Day 2: 0.5 mg/kg/dose Q 12 h X 2 doses

   Day 3: 0.25 mg/kg/dose Q 12 h X 2 doses

   Day 4: 0.125 mg/kg/dose X 1 dose.

10. **Thyroxine** – 10-15 mcg/kg/dose PO in milk
11. **Calcium :** 1 ml/kg Q 8 h IV in 1:1 dilution under cardiac monitoring. For hyperkalemia 2 ml/kg Q 6h. Oral : 100-150 mg/kg/d of calcium in 3 divided doses.
12. **Multivitamin preparation:** Oral: 0.3 ml/kg Q 24 h (visyneral Z). 1ml/100 ml IVF in TPN.
13. **Iron :** Prophylaxis start at 15 days.

    < 2 kg – 2mg/kg/day

    1-1.5 kg – 3 mg/kg /day

    <1 kg – 4 mg/kg/day.

    Treatment 6 mg/kg/day.

In 2 divided doses. Ensure that 2 hours interval is maintained between administration of calcium and iron.

14. **Vit E:** ROP prophylaxis – 0.25 ml of Evion drops Q 12 h.
15. **Vit K:** 1 mg IM/IV term. 0.5 mg IM/IV preterm. Use K1 preparation preferably.
    a. Routine administration at birth & all outborn whose vit K status not known.
    b. In presence of coagulopathy for 3 days.
    c. Every Week –
        i. In sick NICU babies
        ii. Infants on antibiotics
        iii. VLBW infants
16. **Vit A** – 5000 U IM X 3 times /week X 12 doses for BPD prevention in <28 weeks.
17. **Aminoacid preparation:** Start on Day 1 at 1 g/kg and increase to maximum of 3.5 g/kg.
18. **Lipid preparation:** Start between 24- 72 h at 0.5 g/kg as 10% soln. Increase to maximum of 3 g/kg. Switch to 20% soln after reaching 2g/kg. If risk of adverse events such as sepsis – decrease dose to 2 g/kg.
19. **Cholestatic regimen:**

    UDCA – 10/mg/dose Q 12 h PO

    Vit A- 5000 - 25000U /d PO

    Vit D: 400-1200IU/day PO

    Vit E: 0.5 ml BD PO(50-400IU/day)

    Vit K: 2.5 mg every alternate day PO or 2.5 mg IV every 4 weeks

    Vit B & C : 1 ml BD PO

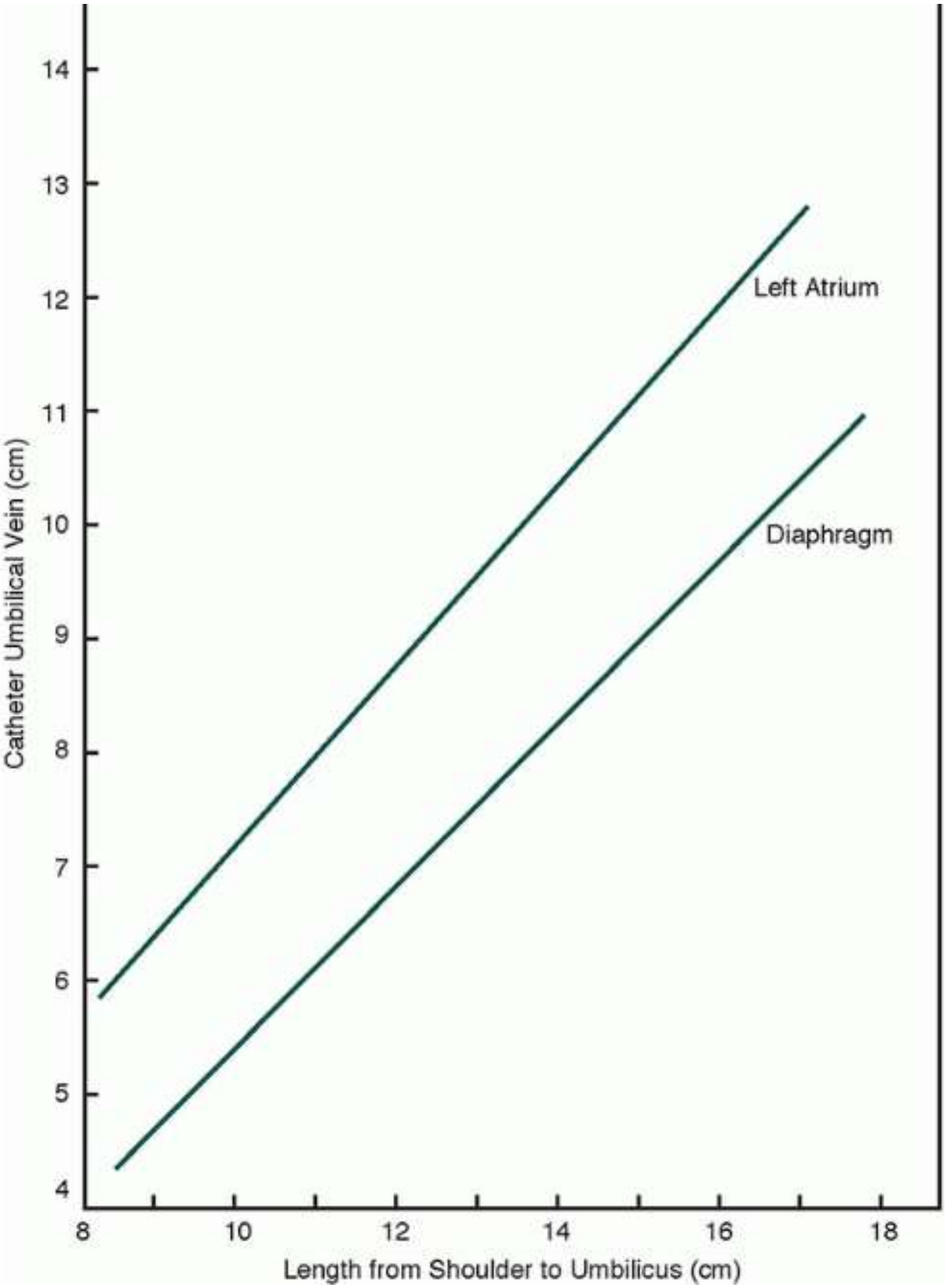
    Calcium : 20-100mg/kg/d ; Phosphorus – 25- 50 mg/kg/day

    Zinc – 1mg/kg/day

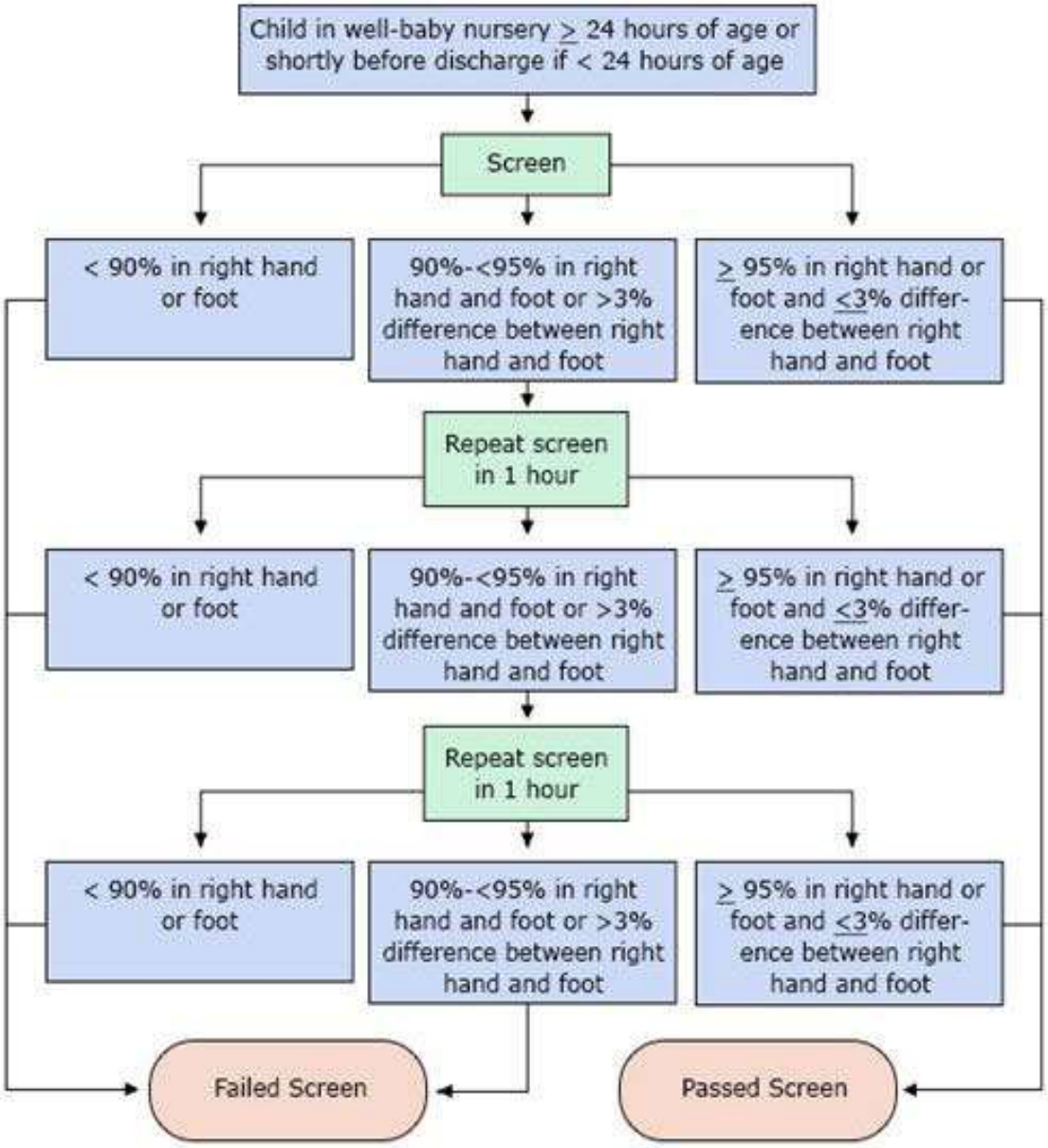
    Iron – 5-6 mg/kg/day

    MCT oil- 1-2ml/kg/day (2-4 div dose

Annex 2- UAC UVS Position



Annex 3- Pulse-Oximetry Screening for CCHD



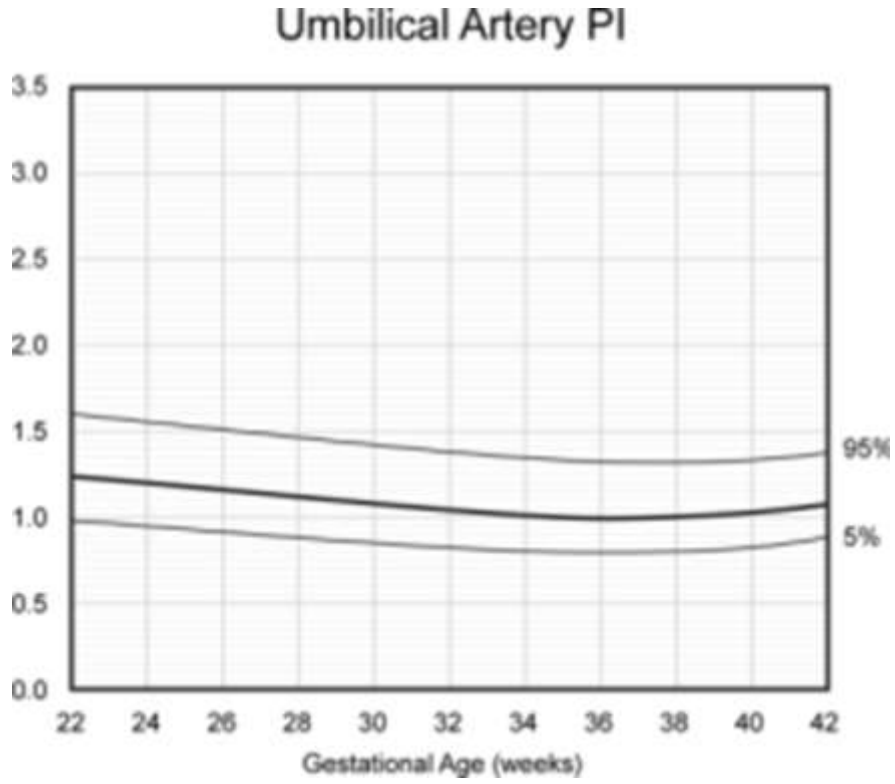
Annex -4- Gratacos Staging for abnormal dopplers

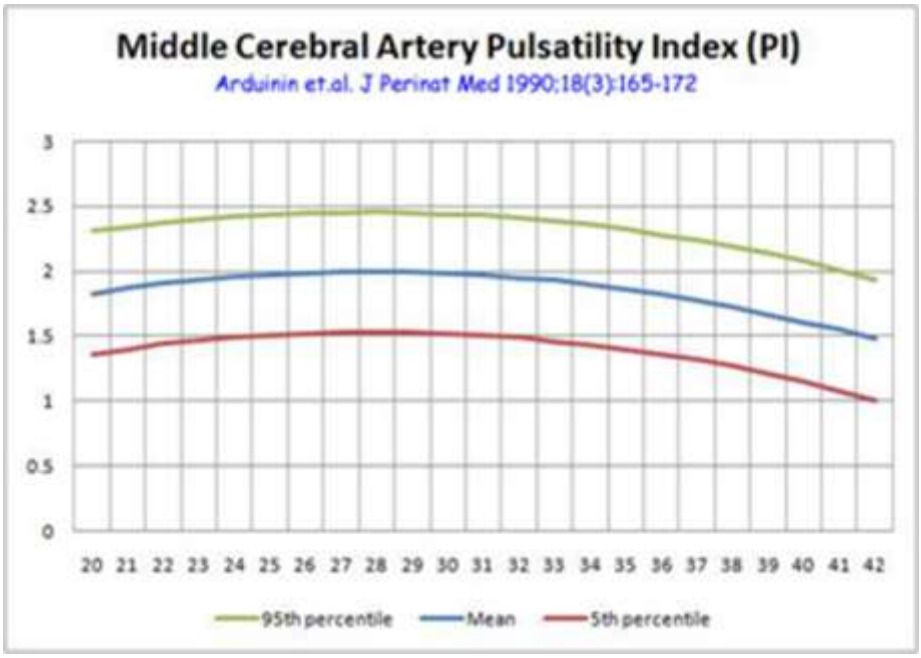
Table 2. Stage-based classification and management of FGR

Stage	Pathophysiological correlate	Criteria (any of)	Monitoring*	GA/mode of delivery
I	Severe smallness or mild placental insufficiency	EFW <3rd centile CPR <p5 UA PI >p95 MCA PI <p5 UtA PI >p95	Weekly	37 weeks LI
II	Severe placental insufficiency	UA AEDV Reverse AoI	Biweekly	34 weeks CS
III	Low-suspicion fetal acidosis	UA REDV DV-PI >p95	1–2 days	30 weeks CS
IV	High-suspicion fetal acidosis	DV reverse a flow cCTG <3 ms FHR decelerations	12 h	26 weeks** CS

All Doppler signs described above should be confirmed at least twice, ideally at least 12 h apart. GA = Gestational age; LI = labor induction; CS = cesarean section. * Recommended intervals in the absence of severe preeclampsia. If FGR is accompanied by this complication, strict fetal monitoring is warranted regardless of the stage.

MCA PSV for ISO – IMMUNIZATION



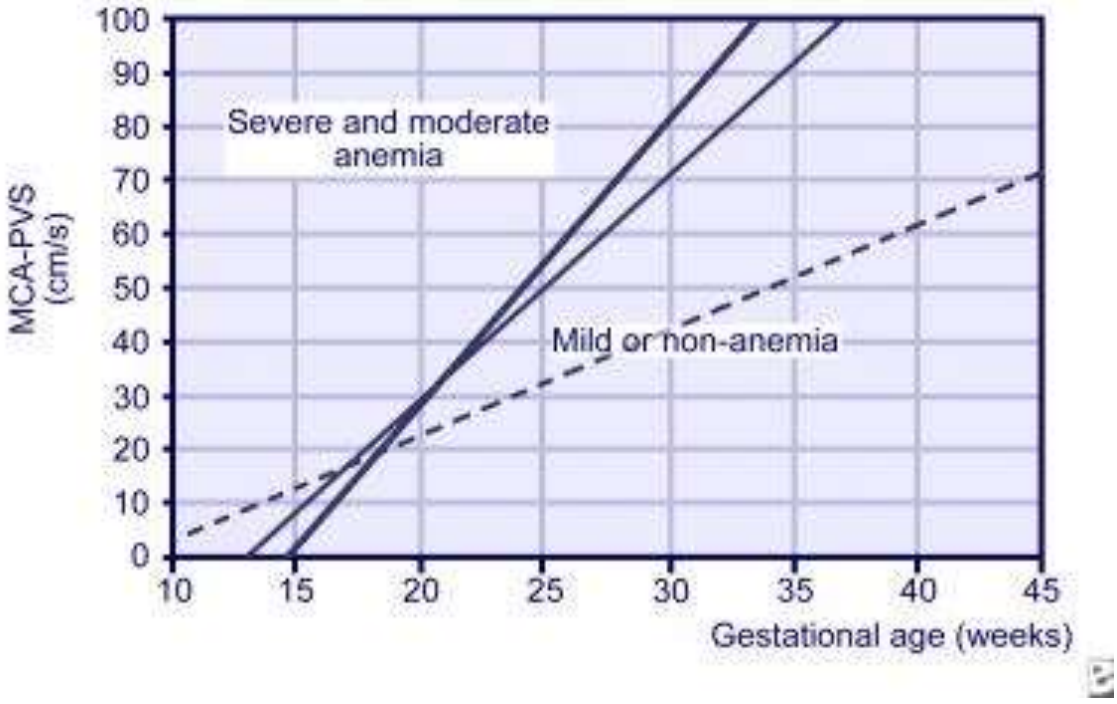


Annex-5-Normalvalue

Table 1 Values for middle cerebral artery peak systolic velocity (cm/s) based on multiples of the median between the 23rd and 35th gestational weeks.

Gestational age (weeks)	Multiples of the median for MCA-PSV			
	1.0	1.29	1.50	1.55
23	35.44	45.72	53.16	54.93
24	35.48	45.77	53.22	55.00
25	35.81	46.20	53.72	55.51
26	36.45	47.03	54.68	56.50
27	37.43	48.29	56.15	58.02
28	38.77	50.01	58.15	60.09
29	40.49	52.23	60.73	62.75
30	42.61	54.97	63.91	66.04
31	45.16	58.26	67.74	70.00
32	48.17	62.13	72.25	74.66
33	51.65	66.62	77.47	80.05
34	55.63	71.76	83.44	86.22
35	60.13	77.56	90.19	93.20

MCA-PSV, middle cerebral artery peak systolic velocity.



Annex-

6 Creatinine Values in Neonates

Age (Day)	<28 Weeks	28-32 Weeks	32-37 Weeks	>37 Weeks
3	1.05 ± 0.27	0.88 ± 0.25	0.78 ± 0.22	0.75 ± 0.2
7	0.95 ± 0.36	0.94 ± 0.37	0.77 ± 0.48	0.56 ± 0.4
14	0.81 ± 0.26	0.78 ± 0.36	0.62 ± 0.4	0.43 ± 0.25
28	0.66 ± 0.28	0.59 ± 0.38	0.40 ± 0.28	0.34 ± 0.2

Source: From Rudd PT, Hughes EA, Placzek MM, et al. Reference ranges for plasma creatinine during the first month of life. *Arch Dis Child* 1983;58:212-215; van den Anker JN, de Groot R, Broerse HM, et

Annex-7 Hematological Values in neonates

Table. Average hematological values for term and preterm infants.

Gestation (weeks)	Hct (%)	Hgb (g/dL)	Retic (%)
37-40	53	16.8	3-7
32	47	15.0	3-10
28	45	14.5	5-10
26-30	41	13.4	—