THE UNITED REPUBLIC OF TANZANIA



MINISTRY OF HEALTH

NATIONAL NEONATAL CARE GUIDELINE

November, 2024

Contents

Preamble 7

CHAPTER 1. ORGANISATION OF NEONATAL CARE UNIT AT DIFFERENT LEVELS 8

1.1 Level of Care 8

1.2 Components of Neonatal Care Units at different levels 9

1.3 Location, Size and Minimum Space requirement of neonatal care unit from level of the health centre 12

1.4 Organizational Structure for Neonatal Care Unit 12

1.5 Space for supplementary service: 13

1.6 Electrical, Mechanical, Water, Light, Thermal and Acoustic Requirements 15

..... 15

CHAPTER 2: History, Examination and Documentation 20

2.1 History 20

2.2 Newborn examination 21

2.3 Documentation 22

CHAPTER 3: INFECTION PREVENTION AND CONTROL (IPC) 23

3.1 Chain of infection 23

3.2 Standard IPC precautions: 24

3.3 Hand hygiene 26

3.4 Processing of equipment 27

CHAPTER 4: ESSENTIAL NEWBORN CARE (ENC) 29

4.1 Delivery and immediate care for the newborn 29

4.2 Overview of Essential Newborn Care in the first 24 hours 31

4.3 Newborn resuscitation 35

4.4 Assessment of the newborn 42

4.4.1 Apgar score 42

4.4.2 Danger signs in the first 24 hours of life 42

Care for newborns delivered outside the health facility 44

4.5 Breastfeeding 44

4.5.1 Breastfeeding assessment (LATCH score) 45

4.5.2 Breastmilk production and milk requirement of the newborn 46

4.5.3 Breast problems 47

4.6 Postnatal discharge preparation for well newborns 48

4.7 Neonatal Neuro-protective 49

4.7.1 Safeguarding Sleep 49

CHAPTER 5: CARE OF LOW BIRTH WEIGHT AND INTRAUTERINE GROWTH RESTRICTED NEWBORNS 58

5.1 Classification of Low Birth Weight (LBW) 58

5.2 Risk factors for low-birth-weight and IUGR delivery 59
5.3 Referral of LBW 60
5.4 Monitoring of LBW/IUGR infants 62
5.5 Feeding and fluid management 62
5.5.1 General principles 62
5.5.2 Feeding practicalities for an LBW infant 63
5.5.3 Fluids management 64
5.5.4 Donor human milk 66
5.6 Micronutrient Supplementation 67
5.7 Breast Milk Fortification 67
5.8 Feeding in Newborn with Special Needs 68
5.8.1 Feeding in newborn babies with cleft lip and palate 68
5.8.2 Extrauterine growth restriction (EUGR) 69
5.8.3 Infants requiring surgery 69
5.8.4 Breast milk substitutes 69
5.9 Parenteral nutrition 70
5.10 Thermal protection 73
5.10.1 Hypothermia 74
5.10.2 Hyperthermia 76
5.9 Kangaroo Mother Care 77
CHAPTER 6: RESPIRATORY CONDITIONS 84
6.1 Respiratory Distress Syndrome (RDS) 84
6.1.1 Continuous Positive Airway Pressure (CPAP) 86
6.1.2 Invasive Mechanical Ventilator 89
6.1.3 Oxygen administration: 99
6.1.4 Air leak syndrome (Pneumothorax) 100
6.2 Meconium Aspiration Syndrome (MAS) 102
6.3 Persistent Pulmonary Hypertension (PPHN) 104
6.4 Pulmonary haemorrhage 108
6.5 Bronchopulmonary dysplasia (BPD) 110
6.6 Apnoea of Prematurity 112
CHAPTER 7: RETINOPATHY OF PREMATURITY (ROP) 116
CHAPTER 8: ELECTROLYTE IMBALANCE 119
CHAPTER 9: PERINATAL ASPHYXIA 128
9.2 Therapeutic Hypothermia 131
9.3 Convulsions 135
CHAPTER 10: NEONATAL ABSTINENCE SYNDROME (NAS) 141

CHAPTER 11: NEURO-DEVELOPMENT AND GROWTH MONITORING 147
Nurturing care for every newborn 147
Description of nurturing Care components 147
Creating a nurturing environment for all newborns 148
Neurodevelopment Assessment 152
Growth and monitoring 155
CHAPTER 12: NEONATAL SEPSIS 157
12.1 Neonatal meningitis 165
12.2 Neonatal pneumonia 167
12.3 Necrotizing Enterocolitis (NEC) 168
12.4 Spontaneous Intestinal Perforation (SIP) 172
12.5 Neonatal tetanus 174
12.6 Urinary tract infections (UTI) 176
12.7 Umbilical infection (Omphalitis) 178
12.8 Umbilical granuloma 179
12.9 Ophthalmia neonatorum 180
12.10 Skin and mucous membrane problems 182
12.11 Bacterial skin infection 182
12.12 Cellulitis/Abscess 183
12.13 Thrush in diaper area 183
12.14 Oral thrush 183
12.15 New-borns delivered by a mother with infection 184
12.15.1 Human immunodeficiency virus (HIV) infection 184
12.15.2 Tuberculosis 185
12.15.3.Hepatitis B 188
12.15.4 Human Herpes Virus 3 (Varicella Zoster Virus VSV) 188
12.15.5 Congenital Rubella 189
12.15.6 Cytomegaly Virus (CMV) 189
12.15.7 Toxoplasmosis 190
12.15.8 Neonatal Herpes Simplex Virus infection 190
12.15.9 Congenital Syphilis 191
CHAPTER 13: BLOOD DISORDERS 193
13.1 Anemia 193
13.2 Anaemia of Prematurity (AOP) 196
13.3 Haemorrhage 198
13.4 Intraventricular Haemorrhage (IVH) 199
CHAPTER 14: CARDIOVASCULAR DISORDERS 202

14.1 Shock 202
14.2 Congenital Heart Diseases (CHD) 207
14.2.1 Patent Ductus Arteriosus (PDA) 209
Clinical findings that suggest a hemodynamically significant PDA in preterm infant 209
CHAPTER 15: NEONATAL JAUNDICE 211
CHAPTER 16: ENDOCRINE DISORDERS 219
16.1 Hypoglycaemia 219
16.2 Hyperglycaemia 222
16.3 Congenital hypothyroidism 223
16.4 Osteopenia (Metabolic Bone Disease) of prematurity 224
16.5 Disorders of sex differentiation (DSDs) 227
16.6 Congenital Adrenal hyperplasia (CAH) 228
16.7 Undescended testes (Cryptorchism) 229
16.8 Neonatal breast enlargement (Mastauxe) 229
16.9 Neonatal withdrawal bleeding 230
CHAPTER 17: NEONATAL DERMATOLGY 231
Congenital Rubella 237
CHAPTER 18: BIRTH INJURIES 242
18.1 Soft tissue injuries 242
18.2 Congenital muscular torticollis 243
18.3 Extracranial injuries 244
18.4 Facial injuries 245
18.5 Intracranial Haemorrhage 245
18.6 Fractures 247
18.7 Dislocations 250
18.8 Nerve injuries 251
CHAPTER 19: NURSING CARE IN THE NEONATAL UNIT (NCU) 253
1. Clinical Care and Monitoring 253
2. Specialized Care 253
3. Family Support and Education 254
4. Interdisciplinary Collaboration 254
5. Documentation and Reporting 254
6. Infection Control 254
7. Developmental Care 254
8. Emergency Preparedness 254
9. Quality Improvement 255
CHAPTER 20: NEWBORN SCREENING 264

CHAPTER 21: FOLLOW UP AND CONTINUUM OF CARE 267
21.1 High risk neonates: 267
21.2 Policy and Health System Support: 270
21.3 Use of Neonatal Data for Quality Improvement 271
21.4 Neonatal Referral Care 273
CHAPTER 22: MORTALITY REVIEW AND ETHICAL CONSIDERATION 276
22.1 Mortality review 276
22.2 Ethical Considerations 277
ANNEX 279
IV Administration 280
ESSENTIAL NEWBORN CARE 295

Preamble

Neonatal care is a crucial component of healthcare systems worldwide, and in Tanzania, it represents an essential area of focus in reducing the morbidity and mortality rates among newborns. The first 28 days of life, known as the neonatal period, neonates are particularly vulnerable, accounting for the highest risk of death compared to any other period in childhood. In Tanzania, despite significant progress in healthcare, neonatal mortality remains a challenge, with complications arising from preterm birth, infections, and birth asphyxia contributing to the high rates of neonatal deaths. Addressing these conditions requires consistent, high-quality care and well-defined practices across all levels of healthcare system.

This guideline is extensively revised from the 2018/2019 version and has been developed to provide healthcare professionals with evidence-based protocols that are practical, comprehensive, and aligned with Tanzania's unique healthcare context. By standardizing neonatal care practices, we aim to ensure that every newborn receives the best possible chance for survival and healthy development, particularly in low-resource settings where the availability of specialized neonatal care is often limited. The guideline emphasizes early identification and management of neonatal complications, efficient referral systems, and collaborative efforts among healthcare workers to reduce neonatal morbidity and mortality.

The need for such a guideline is not only a response to the demands but also a commitment to a brighter, healthier future for Tanzania's youngest generation who need to Survive, Thrive and Transform the society. Through coordinated and compassionate care, we can transform neonatal health outcomes and build a resilient foundation for the well-being of our future generation.

It is my sincere expectation that all health care providers will find this second edition of neonatal care guidelines useful and use it effectively to improve the quality of neonatal and childcare in Tanzania.

Dr. John Jingu

Permanent Secretary

CHAPTER 1. ORGANISATION OF NEONATAL CARE UNIT AT DIFFERENT LEVELS

This chapter guides the establishment of Neonatal Care Units (NCUs), aiming to support and facilitate the planning, establishment, operationalization, and monitoring of NCUs at various levels of health facilities.

In the process of establishing and operationalising the NCU, the hospital management team must ensure the standards are observed. It is important to conduct facility readiness before establishing NCU. The facility should only offer the services based on the available human resources and appropriate equipment needed with a plan to reach the available level of service as equipment and human resources avails. The unit must have access to other support services such as laboratory services, radiology and blood transfusion unit based on the level of care. When feasible, at the hospital level, point-of-care services can be offered.

1.1 Level of Care

The neonatal level of care categories the type of newborn are services that can be offered across the facility level. This is adapted from the WHO model and can be used to assess the facility performance of the signal functions to ensure quality newborn care services are offered across the spectrum of care.

Level care	Signal function	Type of facility
Level 1: Primary care	• Essential newborn care	Dispensary
	• Neonatal resuscitation	
	• Early initiation of breastfeeding	
	• Immunisation	
	• Identifying and stabilisation of referral cases	
	• Routine data collection and MPDSR	
Level 2: Secondary care	Level 1 care with additional of the following • Detection and management of neonatal sepsis with parenteral antibiotics	Health centres
	• Kangaroo mother care	
	• Safe administration of oxygen	
	• Detection of congenital anomalies and appropriate referral to level 3	
	• Routine data collection and MPDSR	
	• Transition care – management of preterm with RDS with CPAP	Only CMOENC and District Hospital

Level 3: Tertiary care	Level 2 care with additional of the following • Mechanical ventilation for advance respiratory support	Regional, Zonal and National Hospitals
	• Investigation and treatment of congenital conditions	
	• Exchange blood transfusion for severe jaundice	
	• Screening for ROP, hearing assessment and other newborn screening services	

238

239 ## 1.2 Components of Neonatal Care Units at different levels

240 The table below describes the components and services for neonates at each level of care.
241 All levels of care must have a stabilisation corner for small and sick newborns (SSN) before
242 referral or triage for admitted patients.

243 **Table xxx**:

Health Facility	Components and type of services
Dispensary	**Services** • Essential newborn care and neonatal resuscitation • Post natal follow up clinic • RCH clinic and immunisation • Newborn screening services Component • Stabilization corner for referral of SSNB (prereferral management)
Health Centre	**Components** 1. General neonatal ward 2. Kangaroo Mother Care ward (KMC) 3. Stabilisation corner **Services** • Essential newborn care services and neonatal resuscitation • Basic Inpatient care for stable newborn babies with LBW • Respiratory support with nasal prongs or oxygen blender for inborn with mild respiratory distress • Parenteral antibiotics for non serious bacterial infection • Management of jaundice with phototherapy • Newborn screening • KMC clinic • Neonatal follow-up clinic • RCH, immunisation and postnatal follow-up clinic

	• Stabilisation corner and pre -referral management
Health Centre – CMOENC(High volume sites)	**Components** 1. HDU 2. General neonatal ward 3. Kangaroo Mother Care Ward (KMC) 4. Stabilisation corner **Services** • Essential newborn care services and neonatal resuscitation • Management of stable newborn babies with LBW – 1800gm • Respiratory support for respiratory distress with CPAP for up to 48hours for inborn babies presenting with respiratory distress with consultation • Management of jaundice with phototherapy • Management of sepsis • KMC follow-up clinic • RCH, Immunisation and postnatal follow-up clinic • Newborn follow-up clinic • Newborn screening services • Pre-referral medication and prompt referral of serious cases
District Hospital	**Components:** • Triage and stabilisation corner • High Dependency Unit (HDU) • General neonatal ward • Kangaroo Mother Care Ward (KMC) • Isolation ward **Service** • Essential newborn care services and neonatal resuscitation • Management of stable newborn babies with LBW • Respiratory support for respiratory distress with CPAP • BT, Birth asphyxia, sepsis, feeding – NGT, thermal care and KMC • Management of jaundice with phototherapy • RCH, immunisation and postnatal follow-up clinic • KMC clinic • Newborn screening • Triage and stabilisation corner
Regional Referral Hospital	**Components:** • Triage and stabilisation unit • Neonatal Intensive Care Unit (NICU) • High dependant unit (HDU) • General neonatal ward

	• Kangaroo Mother Care ward (KMC) • Isolation ward **Services** • Essential newborn care services and neonatal resuscitation at birth • Management of stable newborn babies with VLBW, may care for ELBW. • Respiratory support for respiratory distress with CPAP for babies presenting with respiratory distress • Conventional mechanical ventilation for severe respiratory distress • Management of serious bacterial infection • Extensive phototherapy for neonatal jaundice • Neonatal follow-up clinic (including postnatal follow-up clinic) • KMC clinic • Immunisation and newborn screening • Specialised high-risk follow-up clinic
Tertiary Hospital	**Components:** • Triage and stabilisation unit • Neonatal Intensive Care Unit (NICU) • High dependant unit (HDU) • General neonatal ward • Kangaroo Mother Care ward (KMC) • Isolation ward **Services** • Essential newborn care services and neonatal resuscitation at birth • Management of all babies from ELBW • Respiratory support for respiratory distress with CPAP for babies presenting with respiratory distress • Management of serious bacterial infection • Advance respiratory support with mechanical ventilation • Advance management for term babies with severe birth asphyxia • Advance management for severe jaundice • Neonatal post-surgical care and neuro-tube defects • Neonatal follow-up clinic • (including early postnatal follow-up clinic) • KMC clinic • Immunisation and newborn screening services • Specialised and high-risk follow-up clinic

244

1.3 Location, Size and Minimum Space requirement of neonatal care unit from level of the health centre

Location

- The NCU has to be close to labour ward/maternity unit
- There has to be ambulance access for referrals
- No passages to other services through NCU

Size

- Number of beds can be calculated using the following estimation:
  - 3-5 beds for every 1,000 annual deliveries in the facility, then add 30 % of the estimate for referred-in patients
  - If a facility is already taking care of neonates, the annual number of neonatal admissions and the average length of hospital stay should be taken into consideration
- Room in for mothers (zero separation)
  - The space must allow rooming – in across the entire unit including HDU
  - The beds space in HDU/NICU is 12sqm to allow mothers bed and baby space
  - General ward, mothers will be sating with their babies

Design of the neonatal care unit: refer to the architectural designs for size for each level

- Refer to Schedule of Accommodation for Neonatal Care Unit (Table xxx below)

1.4 Organizational Structure for Neonatal Care Unit

The Neonatal Care Unit at the hospital level apart from the supportive areas, it comprises of general neonatal ward for care of sick (not severe) neonates, Kangaroo Mother Care (KMC) for care of Low birth weight babies, High Dependency Unit (HDU)/NICU and Isolation room for infectious cases. From the labour ward, postnatal or paediatric ward or the OPD during admission, the baby is triaged and will be admitted in the respective room depending on his condition. The level of service and space will depend on the level of care. Level one will have only triage and stabilisation corner while level 3 will have all the services available

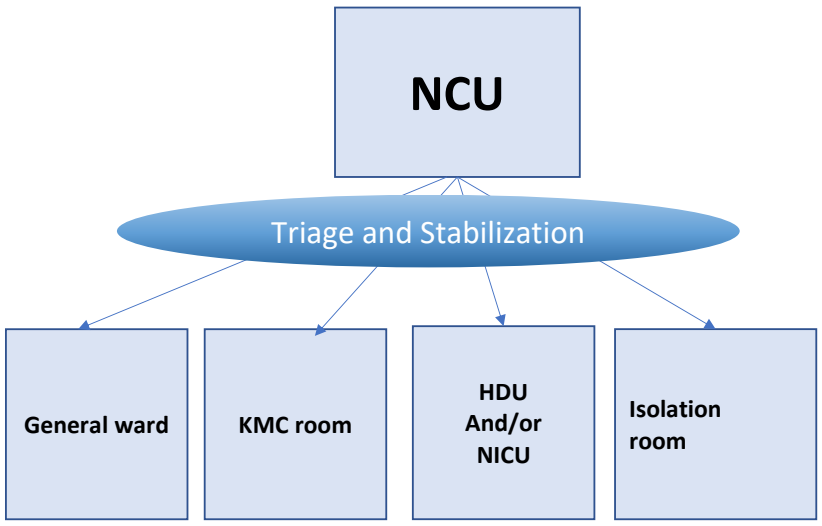


Figure xxx: Organizational structure of NCU services

1.5 Space for supplementary service:

1. **Reception area**
   - Located at the entrance where family members can get information
   - Handwashing facilities before entering the unit
   - Shoe rack for street shoes

   Shoe rack with clean slippers/disposable shoe cover
2. **KMC Follow-up area**
   - Located close to the NCU, but outside to avoid contact with inpatients
   - The space must have a newborn screening room
   - Vaccination room
3. **Newborn screening room**
   - Up to two rooms to allow babies that have been discharged to come for recommended screening services (e.g. ROP, sickle cell disease, Congenital hypothyroidism, hearing assessment, inborn errors etc).
   - Located close to the neonatal care unit
   - Lockers and cabinets for storage of equipment
   - Computer and desk for EMS
4. **Changing room for hospital staff**
   - Changing space for hospital staff
   - Locker/cabinet for staff personal items
   - Washrooms/bathrooms and handwashing areas
5. **Hand washing stations:**
   - There should be a handwashing facility outside each ward.
   - Minimal handwashing space inside the unit with a barrier to prevent splash into a neonate bed, which should be at least 1.5m away from a neonate's bed and clean supply storage. The health care workers and staff should have different hand washing spaces.
   - Should be a hands-free, elbow operated
   - Hand washing SOP should be provided above all sinks
   - Walls adjacent to the sink should be of non-porous and non-absorbent material to prevent the growth of moulds (e.g. tiles)
   - Space for liquid soap and tissue dispenser
   - Space for alcohol hand rub dispenser
   - Space for waste bin

   * The water basin should be solely for washing hands and any feeding utensils for babies and mothers should be cleaned in the designated areas.
6. **Stabilisation corner/Triage area:**
   - Including comfortable seating space for the mother and an escorting family member
   - Stabilisation and resuscitation equipment for the baby
7. **Nurses' station:**
   - Desk for office tasks with computer(s), adequate lighting and power sockets

- Lockable cupboard for files and office supplies

8. **Breastmilk room (lactation unit)**
   - Located in the NCU.
   - Designated spaces for breast milk expression and storage services.
   - Designated space for cleaning feeding utensils for the baby and milk preparation area.
   - For hospital setting lactation unit with facilities for pasteurisation
9. **Counselling room**
   - Allowing complete visual and acoustic privacy for family counselling
10. **Clean area with a cupboard and desk to prepare drugs and IV fluids:**
    - Cupboard for supplies and drugs, sorted and labelled
    - Desk to prepare drugs and IV fluids with easy-to-clean surface
11. **Sluice room:**
    - Design according to specifications and requirements of IPC
    - Location should enable to removal of soiled materials without passing through the newborn care area
12. **Room for nursing mothers (when rooming is not feasible because of space)**
    - Mothers' beds and lockers)
    - Located in close vicinity to NCU
13. **Pantry rooms and washrooms for mothers and caretakers**
    - Located inside the NCU
    - For dining space for mothers and fathers when visiting
    - Design according to specifications and requirements of IPC
14. **Pantry rooms for healthcare workers:**
    - Located within the NCU
    - Staff Office for in charge (both doctors and nurses
    - General doctor's office
    - Conference room
    - On-call ensuite rooms for both junior and senior doctors (male and female)
    - Recreation/tea room
15. **Visitors' area:**
    - Close to the NCU, but outside
    - Comfortable benches
    - Ward attendant desk
    - Hand washing station
16. **Equipment rooms**
    - Located in the NCU from the level of the district hospital
    - Storage of equipment not in use
    - Designed space for minor repair by the biomedical team

1.6 Electrical, Mechanical, Water, Light, Thermal and Acoustic Requirements



- Keep in mind: Safety, easy access and maintenance

1. **Electrical needs:**
   - Power supply:
     - 24-hour uninterrupted stabilized power supply
     - Back-up power supply (generator and/or solar system)
   - Protective devices:
     - Voltage stabilizer for equipment (or central voltage stabilized electrical sockets)
     - UPS for essential equipment (e.g. oxygen concentrator)
   - Electrical sockets:
     - In NICU and HDU 8 sockets per bed
     - General ward 4 sockets per bed
     - In KMC and general ward 2 socket per bed
2. **Mechanical needs:**
   - Floor:
     - Easily cleanable, preferably vitrified tiles, avoid joints
   - Walls:
     - Easily cleanable and highly durable
     - Acoustical properties (should reduce noise)
     - Preferably: wall tiles up to a height of at least 150 cm
3. **Water supply:**
     - 24-hour uninterrupted running water supply
     - When feasible water supply to the NICU should be treated filter and safe to drink from the tape.
     - Preferably: separate overhead tank and central geyser machine (heater).
4. **Centralized oxygen and medical air supply:**
     - Oxygen and air piping from the central plant (if not available provide oxygen concentrator or oxygen cylinders)
5. **Lighting**
   - Ambient lighting:
     - Should provide accurate skin-tone recognition
     - Should be free of glare or veiling reflections
     - Bed spaces should not be in direct light (neither electric nor sunlight) to protect the neonates' retina and cornea
   - Procedure lighting:
     - Most radiant warmers have inbuilt sufficient procedure lights
     - Mobile fibre optic lamp can be used additionally but should be used temporarily only and should not be directed into the neonate's eyes
   - Daylight and blinders
     - At least one source of daylight (window) should be visible in each newborn care area

- Blinders should be available to minimise direct sunlight to the baby.
- Newborn beds have to be at least 0.6 m away from a window (to minimize radiant heat loss or heat gain and to avoid glare)
- At night a dim light switch with a possibility of bright light when needed

6. Temperature and ventilation

- Room temperature should be maintained at 25 – 28 °C, room heater can be used in areas with cold weather.
- Ventilation: minimize cross ventilation in the newborn care area (closed windows and doors, central cooling system can be used when feasible especially in NICU and HDU because of the machine used.

7. Acoustic environment

- Should favour uninterrupted sleep without acoustic distraction for the neonate
- Noise-generating activities or gadgets should be reduced as much as possible
- Should favour privacy for staff and caretakers

Equipment for neonatal emergency trolley

Preparing for an emergency is crucial at any level where a newborn can be found. This will allow prompt appropriate care to be offered promptly. When feasible a crush cart must be available with all the items listed below must be packed in a container and can be within reach and used in case of emergency. After the procedure, the trolley/container must be replenished ready for the next emegency. A checklist must be prepared according to the list below

Neonatal Emergency Trolley

To be able to react timely to a neonatal emergency it is vital to have all required equipment, supplies and drugs ready at all times. The emergency tray should be close to the resuscitation area. The following should be arranged

A. Airway equipment

- Appropriate mask for newborn: size 0 and 1 – 5 each for size
- Appropriate size bag and mask for ventilation
- Suction catheter size 6F and 8Fr each 5 pieces
- Sterile penguin to clear the airway

B: Breathing

- Oxygen tube to connect to the source
- Appropriate nasal prongs and (CPAP from district levels)
- Endotracheal tube in areas where mechanical ventilation can be done
- Nasal gastric tube for decompression
- Airway

C: Circulation

- Cannula 24G and 26G – each 10 pieces
- Syringes 2mls, 5mls, 10mls – each 10 pieces
- Needles: 24 G – 10 pieces
- Prickers
- Surgical blade

D: Medication/Drugs

- Adrenaline – 5 vials
- Phenobarbitone – 5 vials
- Vitamin K – 5 vials

E: Equipment and consumables

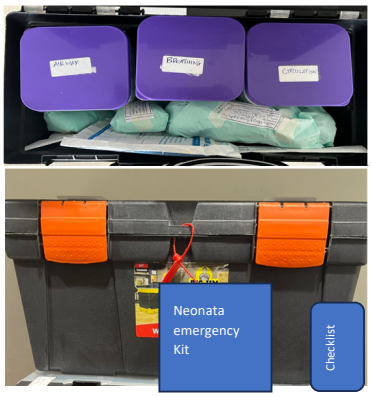
- Glucometer
- Laryngoscope
- Cord clump – 5 pieces
- Sterile gauze and swab
- Box of clean gloves
- Sterile gloves size 7, 7.5 and 8 - 5 pairs
- Plasters

F: Fluids

- Dextrose 10%
- Normal saline
- Water for injection



Crash cart



Neonatal emegency container (inside look)



Emergency tray

General Ward Rules

The NCU is a restricted ward to allow a quiet environment and also reduce the risk of infection, only the following persons are allowed into the unit:

1. The NCU personnel
2. The consulted health personnel
3. Mothers
4. Fathers or next of kin as requested by the mother
5.

Human Resources for NCU

The unit should have the required number of appropriately trained and qualified healthcare personnel. For district hospitals and health centres that do not have paediatricians, the Council health management team must facilitate a regional mentor, preferably a paediatrician, when available to support the facility. Arrangements should be made to conduct mentorship (and teaching ward rounds) at least once every two weeks. Ward rounds should be done daily including on weekends and public holidays. The supporting mentors should be available for on-call consultation in difficult situations up to the dispensary level.

Doctors

- At least 2 doctors for every 10 patients in HDU and NICU
- At least 1 doctor for 15 patients in general and the KMC ward
- A dedicated doctor for each of the follow-up clinics (RCH/ KMC and neonatal follow-up clinic
- On-call team (from the district hospital at least 2 doctors per shift)

Nurses (day and night shift)

- NICU and HDU a maximum of 1 nurse for every 5 patients of CPAP and 1 nurse for every 2 in the NICU
- General ward and KMC: 1 nurse for up to 10 patients.
- Preferably two trained personnel for newborn screening services
- Support staff should be available to clean the ward at least twice per shift or more depending on the need, to clean equipment, and to do other allocated duties depending on the need.

Assistant nurses

- 1 assistant nurse for every 10 patients in NCU.
- They can support with feeding, bed making and support mothers with feeding

Equipment personnel

- Biomedical technician or dedicated nurse assistant who will be responsible for NCU inventory
- Conduct calibrations of devices as directed by the Biomedical engineer
- Prepare and sort items needed for Preventive maintenance plan or major repair

Biomedical team

- Dedicated biomedical team for NCU building, available for troubleshooting on-call at night if needed

Capacity building

Suggested training for medical staff working in an NCU is:

- For a newly established unit, the health care workers can attend clinical attachment to a higher facility or a short course if offered by a zonal facility as needed based on the skills required.
- On-going Supportive supervision, mentorship and coaching can be arranged by the newborn regional mentors
- Regular CME on Neonatal care
- Structured introduction and orientation of new staff in the NCU (according to a written protocol)

CHAPTER 2: History, Examination and Documentation

2.1 History

It is important to take history for all newborns since this information creates awareness about potential health problems that the newborn may be at risk of, duration of any problem in the newborn and chronology of events; this information provides the possible diagnosis for a sick newborn and hence guides targeted management.

In order to avoid missing important information during history taking and care of newborn it is important that structured forms are used during history taking, assessment, care, transfer or discharge.

Present problems if any: problems such as fever, poor feeding, irritability, yellow discoloration of eyes and skin, bleeding, convulsions, abnormal breathing, rash etc, it is important to ascertain the onset, duration and progression.

Review of systems: this is better reviewed in order of relevance to presenting problem, it includes for instance if problem is poor feeding may review other GIT concerns like passing stool, vomiting, abdominal distension. Blue discoloration and tiring out during feeding may suggest cardiac problem while Chocking during feeding may be suggestive of trachea-esophageal fistula.

Antenatal history: This is important as it may allude to the diagnosis or etiology. Gestational age per LNMP and early ultrasound scan, any maternal febrile with fever, rash, vaginal discharge and how it was managed. Maternal antenatal blood screening results including HIV (+Viral load), syphilis, hepatitis B (+viral load), and blood group. If reactive for HIV, syphilis or Hepatitis B whether it was/is being managed. Any maternal illness like diabetes, hypertension, thyroid disease. Any important findings from antenatal ultrasound scans such as oligohydramnios, polyhydramnios among others and of foetal growth and condition. Smoking, alcohol or medicines taken during pregnancy.

Natal history (delivery): Mode of delivery, if caesarean then the indication, if vaginal duration of labor, time of rapture of membranes, liquor amount, colour and smell, any signs of fetal distress. If there was intrapartum fever, maternal or fetal tachycardia. The newborn's condition at delivery and any resuscitation needed. Any medication given to mother including steroids for preterm delivery doses and time, narcotics for pain and time.

Postnatal history (after delivery): APGAR score, Birth weight, length and head circumference, estimated gestational age, any abnormalities detected, if Vitamin K and tetracycline eye ointment were given. Skin to skin done, lactation within first hour, take note of passage of urine and meconium. Any problem in the immediate postnatal period.

Past Obstetric history: mother's age, parity, any pregnancy loss and possible causes and any infant death and cause. Health problems with previous infants, e.g. neonatal jaundice, preterm delivery, congenital abnormalities. History of early onset sepsis in previous infants.

Family social history: History of consanguinity, polygamy and occupation of parents. Family history of congenital abnormalities and familial diseases.

2.2 Newborn examination

Newborn examination should be performed in a warm and well-lit environment in the presence of the parents. It should be done systematically from head to toe. It should preferably be done with the newborn completely undressed (ensure no hypothermia)

Step 1: Perform general exam

This involves a quick assessment to pick any danger signs and obvious abnormalities.

General: Assess quickly colour (pink, pale, cyanosed, jaundice), hydration status, small or large for gestational age,

CNS: Assess quickly level of alertness, fontanelle, tone any dysmorphic features

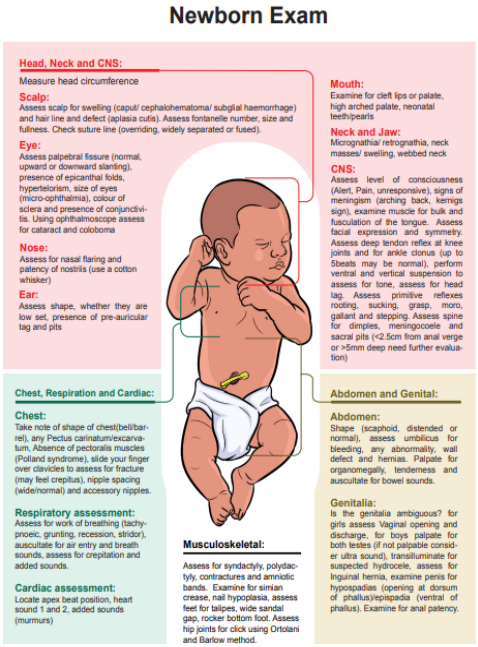
RESP: Assess quickly if there is respiratory distress (grunting, in drawing)

CVS: Assess quickly temperature of hands and feet, colour of lips and tongue

Step 2: Assess vitals

- Temperature: use axillary (normal 36.5-37.5oC)
- Respiratory rate: count for 1 complete minute (normal 30-60b/min)
- Pulse rate: use the brachial pulse (normal 100-160bmin), feel for femoral pulses
- Saturation: on the right hand and right foot (normal >95% and no difference of >3%)

Step 3: Perform head to toe exam



2.3 Documentation

All the necessary documentation can be found on the annex

Newborn Triage Checklist (NTC)

This checklist is to be used on all newborns, it provides for structured assessment as well as stratification of newborn depending on risk level and it also guides disposition. This checklist should be administered at 60-90minutes, 4-8hours, 24 and 48hours after birth. It also has a 6 hourly checklist for newborn who are stable but at risk. (See appendix)

Discharge and postnatal timeline checklist

This checklist is to be used for well newborn not at risk. It shows the time lines and what must be accomplished at each timeline. (See appendix)

Admission form

This form is used for newborn needing admission to neonatal unit. It captures relevant history, structured assessment of the newborn, the possible diagnosis and immediate care plan. (See Appendix)

Observation and treatment chart

This form is used in the neonatal unit, it provides continuous vitals observations, care, investigations ordered and medications. Observation of the trend of vitals may guide on progress of the neonate. (See Appendix)

Discharge form

This for is to be used at the time a newborn is discharged from hospital. It must capture all relevant information including risk, diagnosis, investigation, management and discharge care plan. (See Appendix)

Referral form

This form is used for transfer of newborn from one facility to another, it is intended to capture pre-referral management, the state of the newborn at dispatch, during transit and on arrival. It also captures the names of health workers coordinating the transfer.

See Appendix

Score forms

Some of the scores used in newborn care include Ballard score (refer to gestational age assessment), Thompson score (refer to HIE), Silver Andersen score (SAS) (refer to RDS), Kramers rule (refer to jaundice), Neonatal Infant pain score (NIPS), KMC score (refer to Kangaroo care), these guide the progress of newborn. Every newborn who needs one MUST have a copy

CHAPTER 3: INFECTION PREVENTION AND CONTROL (IPC)

In all health care facilities and whenever care is given, Infection Prevention and Control (IPC) must be followed to protect the mother, newborn, and the health workers from infections with bacteria, viruses and other pathogens, including HIV, hepatitis B etc. Providing protection needs planning and preparation before care is given.

Purposes of Practicing Standard Precautions:

- Prevent and reduce the risk of transmitting microorganisms from known or unknown sources of infection (e.g., patients, contaminated objects, used needles and syringes etc.) within the health care environment
- Protect patients/clients from health care related infections
- Protect health care workers from occupational infections
- Protect communities from acquiring infectious diseases
- Prevent environmental pollution

3.1 Chain of infection

- The chain of infection is how infection can be transmitted from one person to another.
- Transmission of infection occurs when the agent (e.g. bacteria, virus) leaves its reservoir or host through a portal of exit, is conveyed by some mode of transmission, and enters through an appropriate portal of entry to infect a susceptible host.
- Each link in the chain of infection must be connected for infection to be transmitted.
- Breaking any link of the chain (e.g. by hand washing, sterilisation) can stop the transmission of infection.

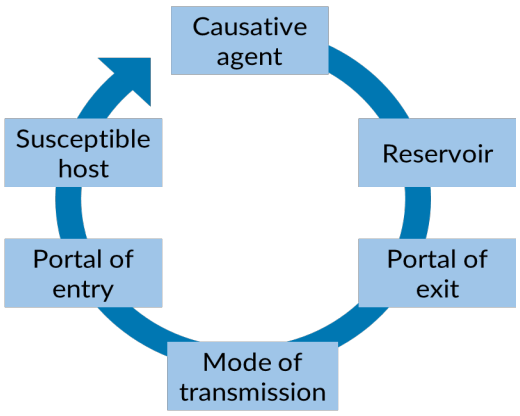


Figure xxx: Chain of Infection

3.2 Standard IPC precautions:

Consider every person (patients/clients and staff) as potentially infectious and susceptible to infection. Consider surfaces as potentially contaminated with pathogens.

Environment

- Wet mopping of the patient areas twice daily (refer to IPC guideline for what solution to use).
- Wipe non-patient surfaces after each use with alcohol (e.g. tables, trolleys).
- Wipe patient surfaces (e.g. beds, infant warmers) with Chlorine 0.5 % after each use, leave it on for 10 minutes, then wipe with soap water.
- Wipe patient surfaces (e.g. beds, infant warmers) with detergent daily while in use, weekly while not in use.
- After one week of continuous use of a patient surface (e.g. beds, infant warmers), shift the patient to another bed and do deep cleaning with Chlorine 0.5 %, leave it on for 10 minutes, then wipe with soap water. If using an incubator follow the same instructions, do deep cleaning including the humidifier water tank according to manufacturer's instructions.
- Promptly and carefully clean up spills of blood and other bodily fluids with Chlorine 1 %, leave it on for 10 minutes, then wipe with soap water.

Waste management

- Safely dispose of waste materials (separate waste according to IPC guideline)
- Position waste bins close to workstations and away from patient beds
- Appropriately handle sharps (e.g. do not recap needles, use safety boxes, place safety boxes hanging at all required workstations)
- Waste bins and safety boxes should be emptied when ¾ full
- Treat hospital linen according to IPC guideline

Equipment

- Process instruments (e.g. ventilation bag, penguin sucker) by cleaning, sterilizing, or high-level disinfection (HLD) following recommended procedures
- Wipe equipment (e.g. thermometer, stethoscope, pulse oximeter probe) before and after each use with 70 % alcohol
- Change oxygen humidifier bottles/CPAP bottles daily if used for the same patient, and change in between patients
- Change CPAP/ventilator tubing after 7 days and in between patients
- Wipe machines with 70% alcohol (avoid chlorine or any strong detergents or chemical solutions). Clean the equipment before and between patients. If the equipment is used by the same patient over the course of a week, wipe it down with a damp cloth daily to remove dust.

Personnel and mothers

- Use appropriate hand hygiene techniques, including routine hand washing, antiseptic hand rubs, and surgical scrubbing (see next paragraph)
- Wear professional attire with short sleeves above the elbow, don't wear anything below the elbow
- Wearing of PPE is not routine, but should be used according to situation, e.g. gloves, masks, aprons, gowns, boots, protective eyewear, and caps
- Introduce cough etiquette and wearing of face masks to staff, caregivers, and

visitors with respiratory illness

- Changing of shoes when entering the NCU can be practised to avoid dirt, but has no benefit in preventing infections

Gowns for mothers have no benefit in preventing infections

Patient and procedures

- Triage patients and isolate those with contagious diseases (e.g. admission in isolation room; wearing long-sleeved gowns and/or other PPE when caring for patients with contagious diseases/multi-resistant pathogens)
- Keep at least 1 meter distance between patient beds
- Avoid placing patient beds close to sinks (at least 1 m distance) and waste disposal area
- Change bed linen daily and if visibly soiled
- Remove lines (e.g. IV, NGT, urinary catheter) as soon as possible and if there are signs of infection
- Scrub the hub: Before any injection, wipe the hub or the injection port of the cannula. Before re-connecting an IV giving set to the cannula, wipe both the hub and the patient's end with a 70 % alcohol swab. Scrub vigorously in a twisting motion for at least 15 seconds with the alcohol-soaked swab, let it air dry for 15 seconds, and then use it.
- Scrub the rubber stoppers of vials similarly before inserting the syringe.



- Write date and time of cannula insertion on the plaster
- Change lines/tubes after the following times:
  - Burette (IV giving set): 72 hours
  - NGT: 7 days
  - Urinary catheter: remove as soon as possible if no longer needed
- Do aseptic skin preparation per procedure (e.g. alcohol swab for IV cannulation)

3.3 Hand hygiene

Hand hygiene is the most important and effective procedure to prevent and control the spread of infections. It is the responsibility of all HCWs to do this at the right moment during patient care.

Practical considerations on hand hygiene

Upon entering the NCU the following must be observed:

- Do not wear artificial fingernails, extenders or nail polish, keep natural nails short
- Do not wear finger rings, watches, bangles
- Wear short sleeved clothes or fold sleeves above the elbows
- Wash hands with soap and water up to the elbows and dry

During patient care:

Use of a 70% to 90% alcohol-based hand rub before and after patient contacts, before a procedure, after a procedure and after touching patient's surroundings (5 moments of hand hygiene).

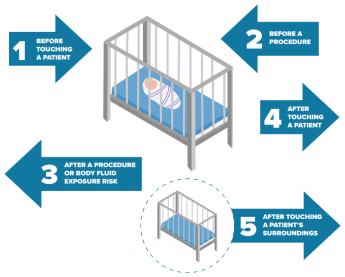
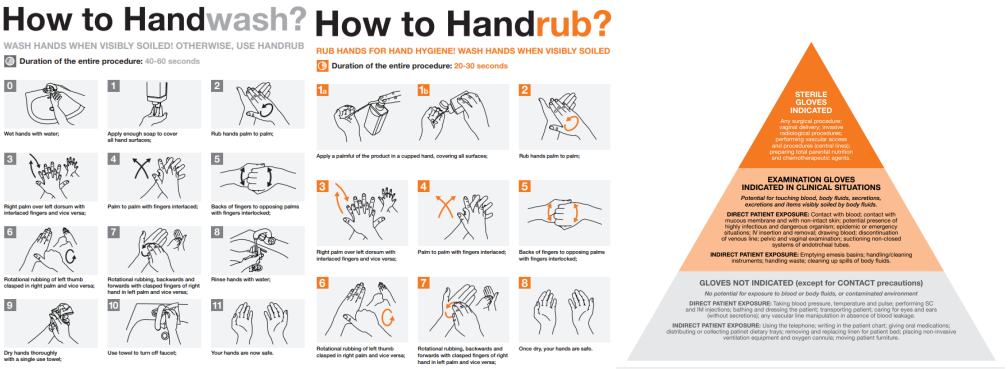


Figure xxx: 5 moments of hand hygiene.

- Hand washing with liquid soap and running water must be performed after touching (with or without gloves) body fluids, and when hands are visibly soiled
- Hand washing should also be done if the hands feel sticky after frequent use of hand sanitizer gels.
- Use appropriate gloves depending on the procedure (for donning and doffing of gloves refer to IPC guidelines)

For proper technique of handwash and handrub see figure XXX and figure XXX below and refer to IPC guideline.



3.4 Processing of equipment

Items which are used in non-intact skin or mucous membranes or which are entering a sterile body cavity need to be sterilized. Items in contact with intact mucous membranes or bodily fluids must be decontaminated by high level disinfection.

High-Level Disinfection (HLD)
is the process that eliminates all microorganisms (including bacteria, viruses, fungi, and parasites), but does not reliably kill all bacterial endospores, which cause diseases, such as tetanus and gas gangrene.
HLD can be done by boiling, steaming or chemicals. Most equipment used in NCU are plastic materials which cannot be sterilised and therefore need chemical HLD. The process is described here:

1. Bucket: Soapy water
   Open and dismantle instruments that have multiple connections (e.g., CPAP tubes, penguin sucker)
   Clean all instruments thoroughly, brush if necessary
2. Bucket: Clean water
   Rinse the instruments and dry them (water from wet items will dilute the Chlorine solution, thereby reducing its effectiveness)
3. Bucket: Chlorine 0.5 % for 10 min
   Set timer for 10 minutes and submerge all instruments, ensure all surfaces are in contact with the solution.
4. Bucket: Soapy water
   Rinse to wash off the chlorine solution
5. Bucket: Clean water
   Rinse to wash off the soap
6. Bucket: Chlorine 0.5 % for 20 min
   Set a timer for 20 minutes and submerge all instruments, ensure all surfaces are in contact with the solution.
   Take the instruments out of this bucket by using sterile forceps or sterile gloves.
7. Bucket: Sterile water
   Rinse to wash off the chlorine solution.

Take the instruments out of this bucket by using sterile forceps or sterile gloves and place all items on a sterile towel for drying. Cover with another sterile towel.

All high-level disinfected instruments **must** be dried before storage in a sterile and dry container. Use within one week.

The solutions must contact all surfaces to achieve HLD. Completely submerge all items in the solution. Place any bowls and containers upright, not upside down, and fill with the solution. For tubes ensure the inside is also cleaned by flushing with each solution.

Ensure timely removal of instruments from Chlorine solutions to prevent desiccation and damage.



Figure xxx: High Level disinfection

CHAPTER 4: ESSENTIAL NEWBORN CARE (ENC)

Essential Newborn Care (ENC) is care that every newborn baby needs regardless of where and when they are born. Essential newborn care involves immediate care at the time of birth, and essential care during the entire newborn period. It is needed both in the health facility and at home.

This chapter aims to ensure health workers have the knowledge to provide appropriate care at the most vulnerable period in a newborn's life. The chapter focuses on infection prevention and control (IPC), preparation for birth, overview of ENC in the first 24 hours with a focus on immediate care after birth (including neonatal resuscitation) and mentions breastfeeding and guidance for home care of the newborn.



Essential newborn care should be practiced at all levels of health care by all health care providers

4.1 Delivery and immediate care for the newborn

Preparation for birth

It is very important for health care workers to prepare and be ready for every delivery. Birth preparation improves quality of care offered to the mother and her soon to be born newborn. It also maximizes ability to intervene whenever an emergency arises, be it to the mother or her newborn.

Identify potential risks for the newborn

It is important for health care workers to anticipate problems before delivery. Furthermore, all high-risk pregnancies should be identified immediately during admission and the required measures must be taken.

Important questions which the neonatal team needs to ask the obstetric team before delivery:

1. Gestational age
2. Number of babies in current pregnancy
3. Maternal illness and medications/drugs in current pregnancy (e.g. DM, hypertension, anaemia, antenatal infections)
4. Outcome of previous pregnancies
5. Colour of liquor if membranes have ruptured
6. Risk for sepsis to the newborn (PROM > 18 hours, intrapartum maternal fever > 38.0 ˚C, offensive liquor, maternal/fetal tachycardia)

Preparation of delivery area

Ensure the delivery area (labour ward and theatre) has/is

- Adequate space and lighting
- Clean and dry
- Warm (25 – 28 °C) and free from draught (close the windows and switch of fans, especially at the time of delivery)

- Resuscitation corner with heat and light source, with a resuscitation table (flat and firm surface)
- The resuscitation corner must be next to the delivery bed/within the theatre room

Preparation of equipment for the newborn



1. Airway
    - Suction device (e.g. Penguin)
2. Breathing
    - Ventilation bag (newborn size) with mask size 0 and 1
3. Circulation
    - Paediatric stethoscope
    - Pulse oximeter
    - Cannula 24 and 26 G
    - Syringes 2, 5 and 10 cc
4. Drugs
    - Oxygen source
    - Oxygen nasal prongs
    - Oxygen tubing to connect to ventilation bag
    - Adrenaline
    - Normal saline
    - Dextrose 10 %
5. Extras
    - Gloves
    - Warm towels
    - Cap
    - Cord clamp
    - Sterile blade/scissors
    - Timer/wall clock
    - NGT (5, 6 and 8 Fr)

Make sure all equipment is prepared for each delivery and checked for functionality

Preparation of delivering team

- Ensure one additional trained staff is on stand-by for the newborn
- Lay a plan for an additional helper

Clean delivery

It is important to establish hygiene to minimize the risk of transmitting infections (e.g. bacteria, hepatitis B and C and HIV) from the mother to the newborn or health care providers and vice versa. Strict aseptic techniques should be followed as outlined below:

- Practise the 3 cleans:
    - Clean surface (as per IPC guideline)
    - Clean hands.

- Clean cord cutting
- Health care providers should use personal protective equipment:
  - Goggles
  - Face mask
  - Gloves
  - Apron
  - Boots

4.2 Overview of Essential Newborn Care in the first 24 hours

Immediately after birth, the newborn has to adapt to a significant change of environment compared to the inside of the womb. The circulation must switch from fetal to adult circulation. This is induced by ventilating the lungs, leading to pressure changes and dilation of the pulmonary vessels.

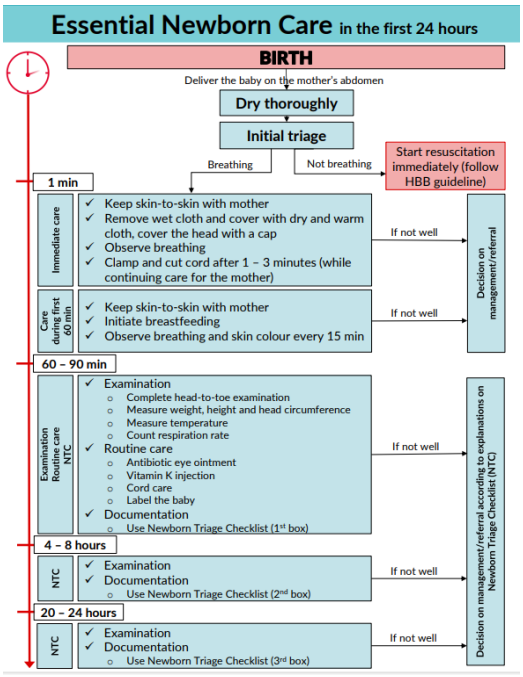


Figure XXX essential care for newborn during the first 24 hours

Steps to follow during delivery

After delivery place the newborn on the mother's abdomen.

Take note of the time and shout it out.

Dry thoroughly.

Initial Triage

Immediately at delivery the newborn is assessed for breathing, activity and colour to decide on the need for resuscitation. Newborns who are not well will need urgent attention, refer to the section on newborn resuscitation below.

The well newborn

For newborns who are well follow the following steps:

1. **Immediate care**

- Thermal care:
    i. Skin-to-skin with mother
    ii. Remove wet cloth
    iii. Cover with dry and warm cloth
    iv. Cover the head with a cap
- Observe breathing:
    i. Observe for signs of respiratory distress
    ii. Make sure airway is open
- Delayed cord clamping (to allow blood flow from the placenta to the baby to avoid anaemia):
    Wait for 1-3 minutes to clamp and cut the cord

Steps for cutting the cord:

- Place two clamps or ties around the cord.
- Place the first clamp about 2 fingerbreadths from the newborn's abdomen.
- Place another clamp about 5 fingerbreadths from the abdomen.
- Cut between the clamps or ties with a sterile scissors or blade.
- Look for any bleeding or oozing of blood.
- If bleeding occurs, place a second clamp or tie between the first one and the newborn's skin.
- Leave the cut end of the cord open to the air to dry and do not apply anything on the stump.
- Everything that touches the umbilical cord should be clean to avoid infection.
- Wear sterile gloves when clamping or tying and cutting the cord.

2. **Care during the first 60 minutes (Golden Hour)**

- Continued thermal care:
    i. Maintain skin-to-skin with mother to prevent hypothermia, promote bonding and early lactation
    ii. Don't bathe the newborn within the first 24 hours
- Initiate breastfeeding:
    i. Let the newborn crawl to the mother's breast while in skin-to-skin position
    ii. Observe and facilitate the newborn's feeding cues as needed

iii. Make sure the newborn starts feeding within the first hour

Signs of readiness to breastfeed are:
• Newborn looking around/moving • Mouth open • Searching

- Observe breathing and colour every 15 min

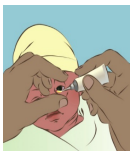
3. Care during 60 – 90 minutes (examination, routine care and documentation)

- Examination:
  i. Conduct thorough head-to-toe examination
  ii. Take anthropometric measurements (weight, length and head circumference)

How to weight the newborn
• Put a clean towel on the scale and tare the scale. • Remove the towel again and wrap the naked newborn in it. Place the newborn with the towel on the scale, keep the newborn naked as briefly as possible. • Measure the length by using a length board. • Measure the head circumference by wrapping the tape snugly around the widest possible circumference - from the most prominent part of the forehead around to the prominent part of the occiput. • Take note of all measurements

  iii. Measure temperature (axillary)
  iv. Count respiration rate (count one full minute)
- Routine care:

i. Eye care



- Early eye care can prevent serious infections and blindness.
- All newborns should receive eye ointment for prevention of eye infection as follows:
  - Pull down the lower lid of the eye
  - Place a portion (usually about 1 cm long) of 1 % Tetracycline eye ointment inside the length of the lower lid beginning with the side closest to the nose and extending to the opposite side of the lid
  - Repeat for the other eye,
  - Discard after use,

  DO NOT SHARE WITH ANOTHER BABY

ii. Vitamin K injection

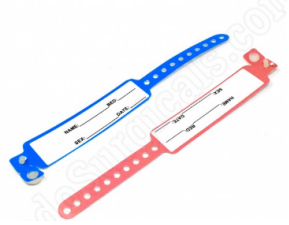
- Newborns are normally deficient of vitamin K1, which can cause severe bleeding during the first week of life.
- **Vitamin K injection should be administered to all newborn without exception**.
    - Give Vitamin K by intramuscular (IM) injection
        - 1 mg for newborns > 1500 g
        - 0.5 mg for babies < 1500 g
    - Inject on the front, outside of mid-thigh

iii. Keep cord dry and clean to prevent infection

- Leave the cord stump uncovered
- Nothing should be placed on the cord
- If the stump is soiled, wash it with clean and safe water and dry it with a clean cloth
- If bleeding, put an extra tie tightly around the cord below the clamp
- Keep the cord area dry
- Give sponge baths only before the cord drops off
- Allow the cord to heal naturally

iv. Label the baby

- Place a name tag either on the arm or a foot of the baby



v. Documentation

Use Newborn Triage Checklist see annex

4. Care at 4 – 8 hours

- The aim is to ensure the baby continues to remain stable, any danger signs are identified, the newborn is feeding, the newborn has received routine medications, and the mother has been educated. All procedures are done in presence of the mother.

- Examination: Conduct head-to-toe examination

5. **Care at 20 – 24 hours**

The aim is to ensure the baby continues to remain stable, any danger signs are identified, the newborn is feeding, the newborn has received routine medications, and the mother has been educated. All procedures are done in presence of the mother. If all examinations have been normal, the newborn can be discharged safely.

- Examination:
    i. Conduct head-to-toe examination
- Documentation:
    i. Use Newborn Triage Checklist (3rd box)
- Newborn vaccinations (according IVD (immunization and vaccine development programme) and PMTCT guideline):
    i. BCG: all stable newborns on day 1
    ii. OPV 0: all stable newborns on day 1
    iii. Hepatitis B: all newborns as soon as possible after birth, preferably within 24 hours; if the mother is HBsAg positive: see chapter on infections
    iv. For critically ill newborns delay the vaccination until stable (BCG only until 2 months of age; OPV 0 only until 2 weeks of age; Hep B only until 72 hours of age)

Always inform the mother about the condition of her baby and about any examination or procedure you undertake

Normal findings of a newborn

- Passes urine within the first 24 hours.
- Passes meconium within the first 24 hours.
- Feeds regularly.

In a previously well newborn who subsequently changes resuscitate as required and plan further care.

The unwell newborn

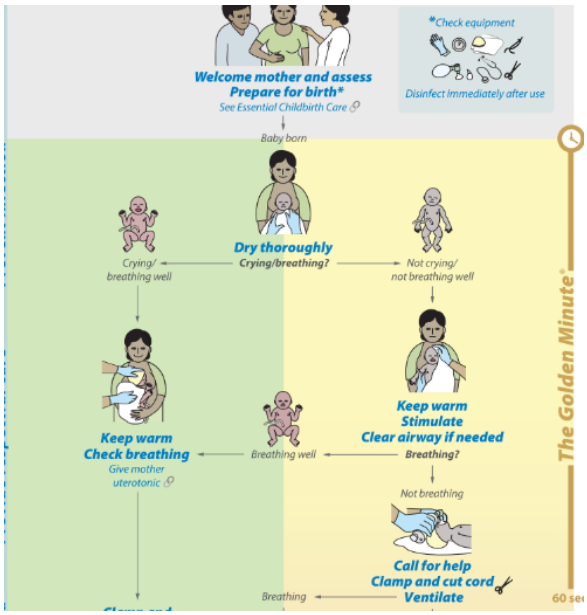
Every baby with a concern during the initial triage needs immediate attention. For a baby who is not breathing or not breathing well refer to the resuscitation flow diagram.

4.3 Newborn resuscitation

The majority of newborns cry and breathe spontaneously immediately after birth. Some babies will need stimulation to start breathing, while others will need positive pressure ventilation with bag and mask. A minority will need advanced life support at birth.

The first minute (Golden Minute®) is the essential window of opportunity to save the life of the newborn and oxygenation should be established within that time, either via spontaneous breathing or via positive pressure ventilation. Initial triage after drying at

birth is the best way to know if a newborn needs help to breathe. The flow diagram demonstrates the initial steps to be taken to resuscitate a newborn.



- It is very important to have emergency equipment ready for use at all times. Searching for equipment at the time of need will make you miss the Golden Minute.
- Always inform the mother about the condition of her baby and about any examination or procedure you undertake

Steps of resuscitation

Resuscitation always follows the **ABC** principle, which means **A**=Airway, **B**=Breathing, and **C**=Circulation.

After drying the newborn thoroughly and triaging for newborns who are not breathing, follow the following steps:

- Keep warm:
  - Skin-to-skin with the mother
  - Remove wet cloth and cover with warm dry cloth
- Stimulate the baby
  - Stimulate by rubbing the back 2-3 times, gently but firmly
  - DO NOT slap or shake the newborn and do not hold the newborn upside down
- Clear airway if needed
  - Slightly extend the neck to keep the airway open.

Note: If the neck is flexed or overextended, air may not enter freely.

- If there are secretions remove secretions
  - By using a cloth for wiping if there are minimal secretions
  - By using a penguin sucker if secretions are thick and larger amounts, and for suctioning the nose
- If there are no secretions avoid unnecessary suctioning
- How to suction the airway:

  - Do brief suctioning only (do not suction with the aim of clearing all secretions but to open the airway)
  - Suck the mouth first, then the nose (to avoid aspiration of large amount of secretions in the mouth)

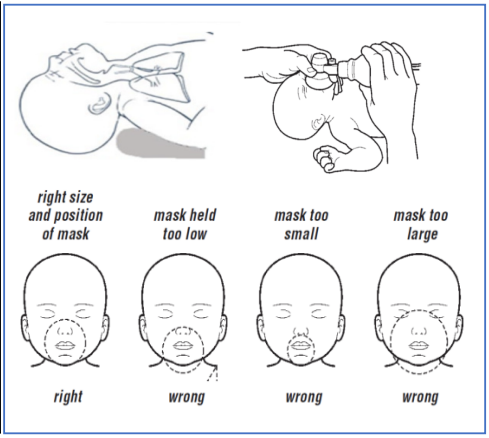
  NB: Suctioning too long, too vigorously, too deeply, or too often can cause injury, slow down heart rate and prevent breathing

➔ If still not breathing or gasping:

- Shout for help
  - **"MSAADA, RESUSCITATION!"**
  - The urgency of the situation should be known by the way of shouting (e.g. tone of voice)
  - If possible, the name of the required person should be mentioned
- Clamp and cut the cord and move the newborn to the resuscitation area
  - Change gloves before cutting the cord
  - Follow procedure of cord cutting as explained above
  - Inform the mother of the newborn's situation
- Start positive pressure ventilation within the Golden Minute (= within 60 seconds after birth)

Perform ventilation

- Stand by the newborn's head
- Choose the correct mask size
- Position the mask over mouth and nose of the newborn
- Use the C-E-grip to hold the mask and to create a good seal
- Using the same grip, perform a slight head tilt by extending the neck and do a jaw thrust
- Give 40-60 ventilation breaths per minute, give just enough volume to see the chest rising
- Continuously evaluate newborn during ventilation: Chest movement? Breathing?



-

NB: Cutting the cord has to be done quickly and should not delay ventilation.

➔ If still not breathing and no/inadequate chest movement during positive pressure ventilation: Improve ventilation by using MR SOPA

How to improve ventilation: MR SOPA
M = Mask size and seal
R = Reposition the head
S = Suction if there are secretions
O = Open the mouth
P = Increase ventilation pressure
A = Consider an alternative airway (ETT, larynx mask) when feasible

➔ If still not breathing:

- Check heart rate
  (NB: remember all the events so that you can assign Apgar score later)
  - Heart rate is checked by using stethoscope or by feeling for cord pulsations.
  - This is done by the 2nd person.
  - Report the heart rate to the team.
  - If heart rate is ≥ 100 /min and newborn is breathing: Stop ventilation and monitor the newborn with the mother.
  - If heart rate is ≥ 100 /min and newborn is not breathing: Continue ventilation and monitor heart rate every minute.
  - If heart rate is < 100 /min: Refer to section on advanced life support.
  - If heart rate is 60 – 100 /min: Check for adequacy of chest rise with ventilation, improve ventilation as needed, observe colour and heart rate.

The most sensitive indicator of a successful response to resuscitation is an increase in heart rate

Advanced life support

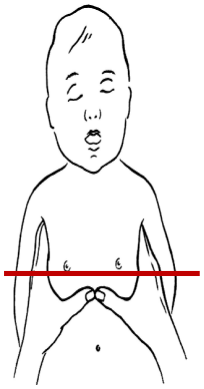
This is applicable in a setting where there is staff with enough knowledge, skills and experience to provide advanced life support to newborns. At least three people are required once drugs are needed.

This entails chest compressions, giving oxygen, giving medications to stimulate the heart and managing any other cause of poor response to resuscitation.

1. Chest compressions (Compression of the sternum to exert pressure on the heart to forcefully circulate the blood)
   a. Indication: Heart rate < 60 /min despite effective ventilation
   b. Procedure

How to perform effective chest compression:

- ✓ Encircle the chest with both hands, so that the fingers lie behind the baby's back and the thumbs are opposed on the sternum
- ✓ The thumbs are placed on (or just below) the inter-nipple line
- ✓ Compress the chest briskly, by one third of its depth
- ✓ Allow a complete recoil of the chest after each compression
- ✓ Minimize interruptions
- ✓ The ratio is 3:1, meaning 3 chest compressions to 1 breath
- ✓ The rate is 90 compressions + 30 breaths per minute



c. When starting chest compressions connect oxygen 10 l/min to the ventilation bag
d. Ensure a reservoir is connected to the ventilation bag
e. Connect a pulse oximeter on the right hand (= preductal); SpO_2 targets depend on the postnatal age of the newborn as SpO_2 gradually increases.

Targeted Preductal SpO_2 After Birth	
1 min	60%-65%
2 min	65%-70%
3 min	70%-75%
4 min	75%-80%
5 min	80%-85%
10 min	85%-95%

f. Provide chest compression and effective ventilation for 1 minute, then re-assess the heart rate
g. Continue with chest compressions and ventilation until heart rate is > 60 /min
h. If the heart rate is > 60 /min, continue with ventilation only, until onset of regular spontaneous breathing

2. Drugs
   a. If the heart rate is < 60 /min, give adrenaline:
   b. This is done under continuous ventilation and chest compressions
   c. Re-check heart rate after every 3 – 5 minutes
   d. Repeat adrenaline bolus if heart rate is < 60 /min

e. If heart rate is ≥ 60 /min, stop chest compressions, continue with ventilation only until onset of regular spontaneous breathing

Dose: (for dilution refer to the chapter on drugs)
- Adrenaline: range 0.01 – 0.03 mg/kg IV or via an emergency umbilical vein, see JOB AID - Start with 0.02 mg/kg - Inject rapidly - Flush with 3 ml of normal saline
An alternative route is intratracheal with 0.1 mg/kg with a range of 0.05 – 0.1 mg/kg

3. Identify the cause for poor response

   For any newborn who needs advanced resuscitation further review is needed to identify the cause for poor response. This includes e.g. hypothermia, hypoglycaemia, hypoxia and hypovolaemia.

   a. Check temperature and correct if hypothermic
   b. Check blood sugar and correct as needed (DO NOT give Dextrose 10 % blindly)
   c. Make sure oxygen flow to the ventilation bag is at 10 l/min
   d. If there was blood loss (e.g. APH, cord bleeding), consider hypovolaemia. Give Normal saline bolus 10 ml/kg over 5 – 10 minutes while preparing for urgent blood transfusion. A maximum of 2 boluses can be given if there is a response to the first bolus and symptoms of shock persist.

Ending resuscitation



- Inform the parents of ongoing resuscitation and call a senior Dr if not around
- If the newborn has no heart rate and no breathing despite effective resuscitation, discontinue after 10 minutes.
- If the newborn has persistent bradycardia (< 60 /min) despite effective resuscitation, discontinue after 20 minutes.
- If the newborn under ventilation has a normal heart rate (> 100 /min) but no spontaneous breathing, continue ventilation.
    - Consider intubation and mechanical ventilation in level III with the availability of mechanical ventilation. For further management refer to the chapter on HIE.
    - If intubation is not possible, continue bag and mask ventilation at a slower rate (the reason for apnoea could be low CO_2 or acidosis) and maintain SpO_2 94 – 98 %.
    - Inform a senior doctor (if not around) about the situation to decide on the care plan. Neurological assessment by a doctor is mandatory to decide on the viability.
    - Inform the family about viability and discontinue if there is no possibility of tertiary care within 5 minutes) and offer emotional support. Allow the family to be with their baby if they wish to do so.
    - This decision to discontinue resuscitation will always be made by a senior doctor on call.

After successful resuscitation

- A newborn who responded to resuscitation needs admission to NCU
- Give management according to their problems.
- Do HIE scoring and refer to chapter on HIE
- Continue monitoring vital signs and correct as required.
- Document all findings and management provided
- Clean used equipment immediately and make sure it is ready for the next patient
- Refill used supplies and drugs in the emergency box
- Do a debriefing with the involved health care workers.

Always inform the mother about the condition of her baby and about any examination or procedure you undertake

4.4 Assessment of the newborn

4.4.1 Apgar score

The Apgar is used to assess the newborn's adaptation to the extrauterine life. It is not used to decide on the need for resuscitation, but it can be used to monitor response to resuscitation for newborns who need resuscitation. The newborn is scored at 1 minute, 5 minutes and 10 minutes. It is important to take note of the newborns condition at these time points to be able to score the newborn retrospectively.

Table XXX: Apgar Score (for Kiswahili version see Annex xxx)

	2 points	**1 point**	**0 points**
Appearance (colour)	Completely pink body and extremities	Body pink, extremities blue	Pale or blue
Pulse (heart rate)	> 100 bpm	< 100 bpm	No heartbeat
Grimace (reflex to stimulation)	Crying, coughing or sneezing	Grimace or puckering of face	No response
Activity (muscle tone)	Active movements, waving arms and legs, flexion	Some movements, some flexion	Limp arms and legs, no flexion, no movement
Respiration (breathing)	Regular breathing, strong cry	Slow/irregular breathing or chest indrawing or grunting	No breathing

4.4.2 Danger signs in the first 24 hours of life

Clinical signs and symptoms in the newborn are very unspecific and a high index of suspicion is needed to be able to identify a sick newborn. Danger signs might be first

indicators for sickness in the newborn and have to lead to lead to prompt evaluation and care.

- Not feeding
- Vomiting everything
- Fever 37.5 °C / hypothermia < 36 °C
- Jaundice before 24 hours of life or jaundice involving palms and soles or any jaundice in preterm
- Difficulty in breathing (e.g. chest indrawing, grunting), respiratory rate > 60 /min, < 30/min
- Convulsions
- Reduced or no movements (lethargy)
- Irritability/excessive crying
- Bleeding
- Cvanosis

These danger signs can be found in the newborn triage checklist.

Newborn Triage Checklist

Newborn Triage Checklist (NTC) is a tool to triage and classify every newborn into these three categories on the first day of life, which is explained below.

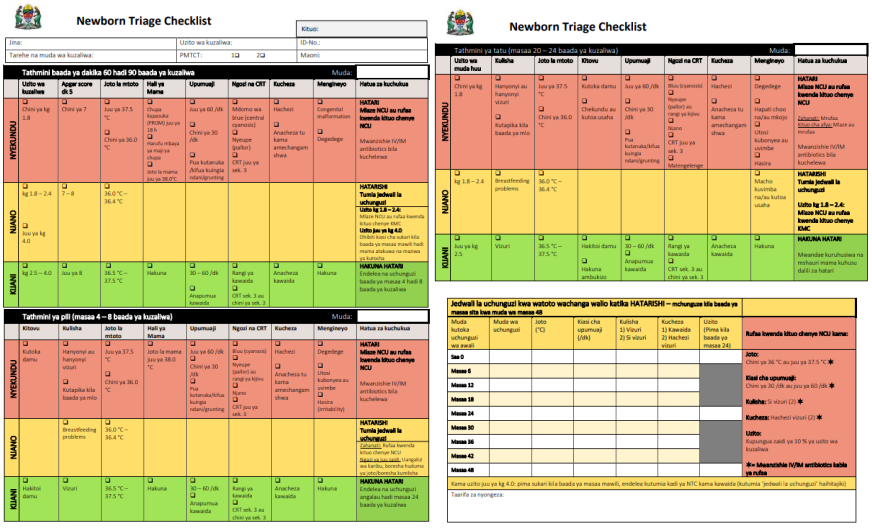


Figure xxx: Newborn Triage Checklist

- Assess the baby using the NTC at 60 – 90 min, 4 – 8 hours and 20 – 24 hours after birth.
- Fill the NTC as per your assessment.
- Categorize the newborn into one of the three risk groups (green, yellow, red).
- Use the column on action/hatua ya kuchukua to decide on the management

Categories of NTC and actions to be taken:

- **All ticks in the green area: No risk**
    - Continue routine care
- **Any tick in the yellow area: At risk**
    - Manage as per action column
- **Any tick in the red area: High risk**
    - Newborns categorised as high risk need admission at NCU
    - Manage as per action column

  Irrespective of the ticks in the different colour areas, consider the highest risk colour as the one to guide the management.

Care for newborns delivered outside the health facility

Health facility delivery is strongly recommended. If the newborn has been born before arrival to the health facility the following should be done on reaching the facility:

- Maintain hygiene.
- Do quick assessment for danger signs and address any problem.
- Take vital signs
- Properly clamp the cord.
- Clean the cord with normal saline, let it dry
- Don't apply anything on the cord.
- Take anthropometric measurements.
- Give Vitamin K and tetracycline eye ointment.
- Do head-to-toe examination and document in NTC and follow the action points.
- Always keep the newborn warm, if possible by skin-to-skin with the mother.
- Initiate/support breastfeeding as soon as possible.
- Take care of the mother, e.g. complete placenta delivery and advise on hygiene
- Check the mother's antenatal card for completeness of prophylactic measures
- Take thorough history to ascertain circumstances of delivery and risks for infection
- For newborns who do not need transfer to NCU: Assess and take vital signs every 6 hours for at least 24 hours in postnatal ward. Meanwhile follow the instructions on essential newborn care for the well newborn.
- DO NOT routinely give antibiotics unless there is a risk or signs of infection

4.5 Breastfeeding

Getting breastfeeding right and established effectively before a mother leaves the facility will help her succeed in maintaining exclusive breastfeeding for the first 6 months. Health

professionals play a very important role in helping mothers establish good breastfeeding practices from the time of birth.

- Start breastfeeding within the first hour of birth
- All infants should continue exclusive breastfeeding for 6 months, then start complementary feeds
- Continue breastfeeding at least until 2 years of age
- For infants of mothers living with HIV: refer to PMTCT guideline

Positioning

The infant must be:

- well supported
- Close to mother's body
- Lying on the side (abdomen to abdomen)
- Head and body in a straight line
- Face opposite the nipple
- Neck not flexed



***Figure xxx**:*
Breastfeeding –positioning

However, there is not only one correct position for breastfeeding, we should not be rigid about positioning.

Attachment

- Good attachment is important for efficient suckling and swallowing.
- The newborn will be able to suck longer without getting exhausted.
- Good attachment also prevents cracked nipples.

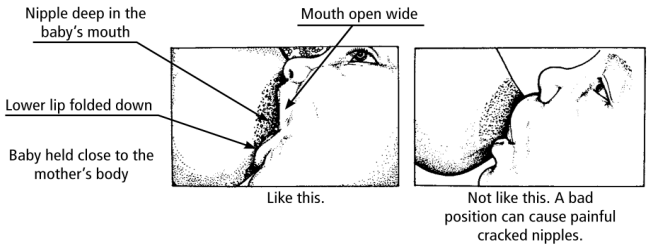


Figure 14: Breastfeeding – attachment

4.5.1 Breastfeeding assessment (LATCH score)

The LATCH score is a structured assessment of breastfeeding. Systematic use of LATCH can help identify mothers and babies who need additional support and is correlated positively with exclusive breastfeeding rates. The use of a structured breastfeeding assessment is recommended at least twice before the newborn's discharge from postnatal ward. Any concerns identified by LATCH should be addressed prior to discharge, including the development of a plan for follow-up.

	0	1	2
L Latch	Too sleepy or reluctant No latch achieved	Repeated attempts Hold nipple in mouth Stimulate suck	Grasps breast Tongue down Lips flanged Rhythmic sucking
A Audible swallowing	None	A few with stimulation	Spontaneous and intermittent <24 hours old Spontaneous and frequent >24 hours old
T Type of nipple	Inverted	Flat	Everted (after stimulation)
C Comfort (Breast/nipple)	Engorged Cracked/bleeding/large blisters or bruises Severe discomfort	Filling Reddened/small blisters or bruises Mild, moderate discomfort	Soft Nontender
H Hold (Positioning)	Full assist (staff holds infant at breast)	Minimal assist Teach 1 side; mother does other Staff holds and then mother takes over	No assist from staff Mother able to position/hold infant

Interpretation of LATCH score:

A composite score of 0 – 10 is possible, depending on the criteria mentioned in the table. It can be interpreted as poor (0 – 3), moderate (4 – 7) and good (8 – 10), but it is more important that health care workers support the mother-newborn dyad to correct all items which scored low individually to achieve exclusive breastfeeding timely and consistently.

4.5.2 Breastmilk production and milk requirement of the newborn

- Lactogenesis is the onset of copious milk secretion at the time of delivery and is due to the drop in progesterone and an increase in prolactin.
- Usually, at day 2 or 3 postpartum, most women experience swelling of the breast along with copious milk production.
- In primiparous women, this stage of lactogenesis is slightly delayed, and early milk volume is lower.
- The volume of the newborn's stomach is small on the 1st day of life (5 – 7 ml for a term baby) and increases slowly with time. On the 3rd day it reaches a volume of around 25 ml. This means that the small amount of breastmilk which is available in the first days is enough to satisfy the newborn.
- Continued regular suckling of the newborn on the breast or expressing breastmilk is what sustains breastmilk production.

4.5.3 Breast problems

- A mother may have **full** breasts in the first two or three days after delivery, when her milk supply is increasing.
- This is **NORMAL,** her milk will continue to flow without difficulty and the newborn can breastfeed without problems.
  - She should feed whenever her newborn wants to be fed (on demand).
  - She should not restrict the length of time the newborn spends at the breast.
  - If she becomes uncomfortably full, she should offer to feed her newborn more often. (The mother needs to be reassured that this 'condition' is normal and lasts for 36 to 72 hours).

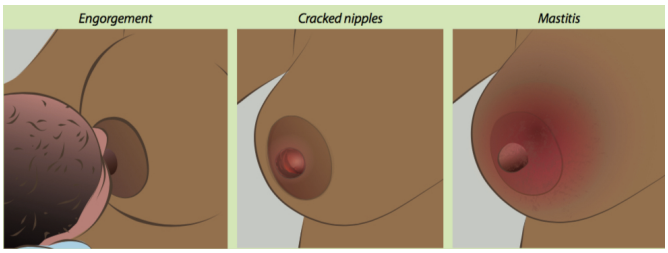


Figure 15: Breast problems

Breast engorgement

- Swelling and shininess of both breasts
- No tenderness or redness

➔ Feed often, express milk

Sore or cracked nipples

- Nipple tenderness and pain during breastfeeding
- Cracks or fissures may be visible

➔ Continue to breastfeed and ensure good attachment
➔ Apply breastmilk to the nipple after feeding
➔ Avoid irritation from clothing

Mastitis

- Painful, red and firm area, usually in one breast only
- Ill feeling, often with fever

➔ Feed frequently and afterwards express breastmilk to ensure emptying
➔ Massage the skin from the areola to the axilla to promote fluid drainage
➔ Apply warm compresses before and cold compresses after feeding
➔ Encourage the mother to drink a lot
➔ Consult the obstetrician for further management

4.6 Postnatal discharge preparation for well newborns

- Well newborns can be discharged with their mothers from the postnatal ward after 24 hours.
- During discharge a full and thorough physical examination must be performed and documented in the newborn triage checklist.
- Health education, information on danger signs and clinic visits must be given to the mother/caretakers.
- The postnatal care checklist (see annex XXXXX) must be initiated by the discharging health care provider and handed over to the mother

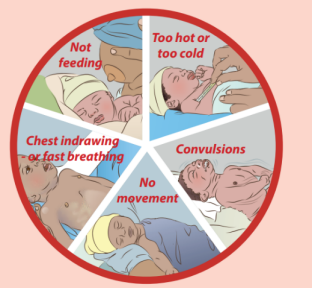
Home care guidance

Parents will continue essential newborn care at home.
Discuss with the family the following key messages:

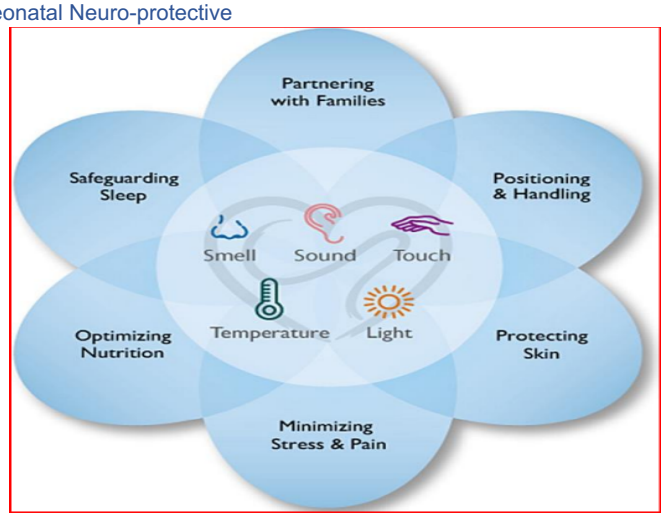
- Exclusive breastfeeding
- Management of common breast problems
- Washing of hands before touching the newborn
- Cord care:
  - Keep the cord area dry and put nothing on it
  - Keep the cord outside the diaper
  - Give sponge baths only until the cord drops off
  - Allow the cord to heal naturally
- Importance of immunization and immunization schedule
- Recognition of danger signs (including detection of jaundice)
- Seeking of immediate care for danger signs
- Go through all danger signs with the family for repetition
- Give birth registration of the newborn to the mother
- Fill out the child health booklet

Danger signs of homecare:

- Feeding problems, vomiting
- Temperature (< 36.0 °C or > 37.5 °C)
- Convulsions
- Reduced movements
- Irritability/excessive crying
- Fast breathing or chest indrawing
- Jaundice
- Pallor



4.7 Neonatal Neuro-protective



Neuro-protective interventions are strategies intended to support the developing brain, facilitating normal development and preventing disability.

In the case of neuronal injury, neuro-protective interventions are intended to help the brain reduce neuronal cell death and permit healing by fostering functional synaptic connections and pathways.

4.7.1 Safeguarding Sleep

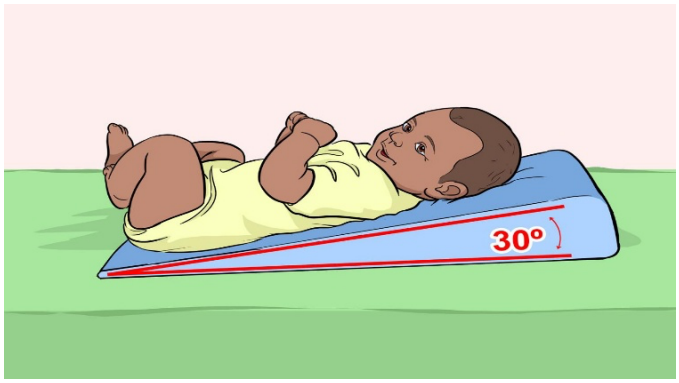
Goal is assessing infant sleep wake state before caregiving, and to protect prolonged periods of uninterrupted sleep whenever possible.

Clustering of Care

- A full assessment of vital signs, diaper change, repositioning, pulse oximeter site change, CPAP break, feeding and any indicated interventions can be done at this time.
- Hourly visual rounding without awakening a sleeping infant, or when an infant is awake and appears uncomfortable (crying, restless, increased HR, etc.).
- Check for wet diapers, evidence of pain, need for repositioning, conditions of IV sites, and mother needs.
- Feedings are given at scheduled intervals (for example, every 3 hours)
- Vital signs should be done twice per shift minimum (approximately every 6 hours), preferably when infant is awake.

Positioning for Success

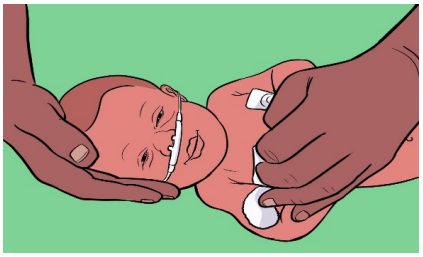
Goal is to eliminate/reduce positional deformities by maintaining infants in a midline, flexed, contained and comfortable position and head elevated at 30 º



IVH Prevention Bundle: For infants <30 weeks GA and body weight <1.25kg for the first 72 hours of life

- IVH bundle in LW
- Maintain neutral head position with head of bed up to the highest position
- No daily weights until day 4
- No holding or kangaroo care, but encourage parents to provide containment ("hand hugs") during this time as tolerated.



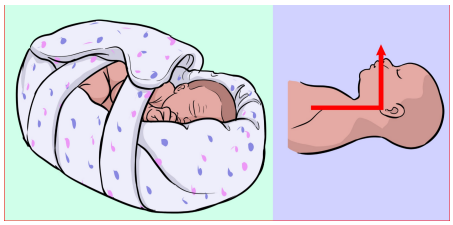


Positioning

- Shoulders softly rounded forward.
- Hands towards midline, able to touch face/mouth, if possible, for self-comforting.
- Hips aligned and pelvis tucked.

- Knees, ankles, feet aligned and softly flexed.
- Neck neutral or slightly flexed, no hyperextension.
- Head midline, or turned slightly right or left,Avoid turning more than 45 º to either side

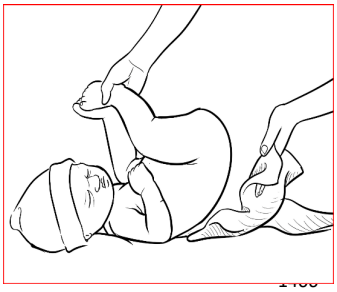


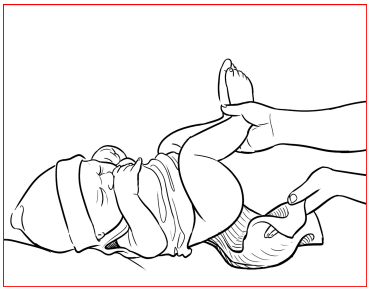


Handling with Care

Goal is to maintain autonomic stability throughout positioning changes and caregiving activities, as well as during periods of rest and sleep.

- Avoid raising feet above head whenever possible
- Slide new diaper under infant and lift slightly at hips to remove old diaper
- To clean diaper area, lift knees to the chest while supporting the back and buttocks
- Consider placing the infant on one side to clean buttocks and diaper area.





Miscellaneous strategies to prevent increased ICP include

- Avoid routine suctioning
- Minimize pain and stress
- Flush and draw from umbilical lines very slowly (1 ml over 30-45 seconds)

For weights or bathing

Provide light swaddling.

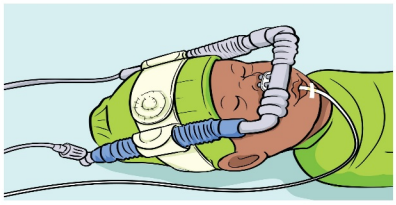
Swaddle bathing is similar to immersion bathing, but the infant is flexed and swaddled in a lightweight blanket prior to placement in the tub.



Protecting Skin

Goal is to protect newborn skin integrity and to provide opportunities for nurturing input through this vital sensory organ.

- Avoid forceful removal of adhesive after apply normal saline or coconut oil
- Use of neonatal friendly plaster i.e Transparent
- Assessing cannula site IV) and peripheral inserted central catheter (PICC) duration frequently i.e. 2 hourly for those in continuously infusion and 86-8 hourly for those with less frequently injection and check before giving next injection
- Before connect CPAP device apply neo seal or cotton wall to prevent /secure nasal septum
- Routine changing of saturation probe



1. Minimizing Stress and Pain

Goal is to reduce stress whenever possible, and to promote both self-regulation and neurodevelopmental organization.

- Assess for stress cues, indicating need for containment and a pause to allow recovery
- Assess for stability cues, indicating that it is safe to continue caregiving or interaction
- Provide nurturing touch whenever possible, especially after caregiving or procedures
- Safeguard sleep

Stress (Disorganization) Cues	Stability (Organization) Cues
Physiologic/Autonomic System	Physiologic/Autonomic System
◦Apnea, bradycardia	◦Maintains consistent color
◦Respiratory pauses, tachypnea	◦Stable respirations
◦Color changes (pallor or cyanosis)	◦Reduction of tremors
◦Tremors, startles, twitches	◦Stable digestion
◦Gagging, spitting up, straining	Behavioral/Motoric System
◦Sneezing, yawning, hiccoughing	◦Smooth, well-modulated tone
Behavioral/Motoric System	◦Synchronous, smooth movements
◦Flaccidity (trunk, extremities, face)	◦Grasping and hand to mouth activity
◦Hypertonicity, arching	◦Sucking
◦Finger splays, fisting	Behavioral/State System
◦Facial grimace	◦Clear, robust sleep states
◦Frantic, diffuse activity	◦Rhythmic, robust crying
Behavioral/State System	◦Active self-quieting/consoling
◦Rapid movement between states	◦Focused shiny-eyed alertness
◦Fussing, irritability	◦Intent, animated facial expression
◦Glassy-eyed, staring, gaze aversion	
◦Panicked, worried alertness	
Self-help Cues	
◦Hand to mouth activity	◦Seeking boundaries
◦Hands clasped	◦Habituating to repetitive stimulation by entering into light sleep
◦Grasping	

Protect sleep by clustering of care whenever possible, but be aware that the infant may not tolerate all of the caregiving measures that have been bundled into a single session. Clustering of care is intended to provide longer rest periods but may actually result in more physiologic alterations (changes in blood pressure, cardiorespiratory stability, altered cortisol levels, and heightened pain responses) than single care-taking events. Clustered care appears to be especially stressful for preterms < 28 weeks GA, so individualized cue-based caregiving is essential to avoid overwhelming an infant.

Minimizing Pain

Goal is to minimize the intensity, duration and physiologic cost of the pain experience, and to maximize the infant's ability to cope with and recover from painful experiences.
Refer to pain management page xxx

2. Optimizing Nutrition

Proper nutrition is integral to brain development. Breast milk, with its rich composition of nutrients and protective factors, is vital in supporting the newborn brain. Ensuring

adequate nutrition, whether through breastfeeding or carefully formulated neonatal formulas, is fundamental to neuroprotection.

3. Family centered care

Goal is to support parents in their role as the most importance caregivers for their infant, and to promote secure attachment.

- Use active, empathetic listening with parents as they express their concerns and fears
- Acknowledge and support where parents are in terms of the stages of grief and loss
- Create a welcoming environment where parents know that they are valued
- Allow parents to join in infant's care
- Encourage containment (hand hugs) both during and after caregiving
- Encourage parents to read and talk to infant when awake to support language development
- Promote skin to skin
- Explain that when dealing with infants, the infant leads and the adult follows
- Help parents become competent in infant care, building confidence towards discharge
- Support parents as they evolve into their roles as expert and advocate for their child.

4. Healing Environment

Goal is to provide an environment that promotes healing by minimizing the impact of NCU environment on the infant's developing central nervous system

Temperature: Provide a neutral thermal environment in which the infant is able to maintain a normal core temperature with minimum oxygen consumption and calorie expenditure. (25-28 C).

Sound and Noise: Increased cerebral blood flow in response to loud noise increases the risk of intraventricular haemorrhage (IVH) maintain noise levels below 45 dB.

The following interventions are useful to decrease noise, encourage uninterrupted sleep, and facilitate normal auditory development:

- Put friendly used doors at NICU
- All trolleys should have rubber tyred wheels

- Speak as quietly as possible within patient bays, avoid loud laughter or conversations
- Avoid talking over incubator/bed cots or allowing medical rounds too close to bedside
- Quiet alarms as quickly as possible, and remember to reset them
- Use blankets or covers over incubator to attempt to muffle noise
- Avoid placing items on incubator/Baby cots, do so gently if necessary.

Lighting and Vision: lighting should be low enough to support undisturbed sleep.

The following interventions are thought to promote good visual function:

- Use adjustable lighting at each bedside, strive towards a day/night cycle for the NCU
- Use minimal amount of light needed to accurately assess and manage infant
- Protect eyes from direct light during assessments, rest periods, and after pupil dilation for ROP exams
- Use heavy incubator covers to limit excessive light exposure during sleep, underside of these covers should be solid and dark colored to minimize unnecessary visual stimulation

Taste and Smell: Exposure to maternal odor is extremely important, and contributes to both sensory development and attachment.

- Maintain a soft/free scent unit for staff, and encourage parents to limit use of fragrances
- Avoid the odor of smoke on caregiver clothing and bodies
- Provide mother's scent when possible with breast pad or soft cloth
- Use colostrum for oral care

Vestibular/Proprioception: Skin to skin contact is the most logical means of providing essential proprioceptive sensory input to the developing brain.

- Provide containment during caregiving, change infant's position slowly and without sudden movements
- Utilize supportive positioning i.e Wraps
- Facilitate skin to skin opportunities

References

1. National infection prevention and control guidelines for health care services in Tanzania (June 2018)
2. WHO Guidelines on Hand Hygiene in Health Care (2009)
3. NRP (Neonatal resuscitation programme) guideline 8th edition
4. HBB/AAP
5. ILCOR 2015
6. ENCC WHO

7. Griffin CM, Amorim MH, Almeida FA, Marcacine KO, Goldman RE, Coca KP. LATCH as a systematic tool for assessment of the breastfeeding technique in maternity. Acta Paul Enferm. 2022;35:eAPE03181.
8. Allen, K. (2013). Treatment of Intraventricular Hemorrhages in Premature Infants: Where is the Evidence? Advances in Neonatal Care, 13(2) 127-130
9. Altimier, L. & Philips, R. (2013). Neonatal Integrative Developmental Care Model: Seven Neuroprotective Core Measures for Family-Centered Developmental Care. Newborn & Infant Nursing Reviews, (13) 9-22
10. Altimeier, L., Kenner, C. & Damus, K. (2015). The Wee Care Neuroprotective NICU Program (Wee Care): The Effect of a Comprehensive Developmental Care Training Program on Seven Neuroprotective Core Measures for Family-Centered Developmental Care of Premature Neonates. Newborn & Infant Nursing Reviews, (15) 6-16
11. Anand, K. (2000). Pain, Plasticity and Premature Birth: A Prescription for Permanent Suffering. Nature Medicine, 6(9), 971-973
12. AWHONN. (2013). Neonatal Skin Care: Evidence-based Clinical Practice Guideline (3rd Ed.)
13. Bader, L. (2014). Brain–Oriented Care in the NICU: A Case Study. Neonatal Network, 33(5), 263-267
14. Baley, J. & Committee on Fetus and Newborn (2015). Skin-to-Skin Care for Term and Preterm Infants in the Neonatal ICU. Pediatrics, 136(3), 597-599 Bissinger, R. (2014). Thermoregulation. Chapter 7 in
15. Bissinger, R., and Annibale, D. (Eds.), Golden Hours: Care of the Very Low Birthweight Infant, 123-138. Chicago, IL: National Certification Corporation
16. Blackburn S. (2010). Factors Influencing Development. Chapter 12 in Kenner, C., and McGrath, J. (Eds.), Developmental Care of Newborns and Infants (2nd ed.), 209-234. Glenview, IL: National Association of Neonatal Nurses.
17. Brown, G. (2009). NICU Noise and the Preterm Infant. Neonatal Network, 28(3), 165-171
18. Caldwell, C. (2015). Single-Family Room NICUs and Neurodevelopmental Outcomes. Academy News, 34(2), 137-138
19. Campbell-Yeo, M., Fernandes, A. & C. Celeste Johnston. (2011). Procedural Pain Management for Neonates Using Nonpharmacological Strategies. Part Two: Mother-Driven Interventions. Advances in Neonatal Care, 11(5), 312-318

20. Crowell, B. & D. Annibale (2014). Intraventricular Hemorrhage. Chapter 15 in Bissinger, R., and Annibale, D. (Eds.), Golden Hours: Care of the Very Low Birthweight Infant, 247-264. Chicago

CHAPTER 5: CARE OF LOW BIRTH WEIGHT AND INTRAUTERINE GROWTH RESTRICTED NEWBORNS

The World Health Organization (WHO) has defined low birth weight (LBW), as the weight at birth less than 2500 g. The global prevalence of LBW is 16 percent, which means that about 22 million such infants are born each year.

Low Birth Weight can be a consequence of preterm birth (defined as birth before 37 completed weeks of gestation), due to small size for gestational age (SGA, defined as weight for gestation < 10th percentile on Fenton chart see annex), or both.

Preterm newborns tend to have more problems than term newborns who are small (less than 2500 g at birth). However, because the newborn's gestational age is not always known, this guide collectively refers to preterm and SGA newborns as LBW.

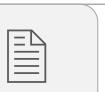
Intrauterine growth restriction (IUGR) can be defined as the rate of growth that is less than normal for a given population. So IUGR may produce infants who are SGA and AGA who experienced reduced fetal growth rates in utero. It is diagnosed intrauterine with ultrasound, HC, femur length, and abdominal circumference and compared with Colorado intrauterine growth charts. It can be symmetrical (involving the whole body caused by fetal conditions occurring early in pregnancy) and asymmetrical (sparing the brain)

LBW and IUGR infants are at higher risk of early growth retardation, infections, developmental delay, impaired respiration, difficulty in feeding, poor body temperature regulation, and death during infancy and childhood.

Global experience has clearly shown that appropriate care of LBW and IUGR infants, including feeding, temperature maintenance, cord and skin care, early detection, and treatment of complications, can substantially reduce mortality in this highly vulnerable group.

5.1 Classification of Low Birth Weight (LBW)

The LBW infants are classified based on weight:



Low birth weight (LBW) – 1500 g - 2500 g
Very low birth weight (VLBW) – 1000 g - 1500 g
Extremely low birth weight (ELBW) – below 1000 g

- Preterm newborns of less than 32 weeks gestational age are at greatest mortality risk.
- The lower the gestation age the higher the risk especially if it is coupled with a small for gestational age (SGA) entity.

This chapter focuses on the prevention and Management of LBW/IUGR Newborns, Feeding and Fluid Management, Thermal protection, Management of Common complications Discharge, and Follow-up.

5.2 Risk factors for low-birth-weight and IUGR delivery

Several factors contribute to low birth weight and put pregnant women at higher risk for having premature delivery and IUGR. History of LBW or premature delivery

- Infection (e.g. untreated urinary tract infections, bacterial vaginosis, TORCHES {Toxoplasmosis, Rubella, Cytomegalovirus, Herpes, Syphilis)
- Hypertensive disorders (Pre-eclampsia, eclampsia)
- Antepartum haemorrhage
- Cervical incompetence
- Premature rupture of membranes
- Placental dysfunction
- Polyhydramnios
- Trauma
- Chronic medical illness (e.g. diabetes)
- Anaemia
- Uterine anomalies e.g. fibroids
- Maternal undernutrition
- Circumstances of life:
    - Stressful work habits
    - Drug abuse, e.g. smoking, alcohol, other drugs, local herbs
    - Age below 20 years or above 40 years
    - Low socioeconomic status
- Multiple pregnancy
- Congenital abnormalities
- Air pollution (*Born too soon: A decade of action on preterm birth. Geneva: WHO; 2022.)*
- Male sex
- Multiparity

Interventions and General Care of Low Birth Weight and intrauterine growth restricted Newborns

The LBW newborns have several needs and problems, which will need immediate, care soon after delivery. Delaying taking action might lead to serious complications and even death. The management of LBW newborns should start during labor and delivery.

Antibiotics

Newborns delivered to women who had premature labour are at increased risk of early-onset neonatal sepsis;

- Give antibiotics only to newborns who meet the criteria. See a chapter on Neonatal sepsis.

Temperature control

- It is important to recognize early, the need to maintain a warm chain once delivery of a premature newborn is imminent.
- Hypothermia has been associated with an increased risk of poor outcomes (for details see section on hypothermia).

Community and Family Involvement in the management of preterm and LBW infant.

- Due to their special needs, LBW infants should be delivered at a facility capable of providing appropriate care to them.
- Any woman who has been identified with a risk of delivering an LBW infant or presents with an early onset of labour, should be referred to the higher-level facility for further care.
- In a situation where a mother has delivered an LBW baby in the community or at a lower-level facility, that cannot take care of LBW infants, a referral is a MUST
- Families of preterm or LBW infants should be given extra support to care for their infants, starting in a health care facility from birth and continuing during follow-up post-discharge.
- The support may include education, counselling, discharge preparation from health workers, and peer support.
- Home visits by trained community health workers are recommended to support families to care for their preterm LBW infant *(WHO recommendations for care of the pre-term or LBW infant 2022)*

5.3 Referral of LBW

Referral of LBW infants should follow the standard referral procedures. However, the following should be considered specifically for LBW:

- LBW should be referred in stable condition (feeding, thermal protection, oxygen therapy if available and required)
- Counsel the mother and the family that LBW infants need advanced care such as:
    - Kangaroo mother care
    - Specialized neonatal care
- LBW infant should always be in a skin-to-skin position during transfer
- Mother and relatives should be briefly reassured

The chart describing actions to follow when referring LBW newborns by; service providers, community health care workers or individuals at different levels

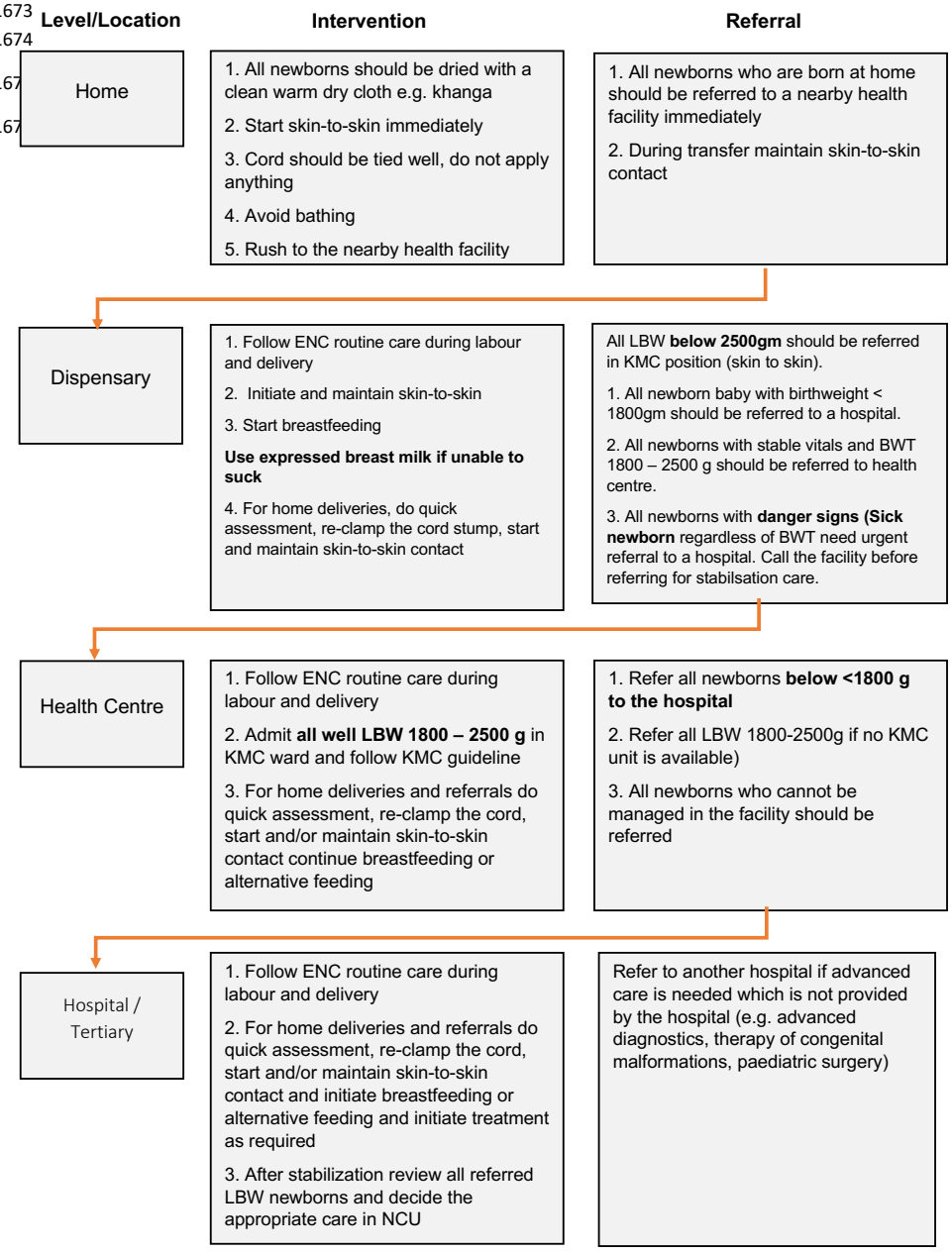


Figure xxx: Referral algorithm

5.4 Monitoring of LBW/IUGR infants

LBW infants are high-risk patients and have special needs that require active monitoring to ensure their survival. The following observations are specific for LBW infants, (< 2.5kg)

Airway and Breathing:

- Airway should be clear and patency maintained
- Breathing should be monitored by counting respiratory rate for one complete minute.
- A rate of > 60 breaths /minute and < 30 breaths /minute is termed fast breathing and slow breathing respectively and these are danger signs.
- Breathing should be monitored and recorded every 4 hours.

Oxygen saturation:

- Use pulse oximetry to measure the oxygen saturation of the LBW infant every 4 hours.
- Oxygen saturation in preterm babies under oxygen therapy should be in the range between 90 – 94%

Heart rate:

- Count the heart rate using a stopwatch for one minute.
- A heart rate above > 160 beats /minute in a resting newborn is high and suggests a newborn is not comfortable or is distressed.
- A heart rate below 100 /min is seen as pathologic and needs further assessment.
- Heart rate should be counted and recorded every 4 hours.

Temperature:

- **1500-2500 g:** every hour for the first 8 hours, then at least twice daily
- **Below 1500 g**: every 30 min for the first 4 hours, then hourly for 24 hours, then at least twice daily

Blood glucose:

- Measure blood glucose at 2 hours after birth. Monitor 8hlry for 48hours. Stop glucose check for the baby that is tolerating feeding well with at least 2 consecutive normal blood glucose levels.
- Refer to the management of hypoglycemia for newborns with hypoglycemia.

5.5 Feeding and fluid management

5.5.1 General principles

- The LBW/IUGR newborns often have difficulty feeding, simply because they are not mature enough to suck well.
- Good suckling and swallowing coordination ability usually is established by 34 to 35 weeks of gestational age.
- Substantial effort may be needed to ensure adequate feeding.
- Optimal nutrition will improve growth and neurological outcomes.

- The recommended feeding is mothers' own milk, second is donor human milk when available and feasible, and lastly standard infant formula when available and feasible.
- Standard human milk fortifiers can be used for preterm and LBW who have attained maximum enteral feeds by mothers or donor milk. This may be given from RRH and above.
- At a district hospital level, fortification can be done provided there is highly qualified personnel to offer such a service.
- Formula milk should not be used to fortify milk
- Total parenteral nutrition can be given to small and sick newborns from the RRH and above.
- Probiotics should not routinely be offered to preterm and LBW unless medically indicated at tertiary facilities.

Mother should be explained that:

- Her breast milk is the best food for the LBW infant
- It may take longer for an LBW infant to establish breastfeeding
- Mother should express breast milk for feeding (cup feeding, tube feeding)



- Inform the mother that her LBW infant may:
  - Tire easily and suckle weakly
  - Pause for long periods between suckling
  - Fall asleep during feeding
  - Not cry when hungry
- Nevertheless, the mother should continue to feed her baby frequently as advised

5.5.2 Feeding practicalities for an LBW infant

It is normal for newborns to lose weight during the first 7 days of life. Birth weight is usually regained by 14 days of life. Birth weight should be used for calculations of feeding volumes until the newborn exceeds birth weight;

- Assess the newborn daily to ensure that the newborn is gaining weight adequately
- Newborns should not lose more than 15 percent of birth weight.
- If a newborn cannot receive enteral feeds (e.g. NPO due to, severe asphyxia on day 1, surgical conditions) he should be given colostrum swabs starting from delivery;
  - Colostrum, the very first breast milk, is very rich in protective factors and therefore especially important for critically ill neonates.
  - A small amount of colostrum is placed directly onto the mucosa in the cheeks for absorption and will not be swallowed.
  - It is done 2 – 3 hourly with about 0.1 ml colostrum in each cheek, given by 2 cc syringe or a sterile cotton swab.

- Starting enteral feeding
  If the feeding of full amounts of breast milk is delayed in preterm or sick newborns Minimal Enteral Feeds (MEF) (=trophic feeds) help to avoid atrophy of the intestinal mucosa, bacterial overgrowth, and other associated problems;
    - Start with breast milk **15ml/kg/day - 20 ml/kg/day** on **day one** of life and this is bonus feeding should not be subtracted from total fluid intake.
    - If a neonate weighs less than birth weight, utilize birth weight in all fluid calculations.
    - Advance daily feeds by 30 ml/kg/day as a standard advancement according to feed tolerance and hemodynamic stability.
    - In the first few days this must be combined with IV fluids to meet the total fluid requirement per day (see the table below).
    - Deduct oral feeds from total fluids when the baby tolerates 20ml/kg/day for three consecutive feeds.
    - In facilities, infants born before 34 weeks gestation can be fed every 2–3 hours. Infants born at 34 weeks gestation or more can be fed every 3–4 hours or by responsive feeding (WHO, 2020
- Maximum feeds
    - Feed advancement aims to reach 160 – 180mls/kg/d by about two weeks in babies weighing <1000 g at birth and by about one week in babies weighing 1000–1500 g.
    - Depending on the newborn condition and tolerance, you can do fast advancement (30–40 ml/kg per day) or slow advancement (15–25 ml/kg per day).
    - If the baby has already reached full feeds (160 – 180 ml/kg/day) and still weight gain is inadequate (less than 20 g per day over three days): Increase the volume of milk to 200 ml/kg per day.
    - If weight gain is inadequate for more than one week and the newborn has been taking 200 ml/kg breast milk per day, investigate possible underlying conditions and consider fortifications
- For newborns who are fed by gastric tube (poor sucking reflex or sick) the mother should be advised to do lip and mouth care with breast milk each time before feeding via NGT (by swabbing lips and mouth with a small amount of milk by using her clean index finger).

5.5.3 Fluids management

How To Give Enteral Feeds and Intravenous fluid

- Calculate the total fluid intake using birth weight (table). Then, minus the amount of milk required for that day, the remaining amount should be given as IV fluids over 24 hours.
- feeding therapy aims to increase the oral portion if tolerated. While doing the changeover from IV to oral feeds, one has to consider the continuous increase of the total amount of fluid as per day requirement.

- Feeding intolerance (FI) is defined as difficulty in digesting enteral feedings and is accompanied by an increase in gastric residuals (Gastric Residual Volume is >5 mL/kg or > 50% of feeds given), abdominal distension (consider CPAP belly if on CPAP), and/ or reflux
- Give this enteral portion via NGT for all infants below 30 weeks (<1.25kg) and for those who don't have a sucking reflex or by cup for babies that are unable to breastfeed.

Table xxx: How to give enteral feeds and IVF

	BWT <1000g	BWT 1000 – <1500g
Day 1	TFI is 100ml/kg/day	TFI is 80ml/kg/day
	15ml/kg/day (as trophic feeds) + 100ml/kg/day as IVF	20ml/kg/day (as trophic feeds) + 80mls/kg/day as IVF
Day 2 Good tolerance	TFI is 120ml/kg/day	TFI is 100ml/kg/day
	20ml/kg/day (Trophic feeds) + 120ml/kg/d IVF	40ml/kg/day (as oral feeds) + 60ml/kg/day as IVF
Day 3 Good tolerance	TFI is 140ml/kg/day	TFI is 120ml/kg/day
	40ml/kg/day (oral feeds) + 100ml/kg/day as IVF	70ml/kg/day (as oral feeds) + 50ml/kg/day as IVF

- Subsequent day advancement EBM by
  -15-25ml/kg/day for infants less than 1kg,
  -20 – 30ml/kg/day for infants less than 1.5 kg and
  -30 – 40ml/kg/day for infants above 1.5 kg while reducing IVF as shown above.
- For extremely low birth weight infants, trophic feeding can be given for one to three days before advancement.
- Avoid routine gastric aspiration to monitor feeding intolerance
- Reduce frequency of feeding (i.e 2hrly-1hrly) or do slow advancement (15 – 20ml/kg/d) if there is abdominal distension or recurrent reflux
- If the infant is in CPAP, insert OGT for air decompression

- If the gastric residual is up to 5ml/kg or less than 50% of feeds given consider subtracting the residual volume from the current feed AND if more than 5ml/kg or more than 50%, push back and consider withholding the current feeding
- IVF should be given as **a continuous infusion for 24 hours NOT bolus** (preferably use an infusion pump if available).

5.5.4 Donor human milk

Mother's milk (MOM) is the first option for feeding preterm or low birth-weight (LBW) infants, including very preterm or very low birth weight (, but when is not available safe donor human milk is the second-best

A. Donor milk processing

1. Identifying donor mother:

Must have surplus milk, so that their baby is growing well.
Mother should volunteer herself, and sign a consent form
Risk assessment and screening of the donor mother:
risk assessment using a structured questionnaire
Serological screening: Hepatitis B and C; HIV (ELISA or DNA –PCR) and Syphilis

2. Expression of donor milk:

-Donor mother will be trained to express milk hygienically

3. Pasteurization of donor milk: (holder method or flash heat, Pretoria Pasteurization)

Donor milk undergoes heat treatment to kill microorganisms while preserving most of the nutrients, immunological, and growth factors.

4. Storage of pasteurized donor milk:

Storage temperature	Stored duration
Frozen -18 to -20 degrees	Up to 6months
Refrigerator -2 to 8 degree	8 hours to 24 hours
Room temperature 25 - 29 degrees	Up to 4 hours

5. Thawing of Frozen milk

Place the container of frozen donor milk in a basin of warm water
Do not put in microwave or hot water
Gently swirl and do not shake vigorously

B. Indication

- A very low birth weight infant (< 1500g) whose mother's own milk is not available
- Any newborn who is an Orphan

5.6 Micronutrient Supplementation

- Enteral iron supplementation is recommended for human milk-fed preterm or low-birth-weight infants not receiving iron from another source. The daily dose of 2–4 mg/kg per day of elemental iron may be initiated after 2 weeks when enteral feeds are well established and may be continued until the infant receives iron from another source (six months of age).
- Enteral zinc supplementation may be considered for human milk-fed preterm or low-birth-weight infants not receiving zinc from another source. A daily dose of 1–3 mg/kg per day of elemental zinc (3-5mg/day) is recommended. Zinc may be initiated when enteral feeds are well established, and may be continued until the infant receives zinc from another source
- Enteral vitamin D supplementation may be considered for human milk-fed preterm or low-birth-weight infants not receiving vitamin D from another source. A daily dose of 400–800 IU may be initiated when enteral feeds are well established and may be continued until the infant receives vitamin D from another source
- Enteral vitamin A supplementation may be considered for human milk-fed very preterm (< 32 weeks' gestation) or very-low-birth-weight (< 1.5 kg) infants who are not receiving vitamin A from another source. A daily dose of 1000–5000 IU may be initiated when enteral feeds are well established and may be continued until the infant receives vitamin A from another source. Common methods of providing enteral vitamin A for preterm and LBW infants include infant multivitamin formulations (e.g. vitamins D, A, C, B group)
- Enteral calcium or phosphorous supplementation is not recommended to be given routinely. It improves bone biomarkers (serum alkaline phosphatase).

5.7 Breast Milk Fortification

- Breast milk alone might not be enough to support preterm infants to grow and develop optimally.
- Caloric requirements for Very low birth weight (VLBW) preterm infants (less than 1500 g) are 110 to 130 kcal/kg/day for enterally fed preterm infants.
- 30mls of breast milk is approximately 20kcal/kg.
- Extra nutrients, such as protein and energy (calories) from carbohydrates or fat, can be added to breast milk to make it 10% to 20% more nutritious. These additional nutrients are called "fortifiers".
- Caloric delivery and nutritional support can be maintained by increasing the caloric density of feedings when feeding volumes cannot be tolerated.
- Human milk should be fortified with protein, minerals, and vitamins to ensure optimal nutrient intake for infants weighing less than 1500 g at birth
- Standard human milk fortifiers can be used for preterm and LBW who have attained maximum enteral feeds by mothers or donor milk. This may be given from RRH, and above
- Human milk-based human milk fortifiers allow a premature infant to receive an exclusive human milk diet throughout their hospital stay, which was shown to decrease the incidence of NEC by 50%
- Powdered infant formulas should not be used for feeding or fortification in hospitalized newborns in an intensive care unit.
- Human fortifier can be used to increase calorie intake of 30mls of breast milk to give 24kcal, 26kcal etc

- Fortification should continue until the preterm attains 2000g, has adequate weight gain of 20g-30g per day

5.8 Feeding in Newborn with Special Needs

Newborns with special needs such as neurological conditions, cardiac problems, or cleft lip/palate and babies who are ill, need breast milk with special consideration

The approach to feeding will depend on the individual baby and his or her condition. Overall, care can be divided into categories based on the baby's condition:

- Newborns cannot take oral feeds; i.e. NEC: Encourage the mother to express her milk to keep up her supply for when her baby can take oral feeds. If possible, freeze her expressed breast milk and use it later
- Newborns can take oral feeds but are not able to suckle i.e Birth asphyxia, Cleft palate: Give expressed milk by tube (nasogastric or oral tube) or special bottles
- Newborns can suckle but not for full feeds or have poor weight gain; Let baby suckle whenever baby is willing. Give expressed milk by cup or tube in addition to what the baby can suckle. Avoid artificial teats and pacifiers as these babies may find it very difficult to learn to suck from both a breast and an artificial teat
- Newborns cannot able to receive any breast milk: For example, metabolic diseases need a specialized formula.

5.8.1 Feeding in newborn babies with cleft lip and palate

Breastfeeding is possible, even in extreme cases of cleft lip/palate. A child born with cleft lip and palate may experience difficulties while feeding. Obtaining a good seal of the oral cavity can be difficult due to the incomplete facial and palatal structures. Nasal regurgitation and choking are common in infants with cleft palate because of the inability of the palate to separate the nasal and oral cavities

- Breastfeeding a child with a cleft palate, the mother needs to implement some modifications. A position that can be used is the modified football hold (the child is usually held at an angle of 45°), which minimizes nasal regurgitation.
- There are a variety of feeding devices that can be very useful in successfully feeding an infant with a cleft lip and palate, like a plastic squeeze bottle, soft and long nipple, specially designed nipple with enlarged opening, and wide based nipple (useful in sealing off the cleft lip).





5.8.2 Extrauterine growth restriction (EUGR)

EUGR is defined by a weight, length, or head circumference value that falls below the 10th percentile of the expected intrauterine growth at 36- to 40-week postconceptional age (PCA) or at discharge.

- EUGR has been reported to affect 40–95% of premature infants.
- Factors that contribute to EUGR include antenatal growth status, postnatal nutritional support, co-morbidities, and genetic and epigenetic factors.
- Suboptimal nutritional support during the first two weeks was identified as the main predisposing factor.
- In newborn with EUGR, Feeding is fortified using formula powder, and caloric density is gradually increased till reaching 30 calories per 30mls for a goal of 120–140 calories/kg/day
- Ensure the baby gets the hind-milk that has a high-fat content to help the baby grow.

5.8.3 Infants requiring surgery

Breast milk is easily digested so requires a shorter fasting time than formula milk or other foods.

- In general, the baby should not need to fast for more than three hours. Discuss with the parents' ways of comforting the baby during the fasting period.
- Breastfeeding can usually commence as soon as the baby is awake after the surgery

5.8.4 Breast milk substitutes

A small number of health conditions of the infant or the mother may hinder breastfeeding temporarily or permanently.

Whenever stopping breastfeeding is considered, the benefits of breastfeeding should be weighed against the risks posed by the presence of specific conditions

Infants who should not receive breast milk or any other milk except specialized formula

- Infants with classic galactosemia: a special galactose-free formula is needed.
- Infants with maple syrup urine disease: a special formula free of leucine, isoleucine and valine is needed.
- Infants with phenylketonuria: a special phenylalanine-free formula is needed (some breastfeeding is possible, under careful monitoring).

Maternal conditions that may justify temporary avoidance of breastfeeding

- Severe illness that prevents a mother from caring for her infant, for example sepsis.
- Herpes simplex virus type 1 (HSV-1): direct contact between lesions on the mother's breasts and the infant's mouth should be avoided until all active lesions have resolved.
- Maternal medication: sedating psychotherapeutic drugs, anti-epileptic drugs and opioids and their combinations may cause side effects such as drowsiness and respiratory depression and are better avoided if a safer alternative is available.
- Radioactive iodine-131 is better avoided given that safer alternatives are available – a mother can resume breastfeeding about two months after receiving this substance;
- excessive use of topical iodine or iodophors (e.g., povidone-iodine), especially on open wounds or mucous membranes, can result in thyroid suppression or electrolyte abnormalities in the breastfed infant and should be avoided;
- cytotoxic chemotherapy requires that a mother stops breastfeeding during therapy.

5.9 Parenteral nutrition

Overview

- Neonates, particularly preterm infants, have high caloric and protein requirements for growth and development. Conditions like necrotizing enterocolitis (NEC) or gastrointestinal surgery or defects can hinder the ability to absorb nutrients enterally.
- Suboptimal nutrition can have adverse outcome for neonates i.e. growth failure, osteopenia, anaemia, BPD, autism, cerebral palsy and neurodevelopmental delay.
- Total Parenteral Nutrition (TPN) is crucial for neonates, especially those who are premature or have specific medical conditions that prevent them from receiving adequate nutrition through oral or enteral feeding.
- Although growth can be obtained with TPN, enteral feedings should be initiated as soon as feasible, because of the risks associated with TPN.
- TPN should be used at facilities that offers level 3 care

Indication

- GIT anomalies like Gastroschisis, congenital diaphragmatic hernia, esophageal atresia.
- For neonates who were previously on enteral feed start TPN if kept NPO and it is unlikely they will be restarted within 72 hours.
- Short bowel syndrome
- When feasible, consider starting TPN in:
    - Neonates with GA <28 weeks (<1000g) if no sufficient enteral feed for 24hrs after birth

- Neonates with GA 28-32 weeks (1000-1500g) if no sufficient enteral feed for 3 days after birth
- Neonates with GA >32 weeks (1500g) if no sufficient enteral feed for 5 days after birth

GENERAL PRINCIPLES:

- TPN should be kept refrigerated at 2-8 degree centigrade
- When indications are met, start TPN as soon as possible
- Among different type of TPN, paediatric formulation is recommended to be used
- Total volume of TPN should be based on weight of the baby and age (days of life)
- Aseptic precaution should be followed from preparation to the administration of TPN and should be done by trained personnel with sterile gloves and gown/apron.
- Bacterial filters to administer TPN may be used when available
- The IV line used for administering TPN should only be restricted for that; don't use it for other purposes like giving medication etc.
- The hanged solution and infusion sets must be discarded after 24 hrs form time of preparation
- Protect the bags and infusion sets of lipid solutions by covering with Aluminum foils because exposure to direct sunlight and phototherapy convert them into toxic peroxides.

Access

- Preferably use a central venous catheter (CVC)
- Consider using peripheral venous access to give neonatal parenteral nutrition only if:
  - CVC can't be placed or would avoid a delay in starting parenteral nutrition
  - Short-term use anticipated i.e., less than 5 days
  - If concentration of dextrose to be administered is <12.5%

- **Heparin** (0.5-1 unit/mL at 0.5-1ml/hr) is added to all central venous lines and to all peripheral infusions running at <2 mL/hr in order to maintain patency**.**

Energy requirements

- Minimal caloric requirements to prevent catabolism is at least 40 kcal/kg/d.
- For growth, energy requirements are 80-120 kcal/kg/day aiming a weight gain of at least 15-20 g/kg/day.
- If starting TPN in the first 72 hours of life: give a starting range of 40-60 kcal/kg/day then gradually increase over 3-4 days to a maintenance range of 75-120 kcal/kg/day.
- If starting TPN 4 days after birth: give a range of 75 to 120 kcal/kg/day.
- Distribution of calories: 60% carbohydrate, 30% lipids and 10-15% protein
- Calories yield from macronutrients
  - Glucose/carbohydrate 3.4 kcal/g
  - Protein 4 kcal/g
  - Lipids 9 kcal/g

Components of TPN:

Protein/Amino Acid

- Extreme preterm losses up to 1.5g/kg/day of protein while term lose 0.7g/kg/day
- Early Amino acid (AA) intake improve nitrogen balance and decrease risk of hyperglycemia as well as minimize protein losses and preserve existing stores.
- For preterm start Amino acid at 1.5 to 2 g/kg/day then gradually increase 0.5-1g/kg/day (over 3-4 days) to a maintenance range of 3 to 4 g/ kg/day.
- For a term neonate start AA at 1 to 1.5g/kg/day then increase gradually over 4 days to maintenance range of 2.5 to 3g/kg/day.
- If starting AA after 4 days of life; give 3-4 g/kg/day for preterm and 2.5-3 g/kg/day for a term neonate.
- Potential complications of AA include: Acidosis, Elevated uremia, Hyperammonemia and Cholestasis with prolonged administration

Lipids

- A vital component of TPN as they provide essential fatty acids and are a concentrated energy source critical for growth and development of infants not receiving enteral feeding. A lipid intake of about 0.5 g/kg/d is required to prevent essential fatty acid deficiency.
- The recommended preparation is a 20% SMOF lipid emulsion (Soybean oil, Medium chain triglycerides, Olive oil and Fish oil).
- For both preterm and term starting range of lipid is 1 to 1.5 g/kg/day then gradually increase in daily increments of 0.5 to 1 g/kg/day (over 3-4 days) to a maintenance range of 3 to 4 g/kg/day.
- If starting lipids after 4 days of life; give 3-4 g/kg/day
- Potential complications include: Hyperlipidaemia, kernicterus at low levels of unconjugated bilirubin, increased risk/exacerbation of chronic lung disease and Persistent Pulmonary Hypertension (PPHN) as well as Lipid overload syndrome with coagulopathy and liver failure

Carbohydrate/Glucose

- Excessive glucose more than body's oxidative capacity has adverse outcome and may lead to excess lipid synthesis (fat deposition), osmotic diuresis, dehydration and promotes cholestasis/hepatic steatosis.
- Start at glucose 6-9g/kg/day then gradually increase over 3-4 days to 9-15 g/kg/day
- Target is Glucose infusion rate (GIR) of 4-8mg/kg/min.
- Advance by 1-2 mg/kg/min daily to a maximum of 12mg/kg/min in selected cases.

Electrolytes

- Must be adjusted according to serum values and clinical condition
- Electrolytes should be added gradually as the patient becomes more stable
- Don't add sodium in the first 24-48 hours of life due to expected ECF contraction and free water diuresis, give 3-5mEq/kg/day can be added thereafter
- Potassium at 2-3mEq/kg/day can be added after stable urine output has been established

Minerals & Vitamin

- Long-term use of parenteral nutrition is associate with increased risk for bone demineralization and fractures, thus Calcium and phosphorus should be added

- Calcium should be given at a starting range of 0.8 to 1 mmol/kg/day then increased to a maintenance range of 1.5 to 3 mmol/kg/day after 48 hours.
- Phosphorus can be started at 1mmol/kg/day then increased to a maintenance dosage of 2 mmol/kg/day after 48 hours
- Magnesium can be supplemented at range of 0.3-0.5mEq/kg/day
- Multivitamin infusion (Paediatric) added at dosage of 1-1.5ml/kg/day

Monitoring during Parenteral Nutrition

Test	When still increasing dose	When stable
BUN/Creatinine, electrolytes	Daily	Twice a week
Glucose/RBG	6 hourly	Twice daily
Calcium, Phosphorus & magnesium	Baseline	Weekly
Bilirubin, Albumin, ALT, GGT, ALP	Every 48hrs	Weekly
Triglycerides	Before each increase in dosage	Weekly
FBP/platelets	Baseline	Weekly

NB: If plasma triglycerides increase >2.8mmol/L consider to reduce lipids by 1g/kg/day. Unexplained thrombocytopenia needs lipid dose reduction

When to stop Parenteral nutrition

- Stop TPN when enteral feeds are greater or equal to 100-120mls/kg/day (meeting at least 2/3rd of required daily energy) OR volume of TPN is < 25-30mls/kg/day
- Wean glucose gradually to prevent rebound hypoglycemia while Lipids may be stopped without tapering

5.10 Thermal protection

Thermal protection of the newborn is the series of measures taken at birth and during the first days of life to ensure that the newborn does not become either cold (hypothermia) or hot (hyperthermia) and maintains a normal body temperature of 36.5 °C – 37.4 °C.

Warm chain

1. Warm delivery room
2. Immediate drying
3. Skin to skin contact
4. Breastfeeding
5. Bathing and weighing postponed
6. Appropriate clothing
7. Mother and baby together
8. Warm transportation
9. Warm resuscitation
10. Training and awareness creation

General principles

- Maintain the room temperature at around 25^0C to 28^0C. Note the temperature by reading from the wall thermometer.
- polythene wraps (food grade) should be used for all neonates <32 weeks to prevent hypothermia
- In areas with cold environments room heaters may be required.
- Baby under radiant warmer must be nested but exposing the trunk and the feet and machine set at servo control with a temperature of 36.5 – 36.8^0C, the temperature probe must always be placed on the right side around 3cm below the right coastal margin. If the temperature probe is not working set the machine to manual mode and monitor every 15 to 30 minutes to maintain the baby's body temperature of 36.5^0C to 37.4^0C
- For facilities with incubators (recommended level 3 NICU), incubators may be used for extremely low birth weight infants for one week then trial for infant warmer on plastic wrap
- The incubator should be set in servo control with temperature 36.5 -36.8 and humidity 70 -80%
- Incubator is a service that needs close monitoring, IPC measures
- In hot weather, if available air conditioner can be switched on to maintain a room temperature of 25 – 28^0C.
- A cold baby should be re-warmed targeting an increase of 0.5^0C every 1 hour, avoiding rapid rewarming as it might cause seizures.
- Hypothermia is a life-threatening condition in small and sick newborns, a drop in 1^0C increases mortality by almost 80%.

5.10.1 Hypothermia

Hypothermia occurs when the newborn's temperature drops below 36.5 °C: 36.0°C – 36.4°C is mild hypothermia (cold stress); 32.0°C – 35.9°C is moderate hypothermia; less than 32°C is severe hypothermia.

- The newborn infant regulates body temperature much less efficiently and loses heat more easily.
- The LBW or SSN are most vulnerable to hypothermia.
- The smaller and more premature the newborn, the greater the risk.
- After birth, the newborn immediately starts losing heat and unless heat loss is prevented, hypothermia will develop.
- Methods to keep these high-risk newborns warm include kangaroo mother care (round-the-clock skin-to-skin), warm rooms, radiant heaters, and incubators).
- Preventive actions should be taken by reducing heat loss and/or providing warmth using external heat sources. Preventive measures include:

Hypothermia may also be

- Environmental factors (Cold season)
- Disorders that impair thermoregulation (e.g., sepsis, intracranial haemorrhage)
- Asphyxia

Signs and symptoms of Hypothermia

- Initially hypothermia may be asymptomatic, and the newborn may appear asleep. The newborn may have the following symptoms:
  - Cold feet
  - Cold skin all over the body
  - Newborn will be less active, suckles poorly, and has a weak cry

- Signs of severe hypothermia include:
  - Lethargy
  - Apnoea
  - Bradycardia
  - Central cyanosis
  - Coagulation abnormalities
  - Hypoglycaemia
  - Hypotension
  - Poor perfusion
  - Hypotonia
  - Feeding intolerance (abdominal distension, emesis, gastric residuals)

- Preventing low body temperature at birth in LBW infants is important for survival and improved long-term outcomes.

Management of hypothermia

LBW infants found to be hypothermic must be **re-warmed** as soon as possible. The following is the process of re-warming a newborn with hypothermia. The temperature of the room where the re-warming takes place should be at least 25 °C – 28^0C.

Mild hypothermia (cold stress): Temperature 36.0^0C – 36.4^0C

- Remove the newborn's wet/cold clothing
- Place the newborn skin-to-skin on the mother's chest dressed in a pre-warmed shirt open at the front, a nappy (diaper),
- Put on a hat and socks
- Cover the newborn on the mother's chest with her clothes and an additional (pre-warmed) blanket
- Check the temperature every 30 minutes until normal
- Keep the newborn with the mother until the newborn's body temperature is in a normal range.
- If the newborn's temperature does not reach 36.5 °C or more after 2 hours of re-warming, re-assess.
- Encourage the mother to continue with KMC including day and night as long as possible

Moderate hypothermia 32^0C – 35.9^0C

- Repeat the same procedure as above.
- Add an extra layer of a warm blanket and cover the baby in a KMC position

- If a radiant warmer is available, nest the baby in the radiant warmer and set the machine to servo control aim to raise the temperature at 0.50C every hour
- If a radiant warmer is not available, cover the baby well with two layers of warm clothes and switch on a heater to heat the room.
- Remember to close windows and doors to prevent drought
- Monitor temperature every 30mins. Continue to re-assess with a thermometer or by touching the newborn's feet: if the newborn is cold use skin-to-skin contact, add an extra blanket, and re-assess even after hypothermia has resolved.
- If referral is needed, keep the newborn in a skin-to-skin position with the mother or other person accompanying the newborn
- If the mother and newborn must be separated, ensure the newborn is dressed or wrapped and covered with a blanket
- Keep the room for the mother and newborn warm, if the room is not warm enough, always use skin-to-skin contact and/or cover the newborn with a blanket
- Make sure the newborn is not overheated
- Hypothermia may also occur at home. Before discharge, explain to the mother the procedures for re-warming the newborn at home:
    - Newborns need one or more layers of clothes than other children
    - Keep the room or part of the room warm (at least 25 °C), especially in a cold climate
    - Continue skin-to-skin at home. If the newborn still has cold feet, report back to the nearby health facility

Severe hypothermia

- keep the baby in a heat source preferably an infant warmer. Warm the baby slowly at the rate of 0.5Celcius per hour
- monitor every 15 to 30 minutes to maintain the baby's body temperature of 36.50C to 37.40C

5.10.2 Hyperthermia

- This is defined as a temperature equal to or above 37.5 °C (axillary)
- Hyperthermia is as dangerous to the newborn as hypothermia and can occur just
    - as easily.
- The temperature of the newborn and its surroundings (especially the incubators)
    - should be set to maintain the body temperature of the baby at 36.5 – 37.40 C
    - (refer to job aid on the use of infant warmer).
- When the newborn has a raised temperature, expose the baby, and assess for
    - feeding/dehydration and other causes of fever.
- Hyperthermia is not a common sign of sepsis in neonates.

Causes of hyperthermia

- Wrapping a newborn in too many layers of clothes, especially in a hot, humid climate
- Leaving a newborn in direct sunlight

- Putting a newborn too close to a fire or heater
- Putting a newborn close to a hot water bottle
- Leaving the newborn under a radiant warmer or in an incubator that is not functioning properly

Signs and symptoms of hyperthermia

- Hyperthermia increases the metabolic rate and rate of water loss by evaporation, which can cause dehydration
- A core temperature above 40 °C can lead to neurological damage
- Signs of hyperthermia include:
  - Rapid breathing
  - Increased heart rate
  - Hot skin
  - Red extremities due to vasodilation
  - Flushed face
  - Restless and lethargic
  - In severe hyperthermia shock, convulsions and coma may occur

Management of hyperthermia

- The newborn should be moved away from the source of heat and undressed partially or fully if necessary (exposed)
- If the newborn is in an incubator, the air temperature should be lowered
- It is important that the newborn be breastfed frequently to replace fluids
- Every hyperthermic newborn should be examined for infection
- Check temperature every 30 minutes after exposing the child and react timely once temperature approaches normal range (avoid hypothermia)



- Expose the newborn and assess signs of dehydration.
- Consider paracetamol at a dose of 10mg/kg/dose if temperature remain persistently high (39^0C) despite feeding and exposure.

5.9 Kangaroo Mother Care

Kangaroo mother care (KMC) is the care of a small newborn who is continuously carried for a prolonged time (8- 24 hours per day) in skin-to-skin contact with the mother, father, or any other caregiver.

KMC can be differentiated from skin-to-skin care by the duration of contact. Skin-to-skin care is usually done immediately after birth for at least one hour for every newborn to ensure that all babies stay warm in the first hours of life and helps in early initiation of breastfeeding

Ways of doing KMC

- Immediate KMC
- Early KMC after stabilization (Any KMC)
- Intermittent KMC:

A session must be more than 60min and the total duration per day at least 8-24 hours

Immediate KMC (I-KMC)

- KMC started as soon as possible, within 2 hours of life, and can be done for all stable or unstable premature or low birth weight infants
- Infants who are unable to breathe spontaneously after resuscitation, are in shock, or need mechanical ventilation I -KMC cannot be done.
- In I-KMC the baby is placed in the skin to skin contact with the mother or surrogate immediately after birth before stabilization
- Immediate KMC is recommended for infants 1.0 to 1.799g who received immediate kangaroo care (before stabilization KMC)

Any KMC

- Started at the facility as soon as the newborn's condition permits (i.e. newborn does not require special treatment such as oxygen or IV fluids).
- Stable babies with birth weights 2000g to 2499g should continue with KMC at home after being evaluated by a health worker, counseled on KMC, and lactation is established.

Effective KMC relies on the following:

- Ensure that the mother is fully recovered from any childbirth complications before she begins KMC
- Ensure that the mother has support from her family to stay at the facility or return when the newborn is ready for KMC
- Discuss with the family and explain the support that the mother needs from them
- Explain to the mother that KMC is the best way of care for her newborn once the condition permits and the benefits are:
    - Newborn will be kept warm
    - Will feed more easily
    - Episodes of apnoea will be less frequent
    - Newborns will be prevented from acquiring infection
    - Increase bonding between her and her newborn
- Skin-to-skin care may be interrupted when changing napkins (diaper), bathing the newborn, or during clinical assessment

Beginning KMC

- Ensure that the room temperature is at least 25 – 28 °C
- The room should be supplied with running water and liquid soap for hand washing
- Arrange with the mother at a time that is convenient to her
- Ask her to wear loose clothing that is comfortable in an ambient temperature
- Provide the clothing that can accommodate the newborn while the mother is holding the newborn
- Describe to her each step of KMC, demonstrate them, and then allow her to go through the steps herself
- Dress the newborn in a pre-warmed shirt open at the front, a nappy or diaper, a hat, and socks
- Place the newborn on the mother's chest

KMC Positioning

- Place the newborn in an upright position directly against the mother's skin
- Ensure that the newborn's hips and elbows are flexed into a frog-like position and the newborn's head and chest are on the mother's chest, with the head in a slightly extended position
- Cover the newborn with pre-warmed cloth/blanket
- Special garments are not needed as long as the mother's clothes keep the newborn firmly and comfortably in contact with her skin
- Use a soft piece of fabric folded diagonally in two and secured with a knot
- Make sure it is tied firmly enough to prevent the newborn from sliding out if the mother stands, but not so tightly that it obstructs the newborn's breathing or movement
- After positioning the newborn, allow the mother to rest with her newborn and encourage her to move around when she is ready

Breastfeeding

- Help the mother to breastfeed
- Have the mother sit comfortably and help her with the correct position and attachment

Daily life for the mother

- Assess the mother if she has adequate milk production > 20mls in a single expression
- Emphasize to the mother the importance of hand hygiene
- Let the mother be comfortable, she can walk, stand, sit, or lie down while doing KMC
- The best sleeping position for the mother during KMC is reclining (lying on the bed in a semi-upright position)
- If the mother's bed is not adjustable, she can use several pillows to prop herself up. She may also sleep on her side
- When the mother needs time away from the newborn for hygiene or any other reason:
    - Have a family member carry the newborn skin-to-skin while the mother is unavailable, or
    - Dress the newborn, place it in a warm bed, and cover it until the mother or the family member is available to continue skin-to-skin contact

Monitoring the newborn's condition

- Measure the newborn's temperature twice daily if the newborn is in continuous KMC
- Teach the mother to recognize the danger signs (apnoea, decreased movement, lethargy, or poor feeding)
- Explain to the mother that whenever there is an abnormal breathing pattern, she should report it immediately to the health care worker

- Comprehensive Newborn Monitoring Chart should be used daily i.e daily KMC scoring sheet, KMC registry, feeding chart, and growth chart (see Annex)
- If the newborn does not begin to breathe immediately resuscitate the newborn using a bag and mask
- Respond to any concern the mother may have. If the newborn is feeding poorly, determine if the mother's technique is incorrect, the newborn is still too immature or the newborn is becoming ill (repeat examination if necessary)

- A newborn **should not be immersed in wate**r until after the umbilical cord has fallen off and healed. Until then, it is good to give the newborn a sponge bath.
- Health care providers at the health facility need to review all babies at KMC room every day through clinical history taking, physical examination and vital signs monitoring and should initiate supplements such as iron after 2 weeks and Vitamin D (multivitamin) after attaining full feeds.

Criteria for discharge from Facility based KMC to home-based KMC

- Infant weight >1500g to 2000g, apnoea free and not on methylxanthines for 5 days on full feed by cup for three consecutive days and
- Daily KMC scoring > 19 for 3 consecutive days

KMC follow-up

Clinic schedules and termination of KMC

- <2000g- visits should be done weekly.
- <2500g – visit should be done every after 2 weeks.
- KMC should continue until the newborn is about 2500 g, After the baby attains 2500g KMC is no longer necessary and may be discontinued

NB: The location of the clinic should be well known and managed by staff who are competent in the care of preterm baby

Care during follow-up

- Check KMC practice, position, and duration and if there is any challenge.
- Feeding: Appropriate Exclusive Breastfeeding or alternative feeding, on maximum feeds and baby tolerate
- Assess for Growth. weight gain of at least 20g/day on average is expected. Check weight for age on the Fenton chart.
- Assess Illness: Babies should be assessed for possible signs of illness, whether the mother has complained or not.
- Drugs: Babies on medication should be given adequate drug supply as per indication with proper instructions. Adjust the dose according to the current weight if it is higher than the previous weight

- Immunization: The baby should receive immunizations as per the National immunization schedule.
- Routine child care Mother should be encouraged to attend routine child care once the baby reaches 2500g or 44 weeks of gestational age.
- Mother's concerns: Mother/family concerns should be discussed as much as possible aiming at solutions.
- Next follow-up visit: This should be discussed and agreed on the next visit, reinforcing specific discussed issues. The mother should be encouraged to keep the next appointment.

Readmission criteria

Readmit baby to hospital if:

- The baby gained less than 15g/kg/day in two consecutive follow-up visits
- The baby has not gained weight at all or the baby has lost weight.
- The baby is sick (febrile/cold, fast or difficult breathing, inability to feed, jaundice, lethargy, dehydration, convulsions, vomiting)
- The baby is anaemic and there is a need blood transfusion.
- If there is no one to continue providing KMC and the baby is less than 2000g

References

1. Ibrahim NR, Van Rostenberghe H, Ho JJ, Nasir A. Short versus long feeding interval for bolus feedings in very preterm infants. Cochrane Database Syst Rev. 2021 Aug 19;8(8):CD012322. doi: 10.1002/14651858.CD012322.pub2. PMID: 34415568; PMCID: PMC8407504. (3hrly feeding)
2. WHO recommendations for care of the preterm or low birth weight infant. Geneva: World Health Organization; 2022. Licence: CC BY-NC-SA 3.0 IGO.
3. Bombell S, McGuire W. Early trophic feeding for very low birth weight infants. Cochrane Database of Systematic Reviews 2009, Issue 3. Art. No.: CD000504. DOI:10.1002/14651858.CD000504.pub3. Accessed 03 September 2024 (trophic feeds 24mls)
4. Flint, Anndrea & New, Karen & Davies, Mark. (2007). Cup feeding versus other forms of supplemental enteral feeding for newborn infants unable to fully breastfeed. Cochrane database of systematic reviews (Online). 2. CD005092. 10.1002/14651858.CD005092.pub2.
5. PATH. Strengthening Human Milk Banking: A Global Implementation Framework. Version 1.1. Seattle, Washington, USA: Bill & Melinda Gates Foundation Grand Challenges initiative, PATH; 2013
6. Naicker M, Coutsoudis A, Israel-Ballard K, Chaudhri R, Perin N, Mlisana K. Demonstrating the efficacy of the FoneAstra pasteurization monitor for human milk pasteurization in resource-limited settings. Breastfeed Med. 2015 Mar;10(2):107-12. doi: 10.1089/bfm.2014.0125. Epub 2015 Feb 10. PMID: 25668396; PMCID: PMC4352695.
7. Jeffery BS, Mercer KG. Pretoria pasteurization: a potential method for the reduction of postnatal mother-to-child transmission of the human

immunodeficiency virus. J Trop Pediatr. 2000 Aug;46(4):219-23. doi: 10.1093/tropej/46.4.219. PMID: 10996983.
8. Li S, Guo P, Zou Q, He F, Xu F, Tan L. Efficacy and Safety of Plastic Wrap for Prevention of Hypothermia after Birth and during NICU in Preterm Infants: A Systematic Review and Meta-Analysis. PLoS One. 2016 Jun 9;11(6):e0156960. doi: 10.1371/journal.pone.0156960. PMID: 27281027; PMCID: PMC4900561.
9. McCall EM, Alderdice F, Halliday HL, Jenkins JG, Vohra S. Interventions to prevent hypothermia at birth in preterm and/or low birth weight infants.Cochrane Database Syst Rev. 2010 Mar 17;(3):CD004210 (wrap)
10. The united republic of Tanzania, ministry of health and social welfare, Reproductive and child care. Kangaroo Mother Care-Guideline. 2008
11. Kenya Ministry of Health Kangaroo Mother Care clinical implementation guidelines. 2023
12. Dutta S, Singh B, Chessell L, Wilson J, Janes M, McDonald K, Shahid S, Gardner VA, Hjartarson A, Purcha M, Watson J, de Boer C, Gaal B, Fusch C. Guidelines for feeding very low birth weight infants. Nutrients. 2015 Jan 8;7(1):423-42. doi: 10.3390/nu7010423. PMID: 25580815; PMCID: PMC4303848.
13. Eichenwald, Eric C., editor. | Hansen, Anne R., editor. | Martin, Camilia, editor. | Stark, Ann R., editor. Title: Cloherty and Stark's Manual of neonatal care: Ninth edition. | Philadelphia: Wolters Kluwer, [2023]
14. Brown JV, Lin L, Embleton ND, Harding JE, McGuire W. Multi-nutrient fortification of human milk for preterm infants. Cochrane Database of Systematic Reviews 2020, Issue 6. Art. No.: CD000343. DOI: 10.1002/14651858.CD000343.pub4
15. Merenstein & Gardner's handbook of neonatal intensive care / [edited by] Sandra L. Gardner... [et al.]. 7th ed. c2011
16. Baby-Friendly Hospital Initiative: Revised, Updated and Expanded for Integrated Care. Geneva: World Health Organization; 2009. Session 10, INFANTS WITH SPECIAL NEEDS. Available from: https://www.ncbi.nlm.nih.gov/books/NBK153455
17. Agarwal A, Rana V, Shafi S. A feeding appliance for a newborn baby with cleft lip and palate. Natl J Maxillofac Surg. 2010 Jan;1(1):91-3. doi: 10.4103/0975-5950.69149. PMID: 22442561; PMCID: PMC3304172.
18. Khasawneh W, Khassawneh M, Mazin M, Al-Theiabat M, Alquraan T. Clinical and Nutritional Determinants of Extrauterine Growth Restriction Among Very Low Birth Weight Infants. Int J Gen Med. 2020 Nov 19;13:1193-1200. doi: 10.2147/IJGM.S284943. PMID: 33239903; PMCID: PMC7682780.
19. Acceptable medical reasons for use of breast-milk substitutes. © World Health Organization 2009
20. Infant and Young Child Feeding: Model Chapter for Textbooks for Medical Students and Allied Health Professionals. Geneva: World Health Organization; 2009. ANNEX 1, Acceptable medical reasons for use of breast-milk substitutes. Available from: https://www.ncbi.nlm.nih.gov/books/NBK148964/
21. National Institute for Health and Care Excellence (NICE), Neonatal parenteral nutrition. NICE guideline NG154 Evidence reviews February 2020, www.nice.org.uk/guidance/ng154
22. Department of pediatrics Baylor college of Medicine. Guidelines for Acute Care of the Neonate, Edition 29,2021-2022

23. Joosten K, et al., ESPGHAN/ESPEN/ESPR guidelines on pediatric parenteral nutrition: Energy, ClinicalNutrition (2018),https://doi.org/10.1016/j.clnu.2018.06.944
24. Fivez T, Kerklaan D, Mesotten D, et al. Early versus late parenteral nutrition in critically Ill children. N Engl J Med. 2016;374:1111-22.

CHAPTER 6: RESPIRATORY CONDITIONS

6.1 Respiratory Distress Syndrome (RDS)

This is a disease of the immature lungs, characterised by a lack of pulmonary surfactant and alveolar collapse. This leads to failure of oxygenation with significant intercostal retractions and progressive lung injury. It is primarily observed in premature infants born less than 34 weeks gestational age. RDS may be noticed soon after birth (mostly within 1 hour of delivery).

If not treated properly, a newborn will end up in respiratory failure due to fatigue and may die.

Most newborns with RDS will improve within 72 hours of life. The WHO recommends the use of early CPAP for premature babies <32 weeks of gestational from the delivery room.

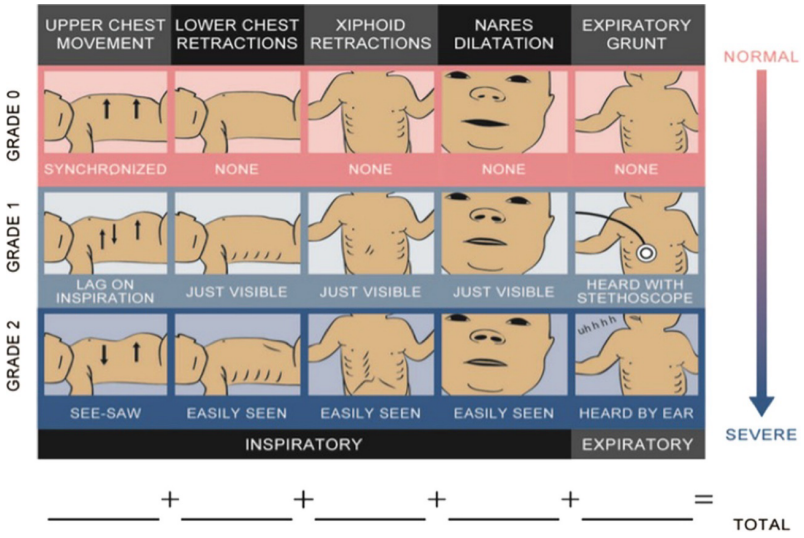
General principles

- Identification of at-risk mothers for premature delivery: multiple pregnancies, severe PIH, Uncontrolled diabetes in pregnancy
- Incomplete or no antenatal corticosteroid use (complete dose is 4 doses of Dexamethasone or 2 doses of Betamethasone).
- Early CPAP use and monitoring of the baby (saturation and signs of RDS) is important to prevent complications.

Clinical features of RDS include:

- Fast breathing (> 60 breaths/minute), severe chest wall indrawing, intercostal retractions, grunting
- Diminished breath sounds
- Cyanosis

Assessment of RDS using Silverman Anderson scoring score (SAS)



Interpretation of SAS score

- Mild RDS: 0 – 3 = Consider oxygen blender (nasal prongs when not
- moderate RDS = 4 – 6 = use CPAP
- severe RDS = 7 and above = consider surfactant for premature with RDS, or mechanical ventilation if available

Note: Prophylactic CPAP for all premature babies <1250gm or gestational age <30 weeks

Management of RDS

Level one facility

- If the mother has already given birth to LBW at this level, stabilize the newborn, start skin-to-skin
- Ensure temperature remains between 36.5^0C and 37.4^0C. This can be achieved by putting a baby in a KMC position, using a radiant warmer, or covering it with warm cloth.
- Prepare and start baby CPAP (you can prepare bedside CPAP see JOB aid).
- Start feeding or IVF as per fluid chart for day 1
- Check RBG and document the care given
- Refer directly to a District hospital.

Level two facility

- Aim to maintain normal temperature and normal blood glucose through out in the management of a premature baby with RDS
- Start the newborn on Continuous Positive Airway Pressure (CPAP). Prepare bedside CPAP if the facility does not have one. This can be started in the delivery room as prophylaxis for all babies <1250gm/ GA <32 weeks.
- Admit the baby in the HDU and continue with CPAP
- Assess for severity of RDS and oxygen saturation and adjust PEEP and FiO_2 accordingly.
- Monitor SAS score and saturation hourly for the first 6 hours.
- Baby with a SAS score of 8 and requiring FiO_2 of 40% to maintain saturation of 90% within the first 6 hours to 24 hours needs to be referred to level 3 for surfactant administration.
- Arrange for referral communicate with level 3 facility and continue with CPAP. The baby must be transferred on CPAP to a higher facility.
- Maintain a normal temperature range and a glucose level > 2.6mmol/l. Feed by NGT or give IVF according to the child's weight.

Level three facility

- Offer level II care with the addition of the following
- Give surfactant if SAS score is 7 and above and FiO_2 requirement is > 40% to maintain a saturation of 90%.
- Early surfactant < 6 hours is associated with good outcomes.

- Surfactant may be repeated after 6 - 12 hours if respiratory distress persists provided the baby is within 48hours of life.
- Baby can continue with CPAP after surfactant administration. Monitor SAS score and saturation record hourly and adjust accordingly to maintain saturation of 90% with minimal FiO_2. Note that respiratory distress usually improves after surfactant administration, and therefore close monitoring is essential to allow gradual weaning of CPAP support.
- Consider mechanical ventilation for a baby who has severe respiratory distress (SAS >7) and FiO2 of 40% after a second dose of surfactant administration.

Refer a baby to another facility if there is no CPAP and surfactant cannot be administered

6.1.1 Continuous Positive Airway Pressure (CPAP)

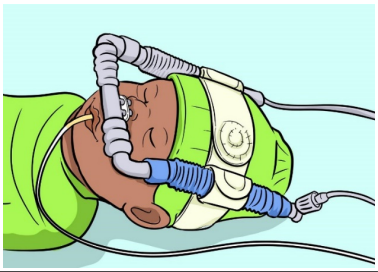
Continuous Positive Airway Pressure (CPAP) is a non-invasive respiratory support method used to maintain open airways and assist breathing in premature babies, particularly those with respiratory distress syndrome (RDS). CPAP provides a continuous flow of air to keep the alveoli in the lungs open, improving oxygenation and reducing the work of breathing. Ideally heated humified CPAP is preferred.

Indication for CPAP

1. Prophylactic CPAP: premature babies with GA < 32 weeks and or BWT <1250gm
    - These babies have a high risk of developing RDS even when it is not apparent at birth
    - When available portable CPAP should be started from the delivery room (theatre and labor ward)
2. Treatment of respiratory distress
    - Premature babies: it is indicated for management of respiratory distress syndrome
    - Term babies
        a. Meconium aspiration syndrome
        b. Transient tachypnoea of newborn
3. Management of severe pneumonia
4. Management of APNEA

How to attach the baby of CPAP

CPAP should not be tight fitting to avoid nasal septum injury. Insert an oral gastric tube for stomach decompression and use nasal septum interphase to protect the nasal septum See JOB AID for a step-wise approach



How to attach nasal CPAP prongs to the baby



Direction of nasal prongs into the nostrils

ble CPAP. In o
flow and can be set. The principle of monitoring remains the same.

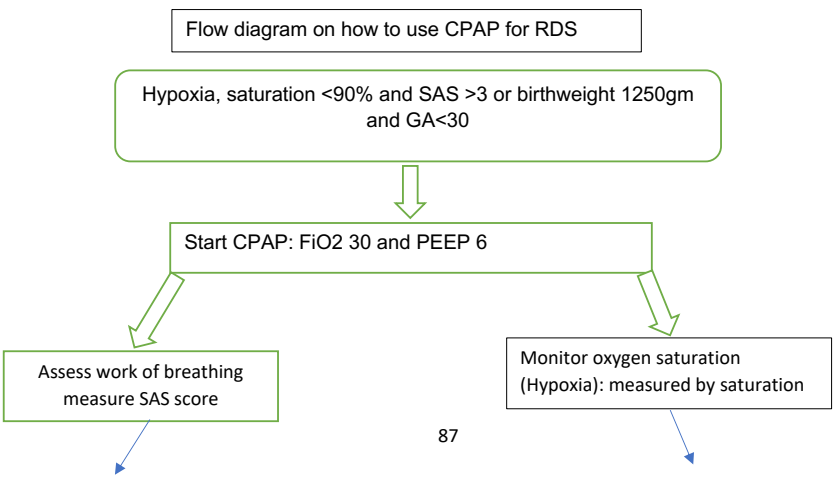
Oxygenation

- Start with fiO2 of 30%. Increase fiO_2 by 5% to ensure the baby can maintain saturation of 90%. Once baby saturation is beyond 94% start weaning saturation by 5 – 10% every hour.
- If the baby fails to maintain saturation of > 90% with fiO2 >50% and has a high PEEP of 8, the baby is likely going to need advanced respiration support and surfactant if available.
- For a baby who has a high FiO_2 requirement and no signs of respiratory distress, the baby might need cardiac evaluation.

Work of breathing

- Ensure the water is filled to appropriate levels depending on the type of machine available.
- Start with **a PEEP of 6** and monitor the SAS score.
- If there is no improvement on the SAS score and it increases, increase PEEP by one and the maximum level should be 8. PEEP > 8 is associated with barotrauma and may result in pneumothorax. Always ensure the water level is at the required level.
- Wean PEEP as baby signs of RDS improve. Wean by lowering PEEP by 1cm/H_20 every hour. The lowest PEEP should be 5.

Flow diagram on how to use CPAP for RDS



1. Start with PEEP of 6
2. Increase PEEP to 7 if the baby work of breathing is not improving and is saturating above 90% with the current fiO_2 setting
3. When the PEEP> 7 and FiO2 is > 40% consider surfactant if indicated for eligible premature babies
4. Consider mechanical ventilation if available for other condition apart from RDS if FiO2 > 50%
5. Wean PEEP when the neonate work of breathing is improving by 1

Accepts saturation >90% with minimal Fio2
Increase FiO2 by 5 – 10% to attain saturation of > 90%
If the FiO_2 requirement is > 40% consider Surfactant and continue with CPAP
If baby saturation improves to above 90% reduce FiO2 to maintain saturation > 90%

rt and sa

DS urgent CXR is indicated to rule out pneumothorax – see below

- If the baby has no signs of respiratory distress and saturation does not improve with increased FiO_2 requirement consider doing an ECHO if available to rule out congenital heart diseases (refer to a chapter on congenital heart diseases)
- A previously resolved RDS premature baby who suddenly develops apnea, hyperglycaemia and becoming pale might have developed intracranial haemorrhage and will need cranial ultrasound, but also consider septic workout (refer to a chapter on neonatal sepsis)
- While the baby is on CPAP, especially non-humidified heated air, add saline drops every three hours. Ensure the nasal interface is not too tight to cause nasal septum injury.
- Only distilled water should be used on the CPAP and changed daily.
- Once the signs of RDS have subsided and a baby is on minimal CPAP support without signs of respiratory distress, then it can be transitioned to an oxygen blender. If not, available low flow oxygen is used. Always ensure for a premature baby, target saturation is not more than 90% because of risk ROP.

Disinfection for CPAP and breathing circuit refer to JOB aid

Complications of CPAP

1. CPAP belly

- This is gaseous abdominal distension seen in babies placed on CPAP
- Usually improves once the air is aspirated
- May cause feeding intolerance: inability to breastfeed or vomiting

2. Nasal septum necrosis
   - This injury occurs from very tight application of CPAP
   - Loose fitting and appropriate size fitting mask is advocated – SEE JOB AID
   - Nasal septum interphase (Neoseal can be used to protect the septum)

3. CPAP Failure in Premature Babies

It occurs when CPAP therapy is insufficient to meet the respiratory needs of a premature baby. Defined as worsening respiratory distress, and/or hypoxemia (PaO_2 <50

mmHg)/hypercarbia ($PaCO_2$ >60 mmHg) despite CPAP pressure of 8 cm H_2O and FiO_2 of 60%. Dealy initiation of CPAP is associated with a high CPAP failure rate.

Signs of CPAP Failure

a) Worsening of Respiratory Distress: Continued or worsening symptoms of respiratory distress despite CPAP, such as rapid breathing (tachypnea), grunting, nasal flaring, and retractions.
b) Oxygen Desaturation: Persistent low oxygen levels in the blood (hypoxemia) that do not improve with CPAP.
c) Increased Work of Breathing: Evidence that the baby is working harder to breathe, indicated by more pronounced chest retractions or use of accessory muscles.
d) Chest X-ray Changes: Deterioration in chest X-ray findings, such as increased atelectasis (lung collapse) or worsening RDS.
e) Clinical Deterioration: Overall clinical decline in the baby's condition, including decreased activity or changes in heart rate and blood pressure.

Causes of CPAP Failure

a) Severe Respiratory Distress: If the underlying respiratory condition is more severe than anticipated, CPAP alone may not be sufficient.
b) Insufficient Pressure Settings: Incorrect CPAP pressure settings may fail to provide adequate support for the baby's breathing.
c) Obstructive or Central Apneas: Conditions where the baby has frequent pauses in breathing due to obstructions or central control issues.
d) Underlying Lung Disease: The presence of additional lung conditions or complications, such as pneumothorax, surfactant deficiency etc
e) Malfunctioned devices causing the device not to provide the required support, can be due to inappropriate CPAP machine or interface, such as leaks or incorrect fit.

Management of CPAP Failure

a) Re-evaluate CPAP Settings: Ensure that CPAP pressure levels are set appropriately for the baby's needs. Adjustments may be needed based on ongoing assessments.
b) Assess and Treat Underlying Conditions: Address any underlying issues contributing to respiratory distress, such as administering surfactants or treating infections.
c) Consider advanced respiratory support and or surfactant administration if indicated.

6.1.2 Invasive Mechanical Ventilator

Introduction:

The goals of mechanical ventilation are to facilitate adequate gas exchange and decrease the neonate's work of breathing, while minimizing the risk of lung injury and optimizing

comfort. Conventional mechanical ventilation (CMV) remains the mainstay of assisted ventilation in neonates despite the development of new ventilatory techniques.

Management of infants on mechanical ventilation require specialized personnel, a registrar or consultant should be available at all times.

Ideal nurse to patient ratio for infants on assisted ventilation is 1:1. Because of limited human resources we accept ratios of 1:2 in our unit.

Ventilators commonly use two primary modes of ventilation: **Pressure Control** and **Volume Control**. Each mode offers specific benefits and is chosen based on the patient's condition and clinical goals

Pressure-Controlled Ventilation (Pressure Mode)

- **Mechanism**: Provides a preset pressure per breath, with variable volume based on lung compliance and resistance.

Volume-Controlled Ventilation (Volume Mode)

- **Mechanism**: Delivers a set tidal volume per breath, adjusting pressure as needed to achieve this volume

Volume-Targeted Ventilation (VTV) is now the preferred mode for neonatal mechanical ventilation. It maintains consistent tidal volumes by adjusting inspiratory pressures based on lung compliance and resistance, reducing the risks of lung overdistension and inadequate ventilation.

Types of Mechanical Ventilation for Neonates

- **Conventional Mechanical Ventilation (CMV)**
    - **Assist Control Ventilation (AC**) or synchronized intermittent positive pressure ventilation (SIPPV) Supports every spontaneous breath, ie delivers preset back up breaths per minute (control breaths) and supports spontaneous breaths above the set rate (assist breaths),.
    - **Synchronized Intermittent Mandatory Ventilation (SIMV)**: Delivers preset breaths with synchronization to spontaneous breaths (supports only a proportion of the spontaneous breaths ie, spontaneous breaths above the set rate are not supported).
    -
    - **Pressure-Controlled Ventilation (PCV)**: Maintains a consistent peak inspiratory pressure.

- **Volume-Controlled Ventilation (VCV)**: Delivers a set tidal volume with each breath.
- Hybrid modes of ventilation: combine the advantages of various modes to make ventilation more physiological and gentler on the lungs
  - SIMV/SIPPV + VG: the set number of breaths will be given with the targeted tidal volume by adjusting PIP based on the previous exhaled tidal volume
  - Synchronized intermittent mandatory ventilation plus pressure support (SIMV + PS) provides mandatory breaths at a set rate (SIMV breaths) and also supports spontaneous breaths above the set rate (PS breaths). The SIMV component uses volume-targeted breaths, while the spontaneous (PS) breaths will be pressure-limited.

- **High-Frequency Ventilation (HFV)**

  May be "lung-protective" relative to CMV, can be used either as the primary mode of MV support following endotracheal intubation ("elective" HFV therapy), or as "rescue" therapy for neonates with poor gas exchange despite efforts to optimize CMV

  - **High-Frequency Oscillatory Ventilation (HFOV)**: Uses high rates and low tidal volumes, often for severe lung diseases.
  - **High-Frequency Jet Ventilation (HFJV)**: Similar to HFOV but delivers rapid jets of air, commonly used in pulmonary air leaks.

Indications for Mechanical Ventilation in Neonates

Mechanical ventilation is indicated for neonates under the following conditions:

- **Respiratory Failure**: PaO_2 < 50 mmHg or $PaCO_2$ > 60 mmHg despite oxygen therapy.
- **Continuous positive airway pressure (CPAP) failure**: Defined as worsening respiratory distress, and/or hypoxemia (PaO_2 <50 mmHg)/hypercarbia ($PaCO_2$ >60 mmHg) despite CPAP pressure of 8 cm H_2O and FiO_2 of 60%.
- **Severe Respiratory Distress Syndrome (RDS)**: receiving nasal CPAP and who need an increasing fraction of inspired oxygen (FIO2).
- **Persistent Pulmonary Hypertension of the Newborn (PPHN)**: With hypoxemia refractory to other therapies iNO, Sildenafil, Milrinone (refer PPHN chapter).

- **Congenital Diaphragmatic Hernia (CDH)**: For stabilization if desaturating preoperatively (typically intubated and mechanically ventilated after birth to prevent gastric distension and lung compression).
- **Sepsis or Pneumonia**: When non-invasive methods fail.
- **Meconium Aspiration Syndrome**: Severe cases where respiratory function is compromised.
- **Apnea of Prematurity**: If unresponsive to non-invasive support or medications.
- Post operatively with respiratory failure

Settings for Neonatal Mechanical Ventilation

Initial settings should be adjusted based on the weight, age, and condition of the neonate:

- **Tidal Volume (Vt)**: Start with 4–6 mL/kg for preterm infants and 5–7 mL/kg for term infants. As a standard approach, initiate with a PEEP of 5 and make adjustments based on the patient's response.
- **Respiratory Rate (RR)**: Set between 40–60 breaths per minute.
- **Peak Inspiratory Pressure (PIP)**: Start with 16–25 cm H_2O (adjust based on chest rise and target tidal volume).
- **Positive End-Expiratory Pressure (PEEP)**: Start with 4–6 cm H_2O; higher in cases of severe RDS.
- **Inspiratory Time (Ti)**: 0.3–0.4 seconds for preterm and 0.35–0.5 seconds for term neonates.
- **FiO_2 (Fraction of Inspired Oxygen)**: Start at 40–60% and adjust to maintain SpO_2 at target levels (90–94% for preterm and term infants).

Initial HFOV Settings for Neonates

1. **Mean Airway Pressure (MAP)**
    - **Setting**: Start at 2–4 cm H_2O above the MAP used in conventional ventilation.
    - **Goal**: MAP should be adjusted to achieve adequate lung inflation, generally between the 8th and 9th posterior ribs on a chest X-ray.
    - **Typical Range**: 10–15 cm H_2O (adjust based on oxygenation and lung volume).
2. **Amplitude (ΔP) or Power**

- **Setting**: Adjust to achieve visible chest vibrations (or "wiggle") down to the umbilicus.
- **Typical Range**: 20–30 cm H_2O but may vary depending on neonate size and disease severity.
- **Adjustment**: Increase amplitude if CO_2 levels are elevated, and decrease if CO_2 is low.

3. **Frequency**
   - **Setting**: 10–15 Hz for very low birth weight neonates (i.e., preterm infants <1,000 g).
   - **Range for Larger Neonates**: 8–10 Hz, as frequency may need to be lowered for improved ventilation in larger infants.
   - **Note**: Lower frequencies allow for better CO_2 clearance.
4. **Inspiratory Time (I: T Ratio)**
   - **Setting**: Typically, 33% (I:T ratio of 1:2).
   - **Goal**: Allows for optimal gas exchange and reduces risk of air trapping.
5. **Fraction of Inspired Oxygen (FiO_2)**
   - **Setting**: Start at 100% FiO_2 and then titrate down to the minimum required to maintain target oxygen saturation levels.
   - **Goal**: Keep oxygen saturation within target range (e.g., SpO_2 of 90–94% for preterm and term neonates).

Ventilator strategies for different conditions

Preterm with RDS (Use lung protective strategies)

- VTV (VG) to minimize volutrauma
- Adequate PEEP to maintain lung recruitment and avoid atelectasis
- Avoidance of high FiO_2 (SpO_2 target 90 to 95%)
- Modest permissive hypercapnia (pCO_2 target between 40 and 65 mmHg)
- Use of HFOV in neonates with refractory respiratory failure while on CMV

BPD:

- SIMV+PS or AC
- Severe BPD may require higher TV to maintain effective ventilation because airway dilation and dead space to tidal volume ratio.
- In patients with uneven airway obstruction, prolong inspiratory time (0.4 to 0.5 seconds) to promote uniform lung inflation
- In case of bronchomalacia use higher PEEP to keep airways open during exhalation
- SpO_2 goal is 90 to 95%
- $PaCO_2$ goal is 55 to 65 mmHg and pH goal is 7.3 to 7.4

PPHN/MAS

- CMV with patient-triggered volume-targeted mode
- Start with Tv of 4 to 6 mL/kg and PEEP of 5 to 7 cm H_2O
- If gas exchange targets are not met with low Tv ventilation, the Tv setting can be liberalized
- If an FiO2 >0.6 is required achieve the target SpO2, increase PEEP or transition to HFV
- Preductal SpO2: 90 to 95%; with pre-and postductal SpO2 difference: <3 to 5%
- Permissive hypercapnia (PaCO2: 40 to 45 mmHg), provided that pH is not <7.25

CDH:

- CMV with a gentle ventilation with permissive hypercapnia provided that pH remains >7.25 and preductal oxygen saturation targets above 85%
- Pressure-limited ventilation with a goal positive inspiratory pressure <25 cm H_2O.
- HFOV if fail to achieve targeted goals on CMV or in severe CDH

Congenital heart disease

- CHD with inadequate pulmonary blood flow (decreased pulmonary vascular markings on CXR): aim to reduce PVR through the use of higher FiO_2 and larger tidal volumes
- CHD with excessive pulmonary blood flow (decreased pulmonary vascular markings on CXR): increase PVR though use of lower FiO_2, and smaller Tidal volumes

Monitoring in Neonates Post-Intubation

- Blood Gas
  - 30 Minutes Post-Intubation: Initial blood gas to assess ventilation and oxygenation effectiveness.
  - Every 1-2 Hours: For ventilator adjustment and stabilization.
  - Every 4-6 Hours: Once stable and settings are optimized.
  - Every 12-24 Hours: In stable neonates on consistent settings, or as clinically indicated.
- Radiologic Assessment: Chest X-ray, confirms ETT placement, assesses lung expansion, identifies underlying pathology, and monitors ongoing ventilation effectiveness.
- Adjustment: Settings should be adjusted based on clinical response, including blood gas results, oxygen requirements, and lung inflation.

Always consult with the medical team (Neonatologist, Pediatrician or intensivist) before altering ventilator settings to ensure safe, accurate modifications for the neonate's needs. Each change in ventilator settings

Table summarizing ventilator adjustments based on blood gas and oxygenation needs in a ventilated neonate:

Condition	Parameter to Adjust	Adjustment Action	Goal
Retaining Carbon Dioxide	Respiratory Rate (RR)	Increase RR to promote CO_2 elimination.	Lower $PaCO_2$ to normal range (35-45 mmHg)
	Tidal Volume (Vt) or Pressure	Increase tidal volume or inspiratory pressure if safe to enhance CO_2 removal.	
Over-Oxygenated	FiO_2 (Fraction of Inspired O_2)	Decrease FiO_2 to reduce excess oxygenation.	Maintain SpO_2 between 90-94%
Low Oxygen Saturation (Hypoxemia)	Positive End-Expiratory Pressure (PEEP)	Decrease PEEP if oxygenation remains high and lung compliance is adequate.	Achieve target SpO_2 within safe range
	FiO_2	Increase FiO_2 gradually to improve oxygenation.	
	PEEP	Increase PEEP to open alveoli and improve oxygenation.	
Respiratory Acidosis	Respiratory Rate or Vt	Increase RR or Vt to enhance CO_2 clearance and correct acidosis.	Normalize pH (7.35-7.45)
Respiratory Alkalosis	Respiratory Rate	Decrease RR to retain CO_2 and reduce alkalosis.	Normalize pH
Low Tidal Volume/Apnea	Inspiratory Pressure or Vt	Increase inspiratory pressure or Vt if CO_2 is elevated due to low volume.	Ensure adequate ventilation

Weaning Mechanical Ventilation

The goal is to gradually decrease support as the neonate demonstrates improved respiratory stability:

- **Assess Readiness**: Reduction in oxygen requirement ($FiO_2 \leq 0.3$), stable blood gases, consistent respiratory effort.
- **Gradual Reduction in Settings**:
  - Decrease PIP in 1–2 cm H_2O increments.
  - Reduce respiratory rate if neonate initiates spontaneous breaths.
  - Decrease FiO_2 as tolerated.
- **Monitor Parameters**: Maintain stable blood gases, monitor for respiratory distress, adjust based on chest expansion and vital signs.

Trial Periods Off Ventilation: Consider extubation when settings are low (PIP ≤ 15 cm H_2O, PEEP ≤ 4 cm H_2O, RR ≤ 20).

Contraindications to Mechanical Ventilation

Mechanical ventilation is generally indicated when necessary for respiratory support; however, contraindications may include:

- **Terminal Illness or Futility of Care**: If ventilation will not provide a quality of life or a viable prognosis.
- **Severe Neurological Damage**: Cases where irreversible brain damage precludes meaningful recovery.
- **Parental Wishes**: If parents decline invasive interventions in cases of poor prognosis.

Complications of Mechanical Ventilation in Neonates

- **Barotrauma**: Lung injury from excessive pressure, leading to conditions such as pneumothorax.
- **Bronchopulmonary Dysplasia (BPD)**: Chronic lung disease caused by prolonged ventilation, more common in preterm infants.
- **Intraventricular Hemorrhage (IVH)**: Common in premature infants, often associated with fluctuating blood pressure, Hypercapnia and Hypocapnia
- **Pneumothorax**: Air leaks due to high PIP or inadequate ventilation settings.
- **Infection**: Ventilator-associated pneumonia or sepsis.
- **Retinopathy of Prematurity (ROP)**: Exacerbated by high oxygen concentrations in preterm infants.

Sedation for Neonates on Mechanical Ventilation

Sedation in neonates on mechanical ventilation is used selectively based on individual needs to enhance comfort, reduce distress, and prevent complications. Sedation may be necessary in cases of agitation, severe respiratory distress, ventilator-patient asynchrony, procedural pain, or high intracranial hemorrhage risk. In stable, minimally supported neonates, sedation might not be required due to risks like respiratory depression and potential neurodevelopmental impacts.

Common Sedatives and Analgesics:

- **Morphine**: Provides sedation and analgesia but may cause respiratory depression.
- **Fentanyl**: Quick-onset analgesia for short-term use, with caution for respiratory effects.
- **Midazolam**: Sedative, often used with opioids, with risk of respiratory depression.
- **Dexmedetomidine**: Sedation with minimal respiratory impact, but off-label for neonates.
- **Ketamine**: Used in specific cases for sedation and analgesia without major respiratory effects, typically reserved for unstable neonates.

The **"DOPES"** mnemonic is widely used in clinical practice as a quick guide for troubleshooting sudden respiratory deterioration in patients on mechanical ventilation.

This mnemonic provides a structured approach:

- **D (Displacement)**: Checking for endotracheal tube displacement.
- **O (Obstruction)**: Ensuring the airway is not blocked by secretions or kinks.
- **P (Pneumothorax)**: Assessing for signs of pneumothorax.
- **E (Equipment failure)**: Verifying ventilator function and connections.
- **S (Stomach distension)**: Managing gastric distension with decompression if needed.

Ventilator-Associated Pneumonia (VAP) Overview
VAP is a lung infection occurring in patients on mechanical ventilation for more than 48 hours, especially critical in neonates due to the high risk of complications and increased morbidity and mortality.

VAP Prevention in Neonates

1. **Hand Hygiene**: Strict hand washing and use of gloves with aseptic technique.
2. **Oral and ETT Care**: Regular sterile oral care and securing the ETT to prevent movement.
3. **Closed Suction System**: Use only as clinically needed to reduce contamination.
4. **Minimize Circuit Changes**: Change circuits only when soiled or malfunctioning.
5. **Positioning**: Elevate the neonate's head to 30 degrees to prevent aspiration.
6. **Aspiration Precautions**: Proper NGT/OGT placement and monitor for residuals.
7. **Avoid Unnecessary Antibiotics**: Limit to reduce resistance and maintain flora.

8. **Non-Invasive Ventilation**: Use when possible to avoid intubation.

Comprehensive Neonatal Ventilator Care

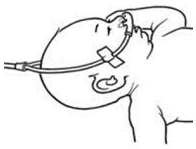
1. **Continuous Monitoring**: Track vital signs and adjust ventilator settings as needed.
2. **Fluid Balance**: Monitor intake and output to avoid fluid imbalances.
3. **Skin and Pressure Care**: Reposition regularly and use padding to prevent sores.
4. **Nutritional Support**: Provide enteral feeding and adequate caloric intake.
5. **Sedation and Comfort**: Minimize sedation; use non-pharmacologic comfort methods.
6. **Developmental Care**: Limit noise, light, and provide skin-to-skin contact if possible.
7. **Laboratory Monitoring**: Regular blood gas, electrolyte, and infection markers.
8. **Family Involvement**: Educate and involve parents for emotional support and improved outcomes.

6.1.3 Oxygen administration:

Oxygen can be administered by nasal prongs. Premature babies require oxygen blenders for to reduce the risk of retinopathy of prematurity. Always ensure the humidifier is filled with distilled water to the appropriate level. Oxygen will be administered to any baby with mild distress, SAS score < 3 who fails to maintain saturation >90%

When to give oxygen support

- Give oxygen when saturation is below 90 % (caution in the delivery room refer to target saturation for the first 10 minutes of life).
- It is advised to use an oxygen blender for all premature babies and titrate FiO2 requirement to maintain saturation of >90%.
    - Select appropriate nasal prongs for the baby. Nasal prongs as a preferred method to administer oxygen to neonates, non-rebreather mask is usually not used in the neonatal care unit.
    - Flow rate 0.5 – 2 l/min, titrate depending on oxygen saturation. Always use with a humidifier.
    - A high-flow oxygen can be used (with heated humidification) a flow of up to 6l/min can be used for moderate preterm babies
- Observe nasal secretions and do gentle suction if obscuring the airways. Use saline nasal drops for dry nose. Routine suctioning is not advised.
- Oxygen should be weaned when the general condition improves:
    - Oxygen saturation is > 90% with minimal flow and minimal FiO_2.
    - Breathing well and no signs of distress (normal respiratory rate, no chest in drawing and intercostal recession)
- Document: Oxygen flow rate, heart rate, respiratory rate, oxygen saturation.
- Remember to change distilled water daily



How to secure nasal prongs

6.1.4 Air leak syndrome (Pneumothorax)

Pneumothorax: this is a leakage of air into the pleural space causing lung collapse on the affected side.

Clinical signs of Pneumothorax

- Worsening respiratory distress with severe of hypoxia failing to respond to CPAP
- Asymmetrical chest movement and decrease of air entry on the affected side
- Collapse of the affected side and hype-infected on the contralateral side

Investigation

- Urgent CXR or lung USS if available
- Cord light can confirm an air leak.
- Blood gas analysis

Management of Pneumothorax

It is a medical emergency. Do a needle decompression to release pneumothorax in an emergency or insert a chest tube after confirming a chest XRAY. If feasible a lung ultrasound can be done. A needle decompression might be followed by a chest drain in case of persistent worsening of signs of distress and hypoxia. Always remember to seal the area after decompression

How to perform a needle decompression

The steps for inserting a needle decompression in a neonate with pneumothorax are:

1. **Position the neonate**: Place the infant in a supine position
2. **Prepare the area**: Cleanse the skin with an alcohol wipe or antiseptic solution
3. **Insert the needle**: Insert the needle into the pleural space, usually at the 2nd ICS anterior mid-clavicular line
4. **Aspirate**: Aspirate air or fluid until you feel resistance
5. **Remove the needle**: Remove the needle and place a sterile dressing over the site
6. **Monitor**: Monitor the neonate's vital signs closely



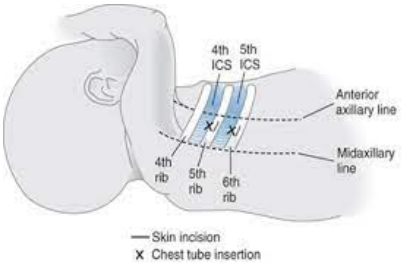
How to do a needle decompression

Procedure for insertion of a chest drain

Consult the surgical team if the team is not capable of inserting a chest drain. This should be done preferably in a level three care facility, if ababy need to be reffered a needle decompression can be done

- **Position the baby**: Elevate the affected side of the baby by placing a towel under their back. An assistant should rotate the baby's arm toward their head.
- **Prepare the skin**: Clean the area with 70% alcohol and allow it to dry.
- **Infiltrate with local anaesthetic**: Inject the area around the anterior axillary line with a local anesthetic, such as 1% Lidocaine.
- **Make an incision**: Incise the skin above the rib in the 4th or 5th intercostal space.
- **Bluntly dissect**: Use a clamp to bluntly dissect through the subcutaneous tissue and into the pleural space.
- **Insert the introducer needle**: Insert the introducer needle into the pleural space at a right angle to the skin. Once you enter the space you will release pressure with a pop sound,
- **Thread the catheter**: Thread the pigtail catheter/chest tube catheter onto the guide wire and insert it into the chest.
- **Secure the catheter**: Fix the catheter to the chest wall with a plaster (preferably tegaderm if available)
- **Apply dressings**: Apply tegaderm dressings on opposite sides of the catheter.
- **Connect to drainage system**: Attach the tube connector to the underwater drainage system.
- **Take an X-ray**: Obtain a chest X-ray to confirm the position of the chest tube.

When a chest tube cannot be inserted and the neonate needs an urgent referral to a higher facility



6.2 Meconium Aspiration Syndrome (MAS)

Respiratory distress in neonate born through meconium-stained amniotic fluid (MSAF) whose symptoms cannot be otherwise explained. It occurs in approximately 2-10% of neonates born with meconium -stained amniotic Fluid.(1) The pathophysiology of MAS involves intrauterine passage of meconium into amniotic fluid, which the neonate aspirate. Meconium is a sterile, thick odourless material firstly produced during the third month of gestation, becomes infrequent by 20 weeks. However foetal stress may result in meconium passage due to increased peristalsis and relaxation of the anal sphincter.

Meconium stain: Neonate born through MSAF

Meconium Aspiration: Meconium in amniotic fluid can be aspirated during foetal gasping or in the initial breaths after delivery. When aspirated into the foetal or neonatal lung, it causes pulmonary injury with airway obstruction, inflammation and hypoxemia. Generally, neonates who develop MAS exhibits signs of respiratory distress after birth.

Note: A baby may swallow meconium (meconium ingestion) which is harmless.

The severity varies and depends on the oxygen demand and duration of need of respiratory support (2)

Risk factors (3)

- Post-term delivery
- Foetal distress (Non reassuring fetal Heart Rate based on Fetal Heart Monitoring)
- Low Apgar Score
- Maternal Infection or morbidity e.g. Diabetes, Hypertension
- Intraamniotic inflammation and infection
- Vaginal breech delivery
- Caesarian delivery

Clinical Presentation

- Evidence of Meconium-Stained in Skin/Umbilical Cord/Nails
- Features of birth asphyxia-Presents a few hours after birth (Floppy baby, bradycardia, cyanosis, apnoea)
- Respiratory Distress: Grunting, nasal flaring, fast breathing, and severe chest wall indrawing, hyperextended, barrel shaped thorax.
- Cyanosis/ Hypoxia
- Pulmonary Hypertension (as discussed in the chapter of PPHN), which is characterized by right to left shunt. There will be a difference of >10% saturation of pre-ductal and post-ductal.
- Signs of post-term delivery, such as dry parched and peeling of skin, long nails.
- Pulmonary air leak -Pneumothorax, pneumo-mediastinum.
- Respiratory failure in severe disease.

Investigations

1. Chest Xray
   - At initial stage - streaky, linear densities

- As it progresses -Lungs appear hyperinflated with flattening of the diaphragm with patch densities.
- Severe diseases: Homogenous opacification, collapse.

2. ECG: Shows features of Right ventricular hypertrophy and Right axis deviation.
3. Acid Gas Analysis: Acidosis, with carbon dioxide retention. The goal is to maintain pH in the range 7.25–7.40 and PaCO2 in the range 40–55 mmHg.
4. Septic work-up such as FBP, Blood Culture, CRP
5. ECHO to check Pulmonary hypertension (as indicated in the PPHN chapter) and critical congenital structural heart diseases

Management.

1. Initial management: Should be guided by the general principles of Neonatal resuscitation -Airway and Breathing: Dry and stimulate the baby, (Refer the topic of Neonatal Resuscitation).

N.B Routine intrapartum nasopharyngeal suctioning in neonates delivered through MSAF is not recommended.

2. Respiratory support: Focuses on maintaining optimal oxygenation and ventilation. Need of respiratory support is based upon neonatal respiratory efforts. Use Downes /SAS score to make a decision of using LNFC/HFNC/CPAP/Mechanical Ventilator. Peripheral oxygen saturation (SPO2) should be maintained at 95 – 98% (avoid hypoxemia because it contributes to pulmonary vasoconstriction and worsens PPHN if present).

Note: When a neonate does not achieve target oxygenation saturation on LFNC/HFNC, requiring CPAP, should be referred to the facility with Level 2 NCU.

3. Hemodynamic support: Maintain adequate BP (mean arterial blood pressure should be between 30-40mmHg) and Perfusion

- Inotropic Therapy in neonates with hypotension or reduced left cardiac output can be used. (Dopamine or Norepinephrine)
- For severe PPHN, the use of sildenafil and/or Milrinon may be given. (Refer to PPHN Chapter)

4. Correction of metabolic abnormalities such as acidosis and hypoglycemia
5. Antibiotics therapy should be given until infection has been excluded.
6. Minimal handling to avoid agitation which may exacerbate PPHN if present
7. Should be cared in a neutral thermal environment.

Additional interventions

- Surfactant is limited to severe diseases and to small neonates with meconium aspiration syndrome.
- Inhaled Nitric Oxide especially when saturations are not maintained despite full ventilatory support.
- In severe cases where neonates are refractory to mechanical ventilation Extracorporeal Membrane Oxygenation (ECMO) may be needed in centres where available.

Supportive care:

- Supportive care such as maintenance of temperature, reduction of noise and tactile stimulation, nutrition and fluid management should be done continuously.

Complications

- Pulmonary complications: Pneumonia, pneumothorax (air in the chest cavity), or persistent pulmonary hypertension of the newborn (PPHN).
- Long-term effects: Potential developmental delays or chronic lung disease in severe cases.

Prognosis

- Generally favourable with appropriate and timely intervention.
- Severity of MAS and associated complications influence outcomes.
- Long-term follow-up may be necessary for monitoring developmental progress.

6.3 Persistent Pulmonary Hypertension (PPHN)

Persistent pulmonary hypertension of the newborn (PPHN) occurs when pulmonary venous resistance (PVR) remains abnormally elevated after birth. This results in right to left shunting of blood through fetal circulatory pathway leading to hypoxemia.

Causes

Table xxx: Causes of PPHN

Underdevelopment of Pulmonary Vasculature
• Congenital diaphragmatic hernia
• Congenital Pulmonary Airway Malformation (CPAM)
• Pulmonary hypoplasia
• Renal Agenesis
• Oligohydramnios with fetal obstructive uropathy
• IUGR /SGA
Maldevelopment
• Post term delivery
• Premature closure of ductus arteriosus e.g. Congenital Heart Diseases such as Total anomalous Pulmonary Venous Return (TAPVR)
• Idiopathic
Maladaptation of Pulmonary Vasculature
• Meconium aspiration syndrome (MAS)
• Transient Tachypnoea of Newborn (TTN)
• Congenital pneumonia
• Sepsis
• Respiratory Distress Syndrome
• Perinatal hypoxia
• Hypothermia

Clinical Features

Most neonates with PPHN present within the first 24 hours of life with signs of respiratory distress. (Use Downes Score for term neonates, see annex ....)

- Tachypnoea
- Tachycardia
- Cyanosis - right-to-left extrapulmonary shunting in the presence of high PVR
- Respiratory acidosis
- Labile hypoxemia (may be unresponsive to O_2 therapy but respond to increasing BP
- Loud, single second heart sound (S2) or a harsh systolic murmur on left lower sternal border (secondary to tricuspid regurgitation)

Diagnosis

Diagnostic features of PPHN (1)

1. SPO2 below 95% in 100% FiO2.
2. Oxygenation index (MAP*FiO_2/PaO2) >25 OR PaO_2 <13.3 in 100% FiO_2
3. A difference of >5-10% saturation of pre-ductal (Right hand) and post-ductal (left or any lower limb)
   NB: Absence of differential saturation does not exclude PPHN as shunting may be predominantly through foramen ovale rather than PDA
4. ECHO -Definitive diagnosis
   a. Elevated right ventricular Pressure estimated by measurement of the velocity of the Tricuspid Regurgitation (Pressure gradient) if present.

	Mild	Moderate	Severe
Pressure Gradient (PG)(mmHg)	35-45mmHg	46-55mmHg	Above 65mmHg

   b. If there is no TR, Right Ventricular Pressure can be assessed qualitatively- Flattened or displaced ventricular septum.
   c. In severe cases, right to left shunting through patent ductus arteriosus and/or foramen Ovale.
   (See the diagram below)

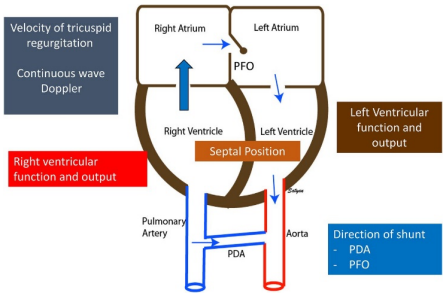


Figure 1; ECHO features in PPHN include; high right ventricular pressures resulting in tricuspid regurgitation. R – L shunt at the patent foramen ovale (PFO) and PDA.

5. Hypoxemia disproportionate to the severity of parenchymal disease on chest radiography should suggest idiopathic PPHN (or cyanotic heart disease)

Investigations

- CXR- May be normal or demonstrate features of an associated pulmonary conditions. e.g., meconium aspiration syndrome, pneumonia, surfactant deficiency).
- ECHO – Gold standard for confirming diagnosis, monitoring treatment efficacy and exclude CHD that mimics PPHN
- Arterial blood gases – typically will show:
    a. Low PaO2 less than 100 mmHg in a neonate receiving Fio2 of 100%
    b. PaCo2 is normal in neonate without accompanying lung disease.
- Sepsis workup (Refer to screening for EOS in sepsis topic

Management

Stabilization

- Resuscitation in the delivery room should focus on optimal lung ventilation (Refer neonatal resuscitation topic).
- Optimize oxygenation (helps to reverse PVR) to maintain a preductal pulse saturations above 90%
- Volume replacement and use of inotropes (Dopamine, Dobutamine or Adrenaline) if there is hypotension (Dopamine should be used with caution; it is a nonselective vasoconstrictor thus may increase PVR and worsen PPHN)
- Minimal handling of the baby, and facilitate relaxation by covering the eyes and ears to avoid stimulation. Avoid invasive procedures like suctioning
- Sedation and analgesia with Morphine or Fentanyl may be considered in neonates on mechanical ventilation
- Stabilize the patient by monitoring and maintaining optimal temperature, blood glucose, acidosis, BP, hypocalcemia.
- Transfer to level 3 care where available

Ventilation

- Initially attempt to achieve and maintain normal ventilation (Arterial Partial pressure of carbon dioxide (PACO2) should be maintained at 40-45 mmHg (permissive hypercapnia) as long as pH remains >7.25
- For mild cases of PPHN with minimal or no respiratory distress supportive care with supplemental oxygen to maintain Sp02 in the range of 90–97% range results in low pulmonary vascular resistance.
- Oxygen can be delivered via Low Flow Nasal Cannula (LFNC)/High Flow Nasal Cannula (HFNC)/Continuous Positive Airway Pressure (CPAP)/Mechanical Ventilation)

- Consider mechanical ventilation if Fi02 60-70% or apnea or respiratory acidosis pH<7.25.
    - Lung protective strategies - Gentle ventilation with optimal PEEP, low PIP or tidal volume. Target to Hypercapnia (PaCo2 =45-60mmHg, provided pH is not less than 7.25 and Spo2 not <90%)
    - Optimal lung recruitment (8-9 ribs on CXR)
- As patient improves with treatment, wean oxygen and ventilatory support slowly

Surfactant

Surfactant improves oxygenation for babies in lung parenchyma disease as surfactant inactivation is observed in many respiratory disorders, such as pneumonia, RDS, and MAS. Its use in children with congenital heart disease is still not conclusive. (For surfactant administration, refer.....) (4)

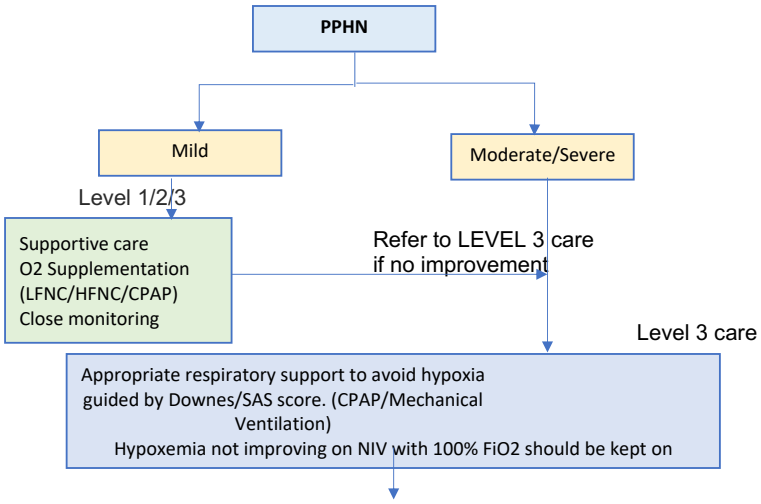
Monitoring

- Pre and post-ductal oxygen saturation
- Blood Pressure (Target MAP >15mmhg for GA). If GA unknown, target MAP of 45-60 mmHg
- Serial Blood gases (If available) – maintain pH >7.25
- Urine output >1ml/kg/hr
- Serial ECHO (if possible)- observe for reduction in estimated right ventricular pressure, resolution in the degree of right to left shunt and improvement of ventricular function.

Complications

Long-term consequences observed in the survivors of PPHN (5)

- Heart failure
- Shock
- Multiorgan damage
- Cognitive abnormalities
- Sensorineural hearing loss
- Chronic pulmonary hypertension



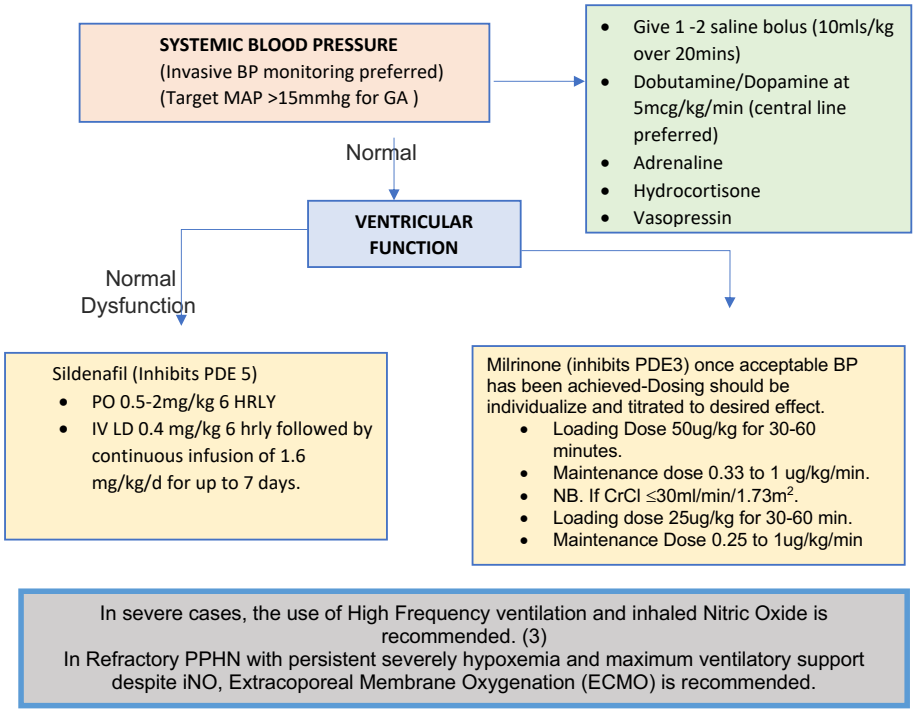


Figure xxx Algorithm of Management of PPHN in newborn

6.4 Pulmonary haemorrhage

Pulmonary haemorrhage is one of the adverse respiratory complications that preterm neonates are at risk for. It is associated with significant morbidity and mortality. Pulmonary haemorrhage usually occurs in the first week on life.

Definition: Pulmonary haemorrhage is an acute catastrophic event characterized by discharge of bloody fluid from the respiratory tract or in the endotracheal tube.

Guideline: this guideline is applicable to neonates admitted to neonatal units

Aim of guideline:

1. To provide evidence based diagnosis pulmonary haemorrhage
2. Describe risk factors for pulmonary haemorrhage
3. To provide evidence based recommendations on the management of pulmonary haemorrhage

Making a diagnosis of pulmonary haemorrhage

The diagnosis of pulmonary haemorrhage is a clinical diagnosis with the following

Clinical characteristics:

- The neonate is acutely ill

- The neonate has a risk factor for pulmonary haemorrhage (hypothermia, sepsis, PDA, asphyxia, thrombocytopenia)
- Evidence of pink / red frothy fluid in the airway

Radiologically Characteristics:

- May show focal or massive infiltrates
- Infiltrates are fluffy or ground glass
- In massive pulmonary haemorrhage complete lung white out

Laboratory Characteristic:

- Haematocrit of the haemorrhagic fluid is <10% of venous (if >10% consider traumatic bleed or DIC)

Risk factors for pulmonary haemorrhage includes:

- Extreme prematurity
- Hypothermia
- Asphyxia
- Intrauterine growth restriction
- Chorioamnionitis
- Sepsis
- Coagulopathy
- Hemodynamically significant PDA
- Administration of surfactant

Approach to neonate with suspected pulmonary haemorrhage

Order the following investigations

- Order an urgent chest Xray
- Obtain an urgent ECHO to assess for PDA
- Labs: CBC, coagulation profile (PT, APTT, d-Dimer), blood culture, CRP, blood gas
- Take note how long the neonates bleeding takes from the sampling site

Airway:

- If not intubated, gently clear secretions, and commence CPAP
- Nurse on the lateral position
- Consider high PEEP on respiratory support (7-10cmH2O)
- Plan for escalation (discuss with team)
- Inform family about the neoantes's situation
- If the neonate is intubated already ensure patency of ETT, gentle clearing of endotracheal tube of blood is important. Suction pressure should be set between 80-100mmH2O. Do not extubate since it will be more difficult to re-intubate

Breathing:

- If the neonate is on none invasive ventilation and coping (not getting apnoeas, saturation holding) then maintain care as you arrest bleeding and optimize circulation
- Prepare for escalation (discuss with team)

- If the neonate is on conventional ventilation consider using higher mean arterial pressure by increasing PEEP and PIP. If at PEEP of 8 and PIP of 25cmH2O and the neonate is stable (saturations holding), maintain care as you arrest bleeding and optimize circulation.
- If the neonate is not coping on conventional ventilation consider high frequency oscillation.
- Consider surfactant for intubated neonate with white out lungs and poor oxygenation.

Circulation:

- Pulmonary haemorrhage is associated with anaemia and hypotension.
- Transfuse with packed red blood cells to keep Hb >12g/dl (do not wait for Hb results if baby is clinically pale, had massive bleeding or is bleeding continuously)
- Arresting bleeding
- Giving FFP at 20mls/kg if abnormal coagulation profile
- Give vitamin k
- Consider IV tranexamic acid at 10mls/kg 8hly
- If intubated consider endotracheal adrenaline 0.1ml/kg

IMPORTANT NOTICE

Because of the difference in levels of care, discuss as a team and consult the next level of care for guidance when you encounter a neonate with pulmonary haemorrhage

of prematurity is one of the complications that some preterm neonates are at risk for which is associated with high morbidity and mortality.

BPD is defined as continued need of oxygen/respiratory support for the first 28days postnatal days.

Classification: Classification is done at 36weeks corrected gestational age (CGA)for babies born at <32weeks and at 56days for those born ≥32weeks of gestation. BPD is classified as mild, moderate or severe if the infant is in room air, on <30% oxygen or ≥30%/ needing any form of respiratory support respectively.

Guidelines

This guideline is applicable to preterm neonates still receiving care in the neonatal units

Purpose of guideline:

1. Define risk factors for BPD
2. Inform on measures to undertake in order to prevent/ minimize BPD
3. Identification of babies with BPD
4. Inform on hospital care of preterm with BPD

Risk factors for Bronchopulmonary dysplasia:

1. Prematurity
2. Small for gestational age
3. Male sex
4. Chorioamnionitis
5. Need for mechanical ventilation in the first 24hours of life
6. Need for CPR at birth

7. Sepsis
8. Formula feeding

Prevention of Bronchopulmonary dysplasia

1. All measures should be undertaken to prevent preterm birth
2. Antenatal corticosteroid use (as may reduce RDS and need for ventilation)
3. Intrapartum antibiotic prophylaxis for mothers with PROM (as indicated)
4. Avoid positive pressure ventilation in spontaneously breathing preterm infants in the delivery room, stabilize respiration with CPAP
5. Early surfactant for preterm neonates needing >40% oxygen after 1hour of CPAP with PEEP 7
6. Consider using LISA method for surfactant administration
7. Caffeine citrate should be given prophylactically (see guideline on apnoea)
8. If mechanical ventilation is needed use volume guaranteed mode, avoid over ventilation (respiratory alkalosis, hyperoxia) and target Fio2 ≤40%
9. Do not routinely sedate during mechanical ventilation.
10. Screen and manage for hemodynamically significant PDA (see PDA)
11. If on high oxygen ≥60% while on mechanical ventilation by day 5 discuss measured to enable weaning from ventilator including use of hydrocortisone (what about on CPAP)
12. Early initiation of breast milk
13. Manage sepsis and prevent infections (see guideline on sepsis and IPC)

Identification of babies with Bronchopulmonary dysplasia

- Review all preterm neonates at 28days of life for continued need of oxygen/ respiratory support and those who needed oxygen/respiratory support will need another review for classification
- Classify neonates at 36 weeks CGA for those born at <32weeks and at 56days for those ≥32wees or at discharge whichever comes first.

Care of baby with Evolving Bronchopulmonary dysplasia (≥10days of life)

1. Babies with evolving BPD should undergo the following investigations:
   - Cranial scan
   - ROP screening at 4weeks
   - Hearing screening at 4weeks
   - ECHO Cardiograph
   - Metabolic bone disease workup
   - Complete blood count
2. Always evaluate oxygen need by weaning carefully and observing how infant tolerates
3. Monitor growth very closely (weight daily/on alternate days, head circumference and length weekly)
4. Nutritional management, keep feeds at 150mls/kg/d, target protein intake of 4g/kg/d (100mls breast milk has 1.2g protein) (consider breast milk fortification), ensure on vitamin d supplementation 400IU daily
5. Feed in small volumes (at risk for reflux)
6. Oxygen target: for babies with evolving BPD <36weeks CGA (90-94%), for those >36weeks (94-96%)

7. Consider sildenafil if pulmonary arterial pressure >30mmHg or other Echo finding suggestive
8. Consider bronchodilators (salbutamol) for bronchospasm
9. If signs of pulmonary oedema present, consider diuretics
10. For established BPD on mechanical ventilation use larger tidal volume (7-10mls/kg), and longer Ti 0.6. Target Fio2 <40%, Ph 7.3, Pco2 45-55mmh2O, Po2 50-70mmh2O
11. Involve family in the care of their baby as much as possible

Other therapies in trial

Corticosteroids: There is no clear benefit of steroids in preventing and management of BPD. The potential risk may out-way the benefit.

Vitamin A: The benefit of Vitamin A supplementation in prevention of BPD is limited, it only improves serum vitamin A levels and possible PVL

Zinc supplementation: Zinc supplementation only improved short term linear growth but had no effect on BPD

Discharge planning of Baby with BPD

- Ensure immunization is up to date
- RSV prophylaxis
- Infection prevention (educate family on infection prevention including avoiding crowded places)
- Young siblings attending school are potential vectors for viral upper respiratory tract infection (educate on respiratory hygiene)
- Pets and animals at home
- Air pollution at home (educate on keeping infant away from smoke while cooking)
- HOME OXYGEN For moderate / sever BPD

6.6 Apnoea of Prematurity

Apnoea is a cessation of breathing for more than 20 seconds, or a shorter absence of breathing (> 10 seconds) associated with bradycardia (< 100 beats/minute), cyanosis (oxygen desaturation or pallor. It poses a significant risk if not detected and treated.

Types:

1. Central: cessation of airflow and inspiratory efforts simultaneously
2. Obstructive: absent airflow in the presence of inspiratory efforts
3. Mixed: central pause is either preceded by or followed by airway obstruction

Causes and Risk factors for Apnoea of prematurity

- GA less than 34 weeks.
- Hypoxia
- Metabolic abnormalities e.g. hypoglycaemia/ hypocalcaemia
- Infection
- Electrolyte abnormalities
- Circulatory disorders, e.g. hypotension, anaemia, PDA,
- Temperature instability
- Intracranial pathology e.g.IVH

Clinical presentation

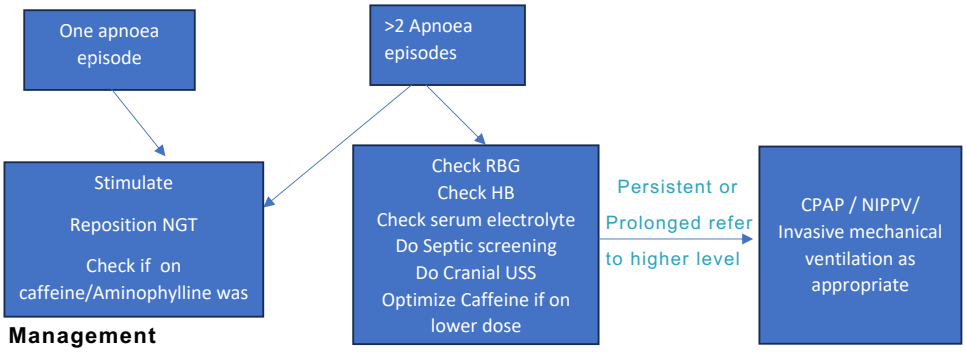
- Periodic cessation of breathing > 20 seconds
- Periodic cessation of breathing > 10 seconds with bradycardia, cyanosis or pallor

Investigation

Apnoea of prematurity does occur in preterm babies due to the immaturity of the brain, but if it occurs repeatedly, investigate to rule out other causes.

- Screen for anaemia
- Random blood glucose
- Electrolyte
- Evaluate for sepsis (complete blood count, C-reactive Protein, +/- lumbar puncture, blood cultures)
- Cranial ultrasound

General management



Management

Dispensary/Health centre level

- Physical stimulation/tactile stimulation (gentle taps to the sole of the foot or rubbing the back)
- If the LBW infant was previously stable, suspect infection, give pre-referral antibiotics, stabilize the patient, make sure Spo2 >90%
- Put newborn skin-to-skin to maintain warm chain
- Refer the patient to higher level facility

Hospital and referral/tertiary level

- Start CPAP or noninvasive positive-pressure ventilation (NIPPV)
- Give loading dose of caffeine citrate IV 20 mg stat, then 5mg/kg OD until baby reaches 34 weeks or 1.5kg. If apnoea is recurrent consider administering another loading dose of 10mg/kg and increase maintenance dose to 10mg/kg/day.
- Remember to adjust the dose per weight gain.
- If caffein is not available give IV or PO aminophylline loading dose 5 mg/kg over 10 minutes followed by starting maintenance dose 12 hours later (1 – 3 mg/kg/dose IV or PO given 12 hourly).

Note: when to stop medication

- Caffein can be stopped when baby reaches GA 34 weeks or 1.5 kg and is stable.
- Consider stopping caffeine if the infant is tolerating full cup feeds for consecutive 3 days and KMC score is 2.
- In case of Extreme low birth weight infant discuss with senior consultant before stopping the caffeine.
- Patient should demonstrate at least 5 days without apnoea when caffein free prior discharge.
- Use an apnoea monitor if available, if not available patient should be on a cardiorespiratory monitor or pulse oximeter.
- Apnoea in term infants is less common, usually secondary to infection; CNS, e.g. hemorrhage, seizures, meningitis; maternal anesthesia and analgesia; upper airway obstruction; gastro - esophageal reflux; metabolic e.g. hypoglycaemia.
- Management: Treat the primary cause, and manage with stimulation, supplemental oxygen, bag–mask ventilation, nasal CPAP or mechanical ventilation as required.

References

1. Bhandari V. Noninvasive repiratory support in the preterm infant. Clin Perinatol. 2012: 39; 497-511.

2. Shetty S, Greenough A. Neonatal ventilation strategies and long term repiratory outcomes. Early Human Development. 2014: 90; 735-749.

3. Sant'Anna G.M, Keszler M. Weaning infants from mechanical ventilation. Clin Perinatol. 2012: 39; 543-562.

4. Carlo WA, Martin RJ, Fanaroff AA. Assisted ventilation and complications of respiratory distress. In Fanaroff and Martin's neonatal-perinatal medicine: diseases of the fetus and infant (8th ed.). Philadelphia, Elsevier, 2006, p1108-1118.

5. Bhandari A, Bhandari V. Pitfalls, Problems and Progress in Bronchopulmonary dysplasia. Paediatrics 2009:123:1562- 1573.

6. Reuter-Rice, K., & Bolick, B. N. (2011). *Pediatric Acute Care: A Guide for Interprofessional Practice*. Jones & Bartlett Learning.

7. Overview of mechanical ventilation in neonates: https://www.uptodate.com/contents/overview-of-mechanical-ventilation-in-neonates

Meconium aspiration syndrome: a role for fetal systemic inflammation.Lee J, Romero R, Lee KA, Kim EN, Korzeniewski SJ, Chaemsaithong P, Yoon BH. Am J Obstet Gynecol. 2016;214(3):366.e1. Epub 2015 Oct 17.

Monfredini C, Cavallin F, Villani PE, Paterlini G, Allais B, Trevisanuto D. Meconium Aspiration Syndrome: A Narrative Review. Children (Basel). 2021 Mar 17;8(3):230. doi: 10.3390/children8030230. PMID: 33802887; PMCID: PMC8002729.

Maternal and fetal characteristics associated with meconium-stained amniotic fluid.Balchin I, Whittaker JC, Lamont RF, Steer PJ,Obstet Gynecol. 2011;117(4):828.

1. Meconium aspiration syndrome: risk factors and predictors of severity.Oliveira CPL, Flôr-de-Lima F, Rocha GMD, Machado AP, Guimarães Pereira Areias MHF, J Matern Fetal Neonatal Med. 2019;32(9):1492. Epub 2017 Dec 8
2. Lakshminrusimha S, Keszler M. Persistent pulmonary hypertension of the newborn.
3. Neoreviews [Internet]. 2015;16(12):e680–94. Available from: http://dx.doi.org/10.1186/s40748-015-0015-4
4. Jooley AH . Neonatal guidelines & Dug doses. 2020. 68–74 p.
5. Kinsella JP, Truog WE, Walsh WF, et al. Randomized, multi- center trial of inhaled nitric oxide and high-frequency oscillatory ventilation in severe, persistent pulmonary hypertension of the newborn. J Pediatr. 1997;131(1 Pt 1):55–62
6. Konduri GG, Sokol GM, Van Meurs KP, et al Impact of early surfactant and inhaled nitric oxide therapies on outcomes in term/late preterm neonates with moderate hypoxic respiratory failure. J Perinatol. 2013;**33**(12):944–949
7. Konduri GG, Vohr B, Robertson C, Sokol GM, Solimano A, Singer J, et al Early inhaled nitric oxide therapy for term and near-term newborn infants with hypoxic respiratory failure: neurodevelopmental follow-up. J Pediatr. 2007;**150**(3):235–240, 240 e231
8. AmericanAcademyofPediatrics/CommitteeonFetusandNewborn.Apnea, sudden infant death syndrome, and home monitoring. Pediatrics.
9. Henderson-Smart DJ, Steer PA. Caffeine versus theophylline for apnoea in preterm infants. Cochrane Database Syst Rev 2010 Jan 10;(1):CD000273.
10. Schmidt B, Roberts RS, Davis P, et al. Long-term effects of caffeine therapy for apnea of prematurity, N Engl J Med 2007;357:1893–1902.
11. World Health Organization (WHO). *WHO Recommendations on Interventions to Improve Preterm Birth Outcomes*. Geneva, WHO, 2015.
12. Eichenwald EC, Committee on Fetus and Newborn, American Academy of Pediatrics. Apnea of prematurity. *Pediatrics* 2016; 137: e20153757. doi: 10.1542/peds.2015-3757
13. Atik A, Harding R, De Matteo R, et al.. Caffeine for apnea of prematurity: effects on the developing brain. *Neurotoxicology* 2017; 58: 94–102. doi: 10.1016/j.neuro.2016.11.012

CHAPTER 7: RETINOPATHY OF PREMATURITY (ROP)

ROP is an eye disease affecting mainly extremely premature newborns generally having received intensive neonatal care. Prolonged use of oxygen leads to adverse effects on the retina (pathologic growth of vessels in the developing retina). A small proportion of babies will develop severe ROP which, if untreated, can lead to serious vision impairment and blindness.

Therefore, every NCU must follow the SOP on SpO_2 targets in neonates and have a protocol on how to organize ROP screening in their setting to enable early diagnosis and treatment.

Risk factors for ROP

- Low gestational age (GA)
- Low birth weight (LBW)
- High or prolonged oxygen supplementation, fluctuations in oxygenation (repeated episodes of hypoxia and hyperoxia)
- Extended assisted ventilation
- RDS
- Apnoea
- Neonatal acidosis
- Severe HIE
- Surgical interventions
- Family history of ROP
- Blood transfusions

Prevention and screening

Prevention and screening are crucial, there are no externally visible symptoms to detect ROP at an early stage.

- Prevention:
  - Prevention of prematurity
  - Strict indication and monitoring of supplemental oxygen use
    ➔ Oxygen therapy must maintain SpO_2 between 90 – 95 %
  - Good neonatal care (prevention of pain, hypothermia, stress, infection; supportive care and minimal handling)
  - Screening programme established in every NCU
- ROP screening:
  Indication and timing are based on gestational age (GA) and birth weight (if GA is unknown: use birth weight for indication, use postnatal age for timing of screening)
  - Infants less than 32 weeks GA (up to 31^{+6} weeks)
    and/or ≤ 2000 g birth weight should be screened for ROP.
  - Screening should begin at 4 weeks postnatal age or at corrected 31 – 33 weeks GA, whichever is later.
  - Infants weighing > 2000 g who have risk factors (see above) should be screened on discharge or before 37 weeks GA, whichever is sooner.
  - The first screening should always be done before 37 weeks GA.

- Screening should always be done before discharge of the newborn from NCU, regardless of age or weight. If the retina is fully vascularised there is no need for further screening.
- The timing of subsequent investigations and termination of screening depends on the findings and will be determined by the ophthalmologist.

Investigations

Retinal examination by an eye specialist with dilated pupils to look for signs of ROP.
For wider access to ROP screening an optometrist can be trained to take pictures of the retina and evaluate them by using a pictorial guide. In case of unclear or abnormal findings the pictures will be sent to an ophthalmologist.

Possible examination techniques:

- Binocular indirect ophthalmoscopy (BIO)
- Wide-field digital retinal imaging (WFDRI)
- Digital photographic screening devices for remote screening and evaluation of the photos via telemedicine

Preparation:

- In mydriasis (use mydriatic eye drops (e.g. phenylephrine 2.5 % with cyclopentolate 0.5 %)).
- Under pain relief if an eyelid speculum is used (topical anaesthesia (e.g. oxybuprocaine) and non-medical pain relief measures like swaddling, non-nutritive sucking (refer to chapter on pain)).
- In presence of neonatal staff for monitoring the newborn (pulse rate, SpO_2, respiration rate) and availability of resuscitation equipment (risk of apnoea and bradycardia).

Classification

The International Classification of ROP (ICROP) includes 5 parameters:

1. Zone (Zone I – III, to describe the location of the disease in the retina)
2. Clock hours (to describe the extent of the developing blood vessels)
3. Stage (stage 1 – 5; to describe the severity)
4. Plus disease (increased venous dilation and arteriolar tortuosity of retinal vessels)
5. Pre-plus disease

Treatment

The goal is to stop the progression of the disease and prevent blindness.
Treatment options are:

- Cryotherapy
- Laser photocoagulation
- Intravitreal injection of Anti-vascular endothelial growth factor (Anti-VEGF)

Notes:

- For both screening and treatment parents need to be counselled and give their consent.
- ROP screening should be done within the NCU (ward or clinic room).

- Long-term follow-up is needed for ROP patients to detect other ocular conditions early.

If ROP screening is not possible in a facility:

- Refer to the next facility offering ROP screening
- Screening must still be done at the respective time points, do not delay or postpone
- Counsel parents on the importance

References:

1. Retinopathy of Prematurity, Aaron C. Brown; Kristen Nwanyanwu (Stat Pearls Sept. 2023)
2. UK screening and treatment of retinopathy of prematurity Updated 2022 Guidelines; A.R. Wilkinsona,* , G.G.W. Adamsb , B.W. Fleckc , R. Nieto-Hernandezd , On behalf of Guideline Development Groups (GDG) of the Royal College of Paediatrics and Child Health (RCPCH) and the Royal College of Ophthalmologists (RCOphth)
3. VISSER, L et al. Guideline for the prevention, screening and treatment of retinopathy of prematurity (ROP). **South African Medical Journal**, [S.l.], v. 103, n. 2, p. 116-125, nov. 2012. ISSN 2078-5135
4. National guidelines for the screening and management of retinopathy of prematurity in Kenya, MoH Kenya, 2018

CHAPTER 8: ELECTROLYTE IMBALANCE

- Electrolytes can be measured in at least level 2b facilities
- For management of symptomatic/ moderate to severe electrolyte imbalances consider referral to level 3 care if there is limited skills/ knowledge/ equipment/ investigations for proper monitoring of such cases
- Consultation can always be done to senior doctors/ pediatricians/ neonatologists to assist in proper management even before referral

Hypokalemia (K+↓)

- Hypokalemia is defined as a serum potassium concentration <3.5 mmol/L

Classification

- Mild hypokalemia: 3.0 – 3.4 mmol/L
- Moderate hypokalemia: 2.5 – 2.9 mmol/L
- Severe hypokalemia: < 2.5 mmol/L

Causes

- Increased GI losses: Vomiting, Diarrhoea, NGT suctioning
- Renal losses: Renal tubular defect
- Decreased intake: Potassium free fluid
- Medications: Diuretics
- Transcellular shifts: Alkalosis, hypomagesemia
- Osmotic diuresis: Hyperglycemia
- Prolonged parenteral feeding
- **Pseudohypokalaemia** *(error in measuring)*

Clinical Manifestations

Hypokalemia is mostly asymptomatic

Muscle weakness, paralysis, lethargy, urinary retention, arrhythmia

Investigations: Electrolytes, RFT, blood gas, urinalysis with urine pH, ECG (U wave with prolonged QT interval, flattening or biphasic T wave and depressed ST segment)

Treatment

- Stop medications that may contribute to hypokalemia or replace with suitable alternative if available
- Emergency treatment of severe/ life threatening cardiac arrythmias:
  KCl 0.5 - 1 mmol/kg slowly IV over 1 hour. Reassess and repeat as necessary
- If moderate hypokalemia or symptomatic, but not life threatening give: KCl 1-3 mmol/kg/day in maintenance fluid or divided in 3 to 4 doses if the baby is feeding orally
- Mild hypokalemia may resolve without treatment

Hyperkalemia

- **Hyperkalemia** is defined as a serum potassium concentration **>** 6.5 mmol/L
- It is common in extremely low birth weight infants

Classification

- **Mild hyperkalemia** (No ECG changes/ asymptomatic): 6.5-7 mmol/L
- **Moderate hyperkalemia** (No ECG changes/ asymptomatic): 7.1- 7.5 mmol/L
- **Severe hyperkalemia** (ECG changes/ symptomatic): ≥7.5 mmol/L

Causes

- Pathologic hemolysis of RBCs, renal failure, metabolic acidosis, tissue damage/necrosis (NEC, birth trauma, hypothermia), dehydration, congenital adrenal hyperplasia, adrenal insufficiency
- Medications: Potassium sparing diuretics
- Iatrogenic (K+ substitution, transfusion induced hyperkalemia)
- Pseudo- hyperkalemia: Hemolysed blood sample

Symptoms

Hyperkalemia may be asymptomatic

Lethargy, muscle weakness, Dysrhythmias (Bradycardia, ventricular fibrillation or other arrhythmia), shock, polyuria, abdominal distension, decreased bowel sounds and visible bowel loops

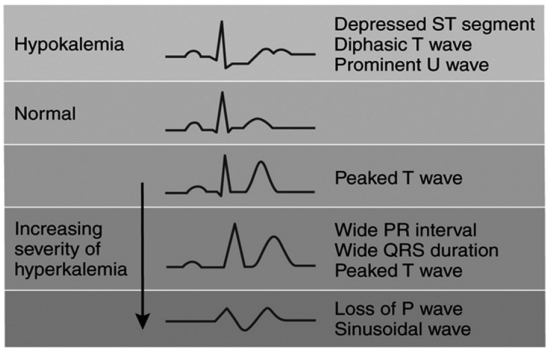
Laboratory investigations: Electrolytes (Specimen appropriately taken, must be done within 1 hour of sample collection. If clinical setting makes hyperkalemia unlikely, repeat before treatment to exclude pseudo hyperkalemia), FBP, ABG, RBG, RFT

Imaging: Abdominal X Ray if NEC is suspected

ECG findings progress with increasing serum potassium:

Peaked or "tented" T waves → widening QRS complexes → prolonged PR interval → flattened or loss of P waves → ventricullar fibrillation → asystole

ECG changes in hypokalemia and hyperkalemia



Treatment

- Stop medications and/ fluids contributing to hyperkalemia or give potassium free fluid
- Treat and manage the underlying cause if known
- Treat symptomatic infants
- Continuous monitor ECG and blood pressure

Step 1: Stabilize myocardium

- Start with Step 1 if the neonate is unstable/symptomatic, the ECG is abnormal or serum potassium is ≥ 7 mmol/L
- Give IV 10% Calcium gluconate dose 50 mg/kg/dose (Diluted Calcium gluconate 0.5 ml/kg/dose) over 10 minutes
- Monitor for arrhythmia, improvement in ECG should occur within 1-5 minutes
- The bolus can be stopped once ECG changes have disappeared
- May repeat dose in 10 minutes if ECG changes persist

Note: Calcium only protects the myocardium and does not decrease the serum potassium

Step 2: Shift potassium intracellulary

Salbutamol

- Nebulisation Salbutamol 400 ug (0.4 mls of salbutamol 1mg/ml respule) add 1.6 mls NaCl to make 2 mls per dose every 2-6 hours as needed
- Salbutamol should be used with IV insulin and glucose infusions for additive effect in severe hyperkalemia

Insulin and glucose

- Give regular/ soluble insulin 0.1 units/kg combined with 4 mls/kg 10% dextrose water over 5 minutes
- If there is concurrent hyperglycemia reduce 10% dextrose water to 2 ml/kg
- The bolus dose may be repeated if necessary
- Monitor glucose after 30 minutes then hourly

Sodium bicarbonate

- IV Sodium bicarbonate 1-2 mmol/kg over 30 minutes

Note: Use only in life threatening hyperkalemia or not at all

Step 3: Increase K+ excretion

- Furosemide IV 1mg/kg/dose every 12 hours

Ensure adequate urine output and normal serum creatinine and urea

Note: For refractory hyperkalemia consider peritoneal dialysis/ double volume exchange transfusion and consult senior neonatologist/ nephrologist

Hypocalcaemia (Ca^{2+} ⇩)

Definition:

Bwt	Total serum Calcium (Ca^{2+})	Ionized Calcium (iCa)
≥ 1500 gms	< 2.0 mmol/l	< 1.1 mmol/l
< 1500 gms	< 1.75 mmol/l	< 1.0 mmol/l

Note: *Only ionized calcium (iCa) maintain hemostasis therefore it is preferred to evaluate iCa directly for treating hypocalcemia*

Risk factors:

- **Early hypocalcemia** (first 3 days of life): Prematurity, infant of a diabetic mother, perinatal asphyxia, critical illness, IUGR, hypoparathyroidism, maternal hyperparathyroidism
- **Late hypocalcemia** (> 3 days of life): High phosphate intake (infant fed cow's milk or formula), after blood transfusion, hypomagnesemia, maternal or perinatal Vitamin D deficiency, metabolic syndromes, maternal hyperparathyroidism, iatrogenic

Clinical findings:

- Infants are often asymptomatic
- Neuromuscular hyperexcitability,(jitteriness, tetany, laryngospasm), seizures, irritability, vomiting, cardiac rhythm disturbances (tachycardia, arrhythmia)

Laboratory investigations: Electrolytes (Calcium, Phosphorus, Magnesium, Alkaline Phosphatase), albumin, Creatinine, Parathyroid, Vitamin D

Imaging: ECG, ECHO

Treatment

- Asymptomatic infants require no treatment, hypocalcemia can resolve with feeding

Acute treatment:

- For symptomatic hypocalcemia, Give: IV 10% Calcium Gluconate 100mg/kg over 15 minutes with concurrent cardiac monitoring; then recheck iCa; if < 1mmol/L, give additional bolus in 10 to 20 minutes

Maintenance treatment:

- Give IV 10% Calcium Gluconate 75 mg/kg/day (8 mL/kg of 10% calcium gluconate) added to the daily IV infusion **OR**
- If asymptomatic and enteral feedings are tolerated, encourage breast feeding and Give: 10% Ca gluconate 50-150 mg/kg/day (elemental calcium) orally divided and given in four to six feedings
- Correct hypomagnesemia if < 0.65 mmol/L with IV magesium sulfate 25mg/kg over 1 hour
- For late onset hypocalcemia: Give Vitamin D3 400 IU/day for 1-2 weeks

Hypercalcemia (Ca^{2+} ↑)

- Hypercalcemia is defined when ionized calcium more than 1.45 mmol/l
- Is very common in VLBW infant who are on Total parenteral nutrition (TPN)

Classification

- Mild hypercalcemia: 1.45 - 1.60 mmol/L
- Moderate hypercalcemia: >1.60 - 1.8 mmol/L
- Severe hypercalcemia: > 1.8 mmol/L

Clinical findings:

- Irritability, poor feeding, hypotonia, lethargy, vomiting,constipation, poor growth, encephalopathy

Causes: Subcutaneous fat necrosis, Calcium supplementation, Vitamin D therapy

Investigations: Electrolytes (serum Na, K,Mg, Phosphorus, and Ca), Serum total protein and albumin-globulin, Alkaline phosphatase, Urine calcium and phosphorus, Creatinine

Imaging studies: Renal ultrasound for calcifications, Long bone x-rays (for demineralization secondary to hyperparathyroidism, or osteosclerotic lesions secondary to hypervitaminosis)

Treatment

- Treatment will depend on the cause and severity of hypercalcemia
- Investigate for underlying cause and treat if possible
- If the hypercalcemia is mild to moderate restrict of all forms Oral and IV of Calcium and vitamin D
- In more severe cases, ensure continuing adequate hydration with normal saline
- Consult senior/neonatologist/pediatric endocrinologist for refractory hypercalcemia who may consider giving: IV Furosemide mg/kg at 6 to 8 hour intervals once adequate rehydration with adequate urine output has been established OR IV Hydrocortisone 1 mg/kg every 6 hours

Hyponatremia

- Hyponatremia is defined as a sodium level< 130 mmol/l
- Severe Hyponatremia: Na+ < 120 mmol/l
- VLBW infants are prone to get hyponatremia
- Hyponatremia is associated with poor neurodevelopmental outcomes and poor growth

Causes

- Hypovolemia - Increased renal Na+ excretion
- Normovolemia - Medications (diuretics), meningitis
- Hypervolemia - Conditions causing water retention (SIADH, heart failure), congenital adrenal hyperplasia (CAH)

Symptoms

- Seizures, irritability, lethargy, apnea, hypotonia

Investigations

- Serum electrolytes, Urinalysis with urine specific gravity, urine sodium, urine and serum osmolality, RFT

Treatment

- Treat symptomatic hyponatremia or severe hyponatremia when Na+ < 120 mmol/l
- If isolated severe hyponatremia, take another sample and repeat the test
- Normovolemic and hypervolemic hyponatremia require fluid restriction up to 60% of maitenance fluid with or without sodium replacement
- If Symptomatic with Neurologic findings:

  Give 3% NaCl at 1-3 ml/kg over 15 min

Recheck serum Na^+ 20 minutes after correction

- If Severe hyponatremia without symptoms use **Sodium Deficit Calculation:**

Mmol Na+ needed = (Desired serum Na (135)) - [current serum Na+] x 0.6 x weight (kg)

- Replace deficit over 24 hours using normal saline or hypertonic saline (Rapid replacement is associated with pontine demyelinosis)
- Goal is to increase sodium (Na^+) by no more than 0.5 mmol/l/hour or 12mmol/l/day

Sodium in mmol per ml in different concentrations of saline	
0.9% NaCl	0.15 mmol in 1 ml
3% NaCl	0.5 mmol in 1 ml

Hypernatremia (↑ Na^+)

- Hypernatremia is defined as serum sodium concentration > 145 mmol/l

Causes

- Decreased fluid intake: Frequently caused by inadequate breastfeeding in full-term infants
- Excessive fluid loss: Increased insensible water and urinary fluid losses in VLBW infants
- Excessive Na intake

Clinical findings:

- Weight loss >10%, tachycardia, low blood pressure, decreased or absent urinary output, dehydration, seizures, irritability
- Edema if caused by excessive administration of NS
- May be associated with intracranial bleeds

Treatment

- Mild hypernatremia: Identify and treat the underlying cause
- Enteral Treatment: Give oral rehydration with human milk or substitute if there is no hemodynamic instability

Hypernatremia in Term Neonate with Anuria and Hemodynamic Instability

Step 1: Emergency treatment

- Calculate % weight loss: (Birth weight - Current weight)/ birth weight x 100 = % weight loss
- If hemodynamically unstable with signs of shock OR ≥ 10% weight loss
  Give: 10 mls/kg NS 0.9% over 30 min. If required, give a second saline bolus

Step 2: Maintenance fluid

- Calculate insensible water loss only
- Insensible fluid loss = 40 ml/kg, add 20 ml/kg if the neonate is under a radiant warmer

Step 3: Calculate Free water required

- Reduce Na concentration level by 0.5 mmol/h, hence not more than 12 mmol/day to prevent cerebral edema and seizures

Free Water (FW) calculation for newborns according to the current Na^+

Current serum Na level	FW to drop serum Na by 1mmol/L	FW required/kg/day
Serum Na ≤ 180 mEq/L	4.5 ml/kg of FW	54 mL/kg of FW per day
Serum Na >180 mEq/L	3.5 mL/kg of FW	42 mL/kg of FW per day

Free water required = FW required/kg/day x body weight x duration of treatment (days)

Step 4: Calculate Total amount of fluid

- Total amount of fluid = (Maintenance fluid + Free water required) -Any fluid bolus given

Step 5: Calculate Total fluid rate (mls/hour):

- Total fluid rate (mls/hour) = Total amount of fluid/ duration to correct Na^+(in hours)

Type of fluid required and duration to correct Na^+ (depends on the initial Na^+ level)

Current Na^+ level	Type of fluid	Correction time
Mild hypernatremia (146-149)	D5% or D5%+ 0.2% NaCl	1 day (24 hours)
Moderate hypernatremia (150-164)	D5%+0.45% NaCl	1 day (24 hours)
Severe hypernatremia (165-180)	D5%+0.9% NaCl (DNS)	2 days (48 hours)
Extreme hypernatremia > 180	D5%+0.9% NaCl (DNS)	3 days (72 hours)

*D5% may be substituted for D10% if infant is hypoglycemic

Step 6: Ongoing Replacement

- Once urine output is observed and measured, replace this urinary volume plus any ongoing fluid losses milliliter by milliliter with the type of fluid required as above

Monitoring of Sodium Level and Follow-Up

- Serum sodium levels should be monitored every 2–4 h for an initial 12 hours or longer, until Na level reaches <150 mmol/L and the rate of fluids is titrated until the desired decline is accomplished
- If the expected sodium decline is > 0.5 mmol/L, the rate of fluid should be reduced by 20% every 2 h until the desired decline is achieved
- Serum electrolytes, glucose, BUN, and creatinine should be monitored likewise
- Monitor vital signs closely: BP, strict monitoring of intake, output, and periodic weight check

Ongoing Management and Monitoring

- Slow introduction of human milk or formula milk can be instituted, and IV fluids decreased accordingly once serum sodium is <150 mmol/L
- Give appropriate antibiotics to hemodynamically unstable infants or those with fever till an infection is ruled out
- **Note:** Hyperglycemia and metabolic acidosis are usually associated with hypernatremia and should not be treated as these will simultaneously improve with rehydration

Hypernatremia in Babies with Observed Urine Output and Hemodynamic Stability

- In a neonate with hypernatremia who is hemodynamically stable with observed ongoing diuresis, the management plan will be almost the same as for an anuric neonate **without step 1 of giving fluid boluses** and difference in calculation of fluid maintenance.

The difference in the calculation of fluid maintenance

- Maintenance fluid considers both, insensible fluid losses and sensible fluid losses
- if <7 days, maintenance fluid will depend on the day of presentation
- If ≥ 7 days of age, daily maintenance fluid will be at 160 mL/kg/day
- Insensible water: 40 mL/kg/day, if a neonate is under a radiant warmer use 60 mL/kg/day

Example 1: Let's calculate fluids for a newborn baby born at term with a birth weight of 3.0 kg having 20% weight loss with sodium of 165 mmol/L. This infant is anuric and hemodynamically unstable, and the current weight checked is 2.4 kg

Step 1 emergency treatment: 10x3 = **30 mls bolus** N/S give slowly in 30 minutes

Step 2 maintenance fluid: 60x3 = **180mls** (neonate is under radiant warmer)

Step 3 calculating free water required:

Free water required = FW required/kg/day x body weight x duration of treatment (days)

54 mls/kg/day x 3 kgs x 2 days

Free water required = 324 mls

Step 4 total amount of fluid:

Total amount of fluid = (Maintenance fluid + Free water required) - Any fluid bolus given

(180 mls + 324) - 30 mls

Total amount of fluid = 474 mls DNS (Initial sodium was 165 mmol/L) to be given in 2 days

Step 5: Calculate Total fluid rate (mls/hour):

Total fluid rate (mls/hour) = Total amount of fluid/ duration to correct Na^+(in hours)

= 474 mls/ 48 hours

Total fluid rate (mls/hour) = 9.9 mls/ hour

Step 6: Ongoing Replacement

As urine output is observed and measured, the mls produced are replaced by adding that amount in infusion DNS.

Example 2: Let's calculate fluids for a newborn baby born at term with a birth weight of 3.0 kg with sodium of 165 mmol/L. This infant is getting urine and hemodynamically stable, and the current weight checked is 2.8 kg

Skip step 1 don't give bolus and start with step 2

- **Step 2 maintenance fluid:** sensible fluid losses + insensible fluid losses
  (160x3)(neonate is 7 days of life) + (60x3) (neonate under radiant warmer)
  maintenance fluid= 660 mls

Step 3 calculating free water required

Free water required = FW required/kg/day x body weight x duration of treatment (days)
54 mls/kg/day x 3 kgs x 2 days

Free water required = 324 mls

Step 4 total amount of fluid

Total amount of fluid = (Maintenance fluid + Free water required) - Any fluid bolus given
(660 mls + 324 mls)

Total amount of fluid = 984 mls DNS (Initial sodium was 165 mmol/L) to be given in 2 days

Step 5: Calculate Total fluid rate (mls/hour):

Total fluid rate (mls/hour) = Total amount of fluid/ duration to correct Na^+(in hours)
= 984 mls/ 48 hours

Total fluid rate (mls/hour) = 20.5 mls/ hour

References

1. Gomella T, Eyal FG, Bany-Mohammed F. eds. Gomella's Neonatology: Management, Procedures, On-Call Problems, Diseases, and Drugs, 8e. McGraw-Hill Education; 2020.
2. Rudolph A.J., Guideline for acute care of the neonates. 29th-Edition-July-2021 https://www.scribd.com/document/528977048/Guidelines-for-Acute-Care-of-the-Neonate
3. Durrani NUR, Imam AA, Soni N. Hypernatremia in Newborns: A Practical Approach to Management. Biomed Hub. 2022 May 19;7(2):55-69. doi: 10.1159/000524637. PMID: 35950014; PMCID: PMC9247442.
4. Hansen, A.R., Eichenwald, E.C., Stark, A.R., Martin C.R. Cloherty and Stark's Manual of Neonatal Care. Wolters Kluwer Health, 2016.
5. Uptodate Accessed July 30, 2024

CHAPTER 9: PERINATAL ASPHYXIA

Asphyxia is a condition of impaired gas exchange leading to significant metabolic acidosis, hypoxemia, and potential multi-organ dysfunction in a newborn. This occurs when there is insufficient oxygen supply before, during, or after birth, often resulting in hypoxic-ischemic encephalopathy (HIE) if severe.

The following are essential characteristics to make a diagnosis of perinatal asphyxia:

- Umbilical arterial cord pH <7.0 or base deficit > 12 mmol/l or both.
- Apgar score <5 at 5 minutes and 10 minutes
- Clinical neurologic sequelae in immediate neonatal period (encephalopathy)
- Evidence of multi organ dysfunction in at least one other organ system (cardiovascular, respiratory, renal, hepatic).

Other factors that might support acute peripartum or intrapartum event

- Ruptured uterus
- Severe abruptio placenta
- Maternal cardiovascular collapse
- Massive foetal-maternal haemorrhage
- Abnormal foetal heart rate patterns
- Abnormal investigation e.g. MRI, ultrasound

CLINICAL FEATURES AND PRESENTATION

- CNS – Seizures, abnormal posture, decreased tone, impaired primitive reflexes, bulging fontanelle, irritability or loss of consciousness
- CVS – Shock/hypotension, myocardial dysfunction, arrythmia
- RS – Respiratory distress, pulmonary haemorrhage, pulmonary oedema, apnoea
- Renal – Oliguria/anuria, renal failure,hematuria (acute tubular necrosis)
- GI – Paralytic ileus, bloody stools, necrotizing enterocolitis
- Hepatic – Liver enzymes elevation, impaired coagulation of blood
- Haematology – Thrombocytopenia, DIC
- Metabolic – Acidosis, hypoglycaemia, hypocalcaemia, hypomagnesemia

Assessment

Use Thompson score or Sanart and Sarnat staging to assess daily for the first 7 days of life.

Thompson Score	0	1	2	3
Level of Consciousness	Normal	Hyperalert or Stare	Lethargic	Comatose
Fontanelle	Normal	Full, not tense	Tense	
Posture	Normal	Fisting, Cycling	Strong, Distal Flexion	Decerebrate
Tone	Normal	Hypertonia	Hypotonia	Flaccid
Moro	Normal	Partial	Absent	
Grasp	Normal	Poor	Absent	
Suck	Normal	Poor	Absent ± bites	
Respiratory	Normal	Hyperventilate	Brief apnoea	IPPV (apnoea)
Fits	None	Infrequent (<3 per day)	Frequent (>2 per day)	
Total Score=____	*Age:___ hrs/ days*	*Date:__ /__ /___*	*Name:_____ Sign:_____*	
Interpretation of total score (i) <7: Normal; (ii) ≥7: Abnormal (Guide is 7-10 = Mild; 11-14= Moderate; >14: Severe HIE				

Hypoxic-Ischemic Encephalopathy in Term Infants
SARNAT AND SARNAT STAGING

SIGNS	STAGE 1	STAGE 2	STAGE 3
Level of consciousness	Hyperalert	Lethargic	Stuporous, coma
Muscle tone	Normal	Hypotonic	Flaccid
Posture	Normal	Flexion	Decerebrate
Tendon reflexes/clonus	Hyperactive	Hyperactive	Absent
Myoclonus	Present	Present	Absent
Moro reflex	Strong	Weak	Absent
Pupils	Mydriasis	Miosis	Unequal, poor light reflex
Seizures	None	Common	Decerebration
EEG	Normal	Low voltage changing to seizure activity	Burst suppression to isoelectric
Duration	<24 hr if progresses; otherwise, may remain normal	24 hr to 14 days	Days to weeks
Outcome	Good	Variable	Death, severe deficits

Investigations

- Blood Gas Analysis: Early gas within 1 hr of life confirms the intrapartum related cause.
-
- Day of life do FBC and blood culture 6 hrs from birth to exclude infection.
- Day 2 of life check for renal function and electrolyte abnormalities.
- Day 2 of life do CRP to decide on whether to stop antibiotics or not. Stop antibiotics if CRP is < 10 mg/dL.
- Do serum Glucose, Calcium, Magnesium and Phosphate if having seizures (hypomagnesaemia tends to occur on the first day, whereas hypocalcemia tends to occur on day 2-3 of life).
- Perform a lumbar puncture in infants with seizures, and CRP >20 mg/dL.
- Babies with clinical presentation of asphyxia with a history not compatible with peripartum cause, should be evaluated for other causes ie inborn error of metabolism or congenital myopathies.
- LFTs (in those with jaundice) and cardiac enzymes (in those with hypotension/ tachycardia) may be done only after discussing this with a consultant.
- Imaging: Cranial ultrasound at day 1,3,7 and 14, MRI for brain injury severity, prognostication and exclude the HIE mimics.
- EEG/ aEEG: Assessing seizure activity, brain function and response to therapy.
- Other investigations will depend on the presentation and system affected

Management

- Principals of HIE management
  - Seizure control
  - Cerebral protection
  - Monitoring
- Supportive care
  - Ensure effective airway and ventilation.
  - Ensure good circulation, give circulatory support if needed.
  - If supplemental oxygen is required limit inspired oxygen to the least required to keep oximeter saturation between 90-94%.

Mild HIE:

- Supportive care, including temperature, glucose,BP,optimal nutrition, fluid management and monitor for any neurological changes
- On day 1 assess ability to feed, if there is suckling reflex.
- If the newborn **cannot breastfeed**, give expressed breast milk using an alternative feeding method (cup feeding, NGT)
- Amount of oral feeds should be adjusted according to the condition and ability to tolerate.
- If newborn cannot tolerate feeds (having significant emesis and/or abdomen distension), consider nil per oral (NPO) for 24 hours, start IV fluids according to feeding/fluid requirement table 4 and evaluate for NEC.
- If newborn cannot tolerate some of the feeds (having emesis and/or abdomen distension) the deficit should be given as IV fluids (to a total of 60 ml/kg on day 1)
- For the following days, refer feeding/fluid requirement Table xx, chapter xx.
- If stable 24 hours later, resume feeds at 50% the amount was previously being given, and advance gradually.

Moderate and severe HIE:

- Supportive care
- Intensive care, control seizures, continuous monitoring, and supportive therapy for multi-organ dysfunction. Therapeutic hypothermia if criteria met.
  - Do not feed orally on day 1
  - Swab the mouth with breast milk (colostrum swabs 0.1 mls each check, refer to chapter 2 for more details).
  - Check glucose levels, correct hypoglycaemia if present
  - Catheterize monitor urine output

- Start Dextrose 10 % IV. Do not restrict fluid if urine output is > 1ml/kg/hr after 6hrs of life or change diaper >2 times in 6 hrs post-delivery. refer feeding/fluid requirement Table xx, chapter xx.
- Restrict the volume of fluid only if there is reduce urine output (<1ml/kg/hr) to 40mls/kg,60mls/kg,80mls/kg per day, for the first three days consecutively, and monitor urine output. (Till the baby is hemodynamically stable).
- Then resume 120mls/kg/day,140mls/kg/day/160mls/kg/day on day 4,5 and 6 consecutively as per table xx, chapter xx.
- From day 2 onward start trophic feeds and advance slowly depending on clinical improvement of newborn (stable vital signs, no abdomen distension, no vomiting and passes stool well).

Give antibiotics

- Antibiotics should be given for;
  - Severe HIE
  - Evidence of existing sepsis
  - Concern for maternal infections
- Use recommended combination of Ampicillin/Ampiclox and gentamicin renal dose for 7 days.
- Anticonvulsants: Refer to chapter on seizures

9.2 Therapeutic Hypothermia

Therapeutic hypothermia is delivered safely with specialized equipment and monitoring in level 3 care with NICU.

Methods for Therapeutic hypothermia

Therapeutic hypothermia can be administered by Selective Head Cooling (SHC) or whole-body cooling (WBC).

1. SHC requires a head cap that circulates cold water to decrease the core temperature of the neonate. The head and brain structures reach a cooler temperature than the body.
2. WBC requires a special blanket that circulates water, which can be cooled or warmed. WBC achieves uniform cooling of the entire body.

Both WBC and SHC have similar safety and effectiveness, also side effects are similar in both methods.

Compared with SHC, WBC provides uniform cooling to all brain structures, offers better or at least similar neuroprotection and provides more accessible access to the scalp for EEG monitoring

Therapeutic hypothermia, which involves cooling the body to 33-34°C within the first 6 hours after birth, is an effective treatment for moderate-to-severe hypoxic-ischemic encephalopathy (HIE) in newborns and improves neurological outcomes. Whole-body cooling is generally the preferred method for this treatment.

Criteria for starting therapeutic hypothermia

1. Appropriate gestation age, birth weight and postnatal age (all of these)

- The infant is within 6 hours of birth
- Gestational age > 35 weeks
- Birth weight ≥1800 grams

AND

2. Any ONE of the following:

- pH of ≤7.0 or a base deficit of ≥16 mmol/L of infant's blood gas done within the first hour of life (can be from cord blood or the baby's blood)
- Acute perinatal event (ruptured uterus, cord prolapse, etc)
- APGAR score of 5 or less at 10 minutes ***or*** assisted ventilation needed for at least 10 minutes after birth

AND

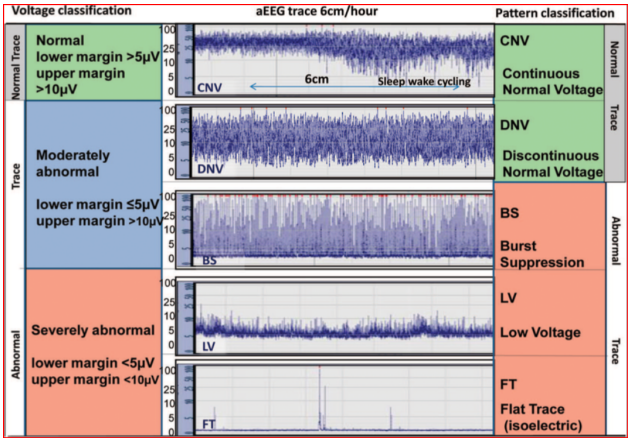
3. The infant must have moderate to severe encephalopathy on an exam (HIE score> 10)

AND

4. Abnormal amplitude-integrated electroencephalography (aEEG) for at least 30 minutes. Abnormalities could be any of the following

- Moderate abnormal background (upper margin of the band above 10μV and lower margin below 5 μV)
- Severe abnormal background (upper margin of the band below 10μV and lower margin below 5 μV)
- Normal background with seizure activity

NOTE: If aEEG is not available but patient meets the other three criteria, cooling should be considered.



Contraindications

- Infants with no spontaneous respiratory effort after 30 minutes post-resuscitation (after excluding possible effect of anesthesia), heart rate below 100 per minute at 20 minutes post resuscitation. Moribund state where further interventions are futile.
- Infants expected to be more than 6 hours of age at the time of starting cooling.
- Significant bleeding or coagulopathy.
- Infant with Persistent Pulmonary Hypertension of Newborn (PPHN)
- Infants with major congenital abnormalities or signs suggestive of syndromes or chromosomal abnormalities that involve brain dysgenesis.

Management during therapeutic hypothermia

- Start on fluid rate of 60 mL/kg and regulated according to urine output, electrolytes and creatinine.
- Keep NPO during hypothermia and for up to 12 hours after rewarming
- Most patients on hypothermia will maintain HR at about 100 b/ min and mean BP >40 mmHg.
- If mean BP is < 40 mmHg, do ECHO to assess cardiac function, start on dopamine, followed by dobutamine or adrenaline as necessary (refer to chapter on hypotension).
- Ventilation: keep pH > 7.25, PaCO2 35-45 mmHg, PaO2- 45 - 70
- Do electrolytes, creatinine, and FBC+ platelets after 24 hours of life and after 48 and 72 hours on hypothermia, PI/PTT day 2 and day 3 on hypothermia, LFTs once at 48 hours of life.
- Manage seizures according to the protocol.
- HIE score should be documented at the start of cooling, daily on cooling and on discharge.

Rewarming

- Rewarm after 72 hours of hypothermia
- Rewarm at rate not faster than 0.5ºC per hour
- Increase radiant warmer set temperature 0.5ºC higher than skin temperature
- Continue monitoring rectal temperature for the next 4 hours post cooling

During Rewarming monitor for

- Rebound Seizures
- Urine Output 1-2 mls/kg/hr
- Hypotension
- Rebound Hypothermia
- Metabolic Acidosis
- Hypoglycaemia

Ongoing care

Assess the newborn every two hours:

- Maintain temperature (36.5 – 37.5 °C)
- Treat convulsions if necessary (see section on convulsion management)
- EEG/aEEG is useful to monitor cerebral background activity, diagnose and treat seizures and predict neurodevelopmental outcomes for preterm and term infants.

Decision to discharge

Requirements for discharge:

- No convulsions for three days after discontinuing anticonvulsant drugs
- Mother is able to feed the newborn
- No other problems requiring hospitalization

Help the mother find the best method to feed the newborn if the newborn is not breastfeeding well. If the newborn is feeding slowly, have the mother feed more frequently

Counsel the mother/caregiver on the newborn's prognosis and how to deal with the problems

Follow-Up Recommendations:

N**eonatologist** leads initial care and coordination

Paediatric neurologist manages neurological assessments and seizure control.

Developmental paediatricians oversee developmental progress, and

Therapists (physical, occupational, speech) address motor, sensory, and feeding needs.

Ophthalmologists and **audiologists** monitor vision and hearing, and the

Physical medicine specialist manages physical disabilities.

Social worker and psychologist support the family's emotional and resource needs

> The patient must be followed up for at least 18 months post-discharge with a multidisciplinary team.

9.3 Convulsions

A sudden, irregular movement of the body caused by involuntary contraction of muscles e.g. lip smacking, cycling, abnormal blinking or deviation of the eyes, tonic posturing, high pitched cry. Convulsions (seizures) may also be subtle, consisting of autonomic changes, apnoea and bradycardia.

Risk factors and causes

- Hypoglycaemia
- Birth asphyxia
- Structural brain lesions (congenital anomaly, haemorrhage, infarction, stroke)
- CNS infections (e.g. congenital or postnatal infections)
- Bilirubin encephalopathy
- Electrolyte imbalance (hypocalcaemia, hypomagnesaemia, hyponatraemia)
- Drug withdrawal syndrome/neonatal abstinence syndrome (maternal drugs/substance abuse)
- Inborn errors of metabolism

Investigations

- Blood glucose
- Septic screening (FBP, CRP, blood culture and sensitivity, urine analysis)
- Electrolytes (calcium, magnesium, sodium)
- Bilirubin as indicated
- Lumbar puncture (if CNS infection is suspected; for contraindications refer to chapter on meningitis)
- Cranial ultrasound (if suspecting e.g. intracranial bleeding)
- CT and MRI brain (if indicated)

- aEEG, EEG

Management

Current convulsions (or within the last hour) are an emergency.

- Apply ABC approach of resuscitation and keep warm and safe.
- Check blood glucose and correct hypoglycaemia if glucose is below 2.6 mmol/l (see chapter XXXXX on hypoglycaemia).
- If convulsions stop after correction of hypoglycaemia, don't start on anticonvulsant.
- All clinical and electrical seizures need to be treated. Give phenobarbitone loading dose (20 mg/kg IV slowly over 15 minutes (if no IV line, give IM)). (dilution see Annex XXXXX on drugs and dilutions)
- If convulsions stop after the first phenobarbitone loading dose and don't recur, don't continue with maintenance dose.
- If convulsions continue or recur within 30 minutes:
    - Give phenobarbitone 10 mg/kg IV (IM) slowly over 10 minutes
    - If still convulsing after 30 minutes, repeat phenobarbitone 10 mg/kg IV, if still convulsing after another 30 min, repeat phenobarbitone 10 mg/kg IV one last time (maximum 50 mg/kg as loading dose within 24 hours). The last dose should only be given under close respiratory monitoring, also consult/refer for further specialist care.
- Once convulsions stopped, continue with maintenance dose 12 hours after last dose of the loading dose.
- If convulsions continue after phenobarbitone loading dose or recur under phenobarbitone maintenance therapy:
    - Switch to 2nd line anticonvulsant
    - Choose one of the following, consider contraindications and available monitoring/emergency interventions:
        - Levetiracetam loading dose 40 mg/kg IV over 15 – 20 min, second loading dose 20 mg/kg IV if required.
        - Phenytoin 20 mg/kg slowly IV over 15 min (If no cardiac abnormality/instability, with cardiac monitoring).
- If 2nd line anticonvulsants are not effective:
    - Switch to 3rd line anticonvulsant
    - Choose one of the following, consider contraindications and available monitoring/emergency interventions:
        - Midazolam 0.05-0.2 mg/kg IV slowly (with respiratory and SpO_2 monitoring), followed by continuous infusion of 1 µg/kg/min (= 0.06 mg/kg/h) by syringe pump. Titrate up to effect, max. 6.7 µg/kg/min (= 0.4 mg/kg/h)
        - Lidocaine (for normothermic newborn above 2.5 kg) 2 mg/kg IV bolus (with cardiac monitoring). After the bolus continue immediately with maintenance dose 7 mg/kg/h for 4 hours, then 3.5 mg/kg/h for 12 hours, then 1.75 mg/kg/h for 12 hours (28 hours total), then stop.

- Phenytoin, Midazolam and Lidocaine should only be given where close monitoring is possible.
- Continue with maintenance dose of the last used effective anticonvulsant.
- In case of persistent convulsions, think of metabolic causes and inborn errors of metabolism.
- A trial of pyridoxine (add-on to anticonvulsants) should be attempted in neonates presenting with clinical features (myoclonic jerks, spasms, abnormal eye movements, grimacing) and EEG characteristics (burst-suppression, discontinuity) suggestive of vitamin B6-dependent epilepsy or in seizures unresponsive to second line anticonvulsants without an identified aetiology.

Other considerations:

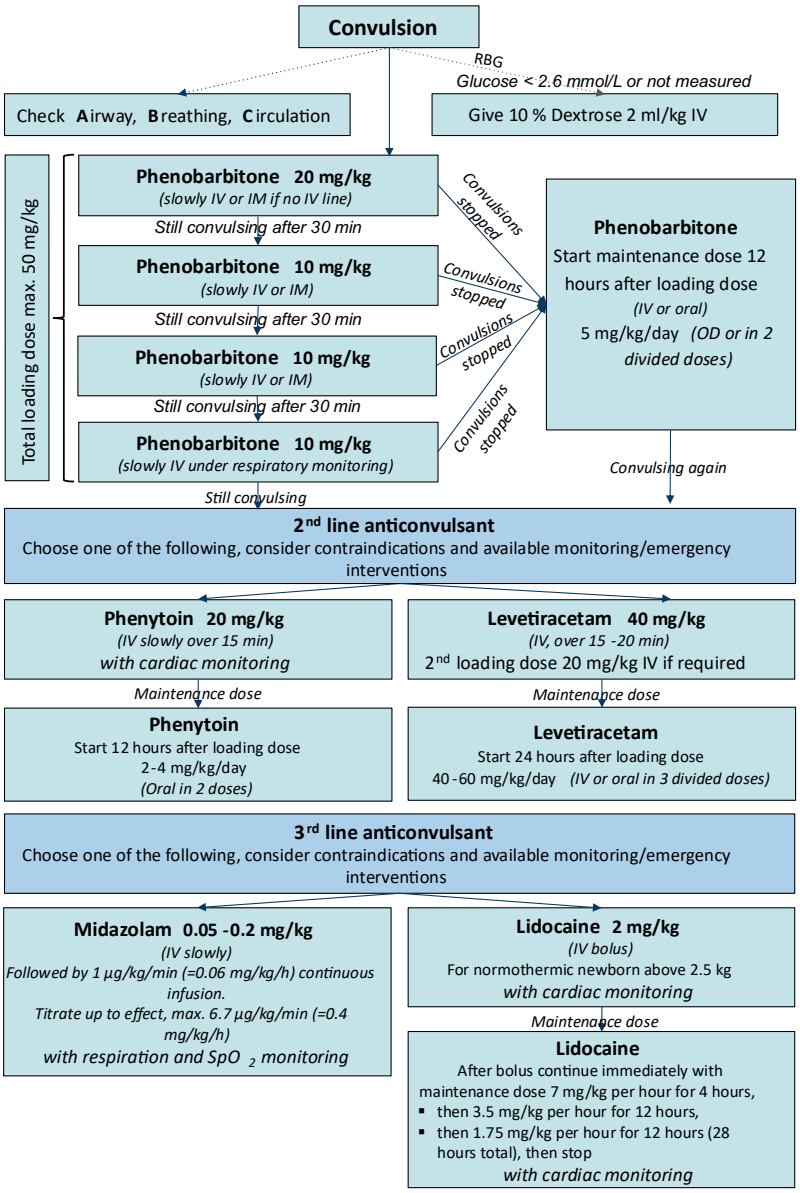
- If the newborn has low oxygen saturation, central cyanosis or other signs of breathing difficulty: Consider to give oxygen to sustain normal SpO_2 and support breathing and circulation as required.
- Keep the newborn in a safe environment, protect from aspiration.
- Take proper history to determine underlying conditions (history and details of the first convulsion are crucial for further diagnostic action).
- Determine cause of convulsion and manage accordingly.
- Begin maintenance therapy according to Flowchart xxxx.

If a newborn has had no convulsion and normal CNS exam for 48 – 72 hours:

- Stop anticonvulsant if the above is fulfilled and drug was used less than one week.
- Wean off the anticonvulsant slowly if used more than one week.
- Remove the most recently added anticonvulsant first and taper off doses gradually over the subsequent week.

NB. For neonates with e.g. underlying brain lesions or neonatal-onset epilepsy syndrome, treatment may be prolonged due to prolonged convulsions. Paediatric neurological follow-up is required.

Flowchart xxxx: Pharmacological management of convulsions in newborns



4444 **Table XXX: Differential diagnoses for convulsions**

Probable diagnosis	Timing and History	Clinical Findings
Hypoglycaemia	• Timing: any time • History of maternal diabetes • Poor or no feeding	• Convulsions, jitteriness, lethargy, or unconsciousness • Small newborn (< 2.500 g, < 37 GA) • Large newborn (birthweight > 4000 g) • **Blood glucose less than 2.6 mmol/l**
Asphyxia or other brain injury	• Timing: within 24 hours of birth • Problems during labour/birth • Resuscitation at birth	• Convulsions, unconsciousness, lethargy, floppiness, abnormal primitive reflexes • Irritability, high-pitched or no cry • Breathing difficulty • Abnormal body temperature
Intraventricular haemorrhage	• Timing: day 1 to 7 (and beyond)	• Convulsions or unconsciousness • LBW or premature • Sudden deterioration of condition • Sudden pallor • Breathing difficulty
Meningitis	• Timing: day 2 or later	• Convulsions or unconsciousness • Lethargy • Signs of sepsis • Bulging anterior fontanelle
Bilirubin encephalopathy	• Timing: day 3 to 7 • Deep jaundice • No or delayed initial jaundice treatment	• Convulsions • Opisthotonus posture • Poor or no feeding • Lethargy or floppiness
Tetanus	• Timing: day 3 to 14 • Change in feeding to poor feeding • Unclean birth • Application of unclean or harmful substances to umbilicus	• Spasms • Infection of umbilicus

4445

4446

4447

References:

1. Tanigasalam V, Plakkal N, Vishnu Bhat B, Chinnakali P. Does fluid restriction improve outcomes in infants with hypoxic ischemic encephalopathy? A pilot randomized controlled trial. J Perinatol. 2018 Nov;38(11):1512-1517. doi: 10.1038/s41372-018-0223-7. Epub 2018 Sep 11. PMID: 30206346.

2. O'Dea M, Sweetman D, Bonifacio SL, El-Dib M, Austin T, Molloy EJ. Management of Multi Organ Dysfunction in Neonatal Encephalopathy. Front Pediatr. 2020 May 15;8:239. doi: 10.3389/fped.2020.00239. PMID: 32500050; PMCID: PMC7243796.

3. McAdams RM, Juul SE. Neonatal Encephalopathy: Update on Therapeutic Hypothermia and Other Novel Therapeutics. Clin Perinatol. 2016 Sep;43(3):485-500. doi: 10.1016/j.clp.2016.04.007. Epub 2016 Jun 22. PMID: 27524449; PMCID: PMC4987711.

4. Bhagwani DK, Sharma M, Dolker S, Kothapalli S. To Study the Correlation of Thompson Scoring in Predicting Early Neonatal Outcome in Post Asphyxiated Term Neonates. J Clin Diagn Res. 2016 Nov;10(11):SC16-SC19. doi: 10.7860/JCDR/2016/22896.8882. Epub 2016 Nov 1. PMID: 28050462; PMCID: PMC5198415.

5. Pu Y, Zhu Z, Yang Q, Zhang Y, Zhao J, Liu M, Yu X. Significance of amplitude integrated electroencephalography in early stage of neonatal hypoxic-ischemic encephalopathy and cerebral function monitoring in Neonatal Intensive Care Units. Am J Transl Res. 2021 Aug 15;13(8):9437-9443. PMID: 34540063; PMCID: PMC8430076.

6. Azzopardi DV, Strohm B, Marlow N, et al. "Effects of hypothermia for perinatal asphyxia on childhood outcomes." *New England Journal of Medicine.* 2009;361(14):1349-1358.

7. Sarnat HB, Sarnat MS. "Neonatal encephalopathy following fetal distress. A clinical and electroencephalographic study." *Arch Neurol.* 1976;33(10):696-705.

for Stopping treatment: upTodate, (reference: Cappellari AM, Palumbo S, Margiotta S, Questions and controversies in neonatal seizures, Children 2024).

WHO guideline 2011, updates Oct 2023

ILAE_Treatment of seizures in the neonate, 2023

CHAPTER 10: NEONATAL ABSTINENCE SYNDROME (NAS)

An infant born to a person with opioid use disorder is at risk for withdrawal, commonly referred to as neonatal abstinence syndrome (NAS) or neonatal opioid withdrawal syndrome (NOWS). These are clusters of symptoms that develop signs of drug withdrawal or neonatal abstinence born to mothers' dependent on drugs during pregnancy, whether opioids or other substances (e.g. selective serotonin reuptake inhibitors, tricyclic antidepressants, methamphetamines or inhalants). Take note of mothers with chronic diseases who have been on opioids. Infants exposed to drugs that cause NAS may initially be asymptomatic and all infants should be observed for at least 2 days. Symptomatic newborns need to be admitted in level III care, RRH. Frequency of presentation, time of onset after birth and duration of symptoms vary according to maturity of the infant and type and dose of drug. Most infants present within 24-48 hours of birth, but infants of mothers on methadone present later at 60-72 hours. At times, withdrawal signs may be delayed by 5 days or more; monitor these infants for longer periods in the hospital. If ≥ 7 days have elapsed between the last maternal opioid use and delivery of the infant, the risk of acute signs of neonatal withdrawal is low. Incidence and severity of NAS are less in preterm infants compared to term infants. The clinical signs can be assessed with the Modified Finnegan Signs and Symptoms.

Clinical presentation

- Excessive crying or high pitch crying
- Hyperactive reflexes
- Poor feeding
- Sleep problems
- Seizures
- Tremors
- Irritability
- Diarrhea
- Blotchy skin coloring (mottling)
- Fever
- Increased muscle tone
- Slow weight gain
- Stuffy nose, sneezing
- Sweating
- Vomiting
- Tachypnoea, apnoea

NEONATAL ABSTINENCE SCORING SYSTEM

Modified Finnegan Neonatal Abstinence Score

	score	AM						PM						comment
Excessive high-pitched (or other) cry < 5 mins	2													
Continuous high-pitched (or other) cry > 5 mins	3													
Sleep < 1 hour after feeding	3													
Sleeps < 2 hours after feeding	2													
	1													
Hyperactive Moro reflex	2													
Markedly hyperactive Moro	3													
Mild tremors when disturbed	1													
Moderate-severe tremors when disturbed	2													
Mild tremors when undisturbed	3													
	4													
Increased muscle tone	1													
Excoriation (chin, knees, elbow, toes, nose)	1													
Myoclonic jerks (twitching/ jerking of limbs)	3													
Generalised convulsions	5													

Sweating	1													
Hyperthermia 37.2-38.3C	1													
Hyperthermia > 38.4C	2													

Frequent yawning (> 3-4 times/ scoring interval)	1													
Mottling	1													
Nasal stuffiness	1													
Sneezing (> 3-4 times/ scoring interval)	1													
Nasal flaring	2													
Respiratory rate > 60/min	1													
Respiratory rate > 60/min with retractions	2													
Excessive sucking	1													
Poor feeding (infrequent/ uncoordinated suck)	2													
Regurgitation (≥ 2 times	2													
during/post feeding) Projectile vomiting	3													
Loose stools (curds/seedy appearance)	2													
Watery stools (water ring on nappy around stool)	3													
Total Score														
Date/Time														
Signature														

Management of NAS

For any mother whose baby presents with signs of NAS, family social support should be assessed. This patient should be managed ideally in level III care where appropriate services can be offered. Communication with the psychiatric department for mental

support of the mother and for those on Methadone support to continue with the supportive care.

Non-Pharmacological Management and Breastfeeding

- Minimal sensory or environmental stimulation
- Gentle handling, dim light, minimal noise levels, swaddling, holding, cuddling, or gentle rocking
- Avoid waking a sleeping infant
- Encourage maternal visitation and participation with supervised demand breastfeeding and rooming-in where possible
- Consider small, frequent feeds (2-hourly) in persistently unsettled infants

Note:

- Maternal therapeutic doses of prescription opioids are usually compatible with breastfeeding
- Monitor infants for poor feeding, sedation or signs of withdrawal
- Urine toxicology is not routinely required

Pharmacological Management

Indications to Start Pharmacological Treatment to Infants who, despite non-pharmacologic care, display Significant signs of NAS. This occurs in

- 3 consecutive Finnegan scores ≥ 8 OR
- When the average of 2 scores ≥ 12 OR
- 2 consecutive scores ≥ 12

A. First Line Agents for Infants of Opioid Dependent Mothers.

1. Oral morphine titrated according to the score
2. Methadone is an alternate when morphine is not available

B. Second-Line Agents for Infants of Opioid Dependent Mothers

1. Clonidine
2. phenobarbitone

   The two drugs can used in combination, especially for mothers with polysubstance dependent mothers. Titration of medication should be based on scores over the preceding 24-48 hours: Phenobarbitone is added after a maximum dose of morphine is reached and the infant is symptomatic

   Note

   i. If the score ≥ 12: increase the dose
   ii. If score 8-11: no change in dose
   iii. If score < 8: decrease dose
   iv. Score 2-4 hourly while on treatment

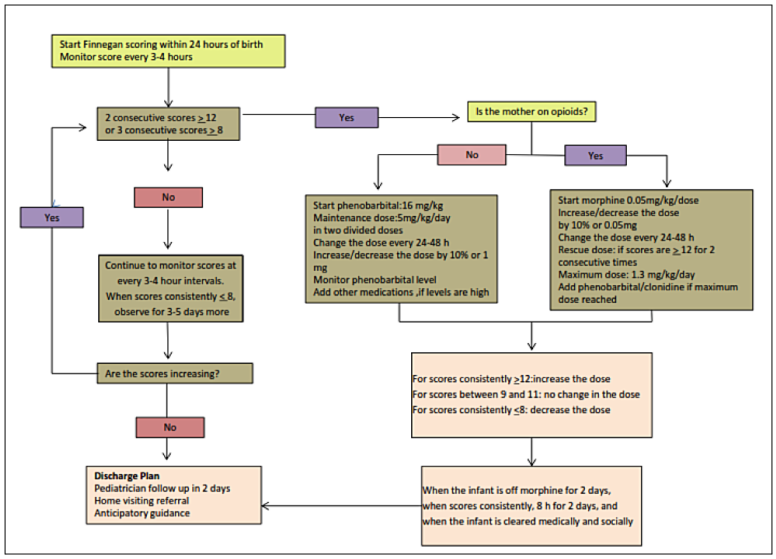


Figure XXX Plan of management of based on the SAS score

How to give the Oral morphine.

- Dose 3-4 hourly (time dosing with feeding)
- Start at 0.05 mg/kg/dose 3 hourly (if receiving 3 hourly feeds) If scores persistently ≥ 12 despite initial dosing → may increase the morphine dose by 0.02 mg/kg/dose. Maximum dose = 0.2 mg/kg/dose
- Add clonidine if the maximum morphine dose is reached and the infant remains symptomatic. If symptoms remain uncontrolled, add phenobarbitone

When and How to Decrease Oral Morphine Dose? Down-titration of dosing occurs after 48 hours of clinical stabilisation i.e. score that remains < 8 for 48 hours. The daily dose may be decreased by 10% of the infant's highest dose in mg/dose every 48 hours. Decrease dose and then frequency of dosing in response to score, before stopping

When the total daily dose of morphine is < 0.2 mg/kg/24 hours (i.e < 0.025 mg/kg/dose if using 3 hourly dosing) may change to daily dosing to stop morphine over the next few days. Observe the infant for 48 hours after stopping the treatment

What to Do if Rebound Withdrawal Occurs While Weaning Oral Morphine? If three scores in 24 hours are ≥ 8 or two scores are ≥ 12 consider increasing the dose back to the last stable dose for 24-48 hours before restarting the weaning process

Methadone

Initial dose: 0.05-0.1 mg/kg/dose 6 hourly; may increase dose by 0.05 mg/kg/dose as

needed, or increase frequency to 4 hourly. Taper the dose by 10-20% of the therapeutic dose and/or extend the dosing interval every 1 to 2 days until 0.05 mg/dose is achieved. Observe for 48 hours following discontinuation of therapy. Methadone has a long half-life

Clonidine

It is given when morphine does not control symptoms (score persistently ≥ 12).

- Dose: Start with 0.5-1 micrograms/kg/dose 6 hourly
- Use the lowest effective dose
- Start weaning clonidine after morphine is discontinued. Wean over 2-3 days

Phenobarbitone

Dose: Load 10-20 mg/kg orally (PO) (if no seizures), then start 2.5 mg/kg/dose orally 12 hourly, 12-24 hours after loading dose. If Finnegan scores≥ 8, increase to 4 mg/kg/dose 12 hourly PO. If Finnegan score remains ≥ 8, increase to 5 mg/kg/dose 12 hourly PO. Start weaning phenobarbitone after all other medication has been discontinued. The dose can be tapered by 20% every second day according to the Modified Finnegan score. Phenobarbitone can be stopped once dose is 1 mg/kg/dose 12 hourly

Convulsions

Convulsions are unusual but may occur. Treat with intravenous phenobarbitone. Morphine should be commenced if the infant is not already on morphine, stabilise the infant and exclude other causes for convulsions (e.g. hypoglycaemia, infection, electrolyte abnormalities).

Discharge and follow-up plan

The baby can be discharged after three days of being asymptomatic and is off morphine for at least 2 days with a consistent score for 2hours. They will need to attend high-risk neonatal follow-up 3 days post-discharge and continue neonatal clinics for neurodevelopmental assessment. Mothers not on methadone clinics will need psychosocial support for the welfare of their children. When available linking with community health care workers will be needed.

CHAPTER 11: NEURO-DEVELOPMENT AND GROWTH MONITORING

Newborn period (first hours, days and weeks after birth) is a precious time for a child's survival, health and development. When cared for in a nurturing environment, babies not only survive, they are also helped to thrive. However, too many neonates are deprived of their right to receive nurturing care, especially when they require inpatient hospital care. Birth is the critical transition for every newborn from being nurtures in the womb to being cared for in the outside world. Essential newborn care is designed to make this transition as smooth as possible and provide the neonate with a nurturing environment in the first minutes and hours after birth, needed for the brain and body to grow and develop.

The first month of life is a once-in-a-lifetime opportunity for children to begin the journey of unlocking their full potential. Policy-makers, health care managers, health care providers and parents/caregivers can lead the transformation that is needed for every newborn to make the best start in life.

Nurturing care for every newborn

In the international public health context, the term "nurturing

care" refers to a more comprehensive coverage, including conditions created by public policies, programs and services. what happens during the early childhood (pregnancy to age 8) lays the foundation for a lifetime. Great strides have been made in improving survival, it is also important to create conditions to help children thrive as they grow and develop. This requires providing children with nurturing care, especially win the earliest years (pregnancy to age 3). Nurturing care is necessary for all babies, but premature and low-birthweight babies, and babies with congenital conditions need it even more. Unfortunately, they often get less of it due to the environment they are first cared in. Interventions during the newborn period such as immediate skin to skin contact, warmth, hygiene, early initiation of exclusive breastfeeding and zero separation of caregiver and newborn improve child outcomes.



- The human brain develops faster from conception to age 3 years than at any other time.

Description of nurturing Care components

Nurturing care comprises five interrelated and indivisible components: good health, adequate nutrition, safety and security, responsive caregiving and opportunities for early learning. It protects children from the worst effects of adversity and produces lifelong and intergenerational benefits for health, productivity and social cohesion.



Fig xxx Components of nurturing care

Good Health

Refers to health and well-being of children and their caregivers. Physical and mental health of caregivers can affect their ability to care for the child

Adequate Nutrition

Adequate nutrition covers the mother's nutrition during pregnancy, the endorsement of exclusive breastfeeding for the first 6 months after birth, complementary feeding after 6 months, in addition to breast milk and food safety and food security. Mother's nutritional status affects her ability to provide adequate care to her young child.

Responsive Caregiving

Responsive caregiving refers to the ability of the caregiver to notice, understand and respond to their child's signals in a timely and appropriate manner. It is considered the foundational component because responsive caregivers are better able to support the other four components.

Opportunities for early learning

Learning is a built-in mechanism for human beings, ensuring our successful adaption to changing circumstances. This component refers to any opportunity for the neonate or child to interact with a person, place or object in their environment. It recognizes that every interaction (positive or negative) or absence of it contributes to the child's brain development and laying the foundation for later learning.

Security and Safety

Refers to safe and secure environments for children and their families. Includes physical dangers, emotional stress, environmental risks (e.g. pollution), and access to food and water.

Creating a nurturing environment for all newborns

When health care providers partner with families to provide nurturing care, more newborns will survive and receive better care in the health facility and at home to ensure they can thrive. One approach is the infant- and family centered developmental care

(IFCDC), which creates a nurturing environment to respond to each baby's needs and minimizes harm (Fig xxx)

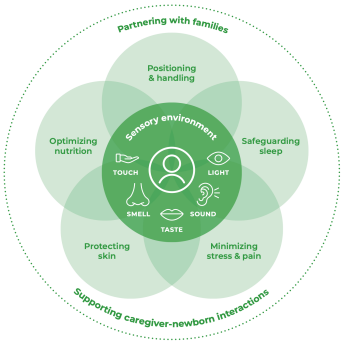


Fig.xxx Components of infant- and family-centered developmental care (IFCDC)

All caregivers need to be empowered and supported to provide nurturing care to their babies. Engage parents as partners in offering care to their sick baby. Fathers should not be forgotten as equal parents and other family members should receive attention and guidance on how to engage in the care of the baby. Encourage family centered approach and educate/counsel on danger sign, health seeking behaviour, and follow-up care (growth monitoring, milestone assessment, vaccination/immunization etc.) of their baby as per the national postnatal guideline.

Nurturing care component	Perinatal period	Hospitalized (small and/or sick babies)	Non - hospitalized
Good health 	• Seeking care and appropriate treatment in case of illness • Preventive health services such as ensuring administration of prophylaxis to the pregnant woman (anti-malarial, deworming, iron supplements, Folic acid, Screen mother for STIs, HIV, HB and other conditions as per ANC guideline) • Immunization for mothers	• Management of conditions as per current national neonatal guideline by providing evidence-based high-quality care for sick or small newborns • Adhere to IPC to prevent infections • Monitor, document and intervene the anthropometric measurement of the neonate (OFC, length, weight) • Appropriate newborn screening, vaccination and supplementation	• Appropriate newborn screening and vaccination before discharge • Educate parents/caregivers on general hygiene during handling the baby (hand hygiene changing diapers, breastfeeding, breast hygiene before feeding) • Identify danger signs and seek for medical care • Encourage parents/caregivers to attend post-natal follow up clinics
Adequate nutrition 	• Educate and counsel the mother, father and family on what to eat during pregnancy • Administer and ensure the mother has been provided with deworming drugs, iron supplements	• Customize feeding plan depending on the condition of the baby with specific nutritional requirements • Optimize early initiation of breast-milk feeding via breast or assisted feeding • Educate and assist mother on appropriate positioning and attachment during feeding • Implement the ten steps to successful breastfeeding; The Baby-friendly Hospital Initiative (BFHI) to equip caregivers with the confidence and skills to provide nurturing care for their newborn	• Early initiation of breastfeeding • Postnatal Baby-friendly Hospital Initiative (BFHI) implementation before discharge • Encourage mother on EBF for 6 months and complementary feeding after 6 months.

Responsive care Giving 	• Family support to the pregnant mother at home - exemption from hard works, emotional support, assist the mother in routine activities • Father involvement during antenatal period and during labor and delivery • Parents should normalize talking to the baby intrauterine	• Promotion of zero separation of small and sick babies and their caregivers • Being aware of newborn's signals which can indicate readiness for a feed, pain or stress, and responding to them appropriately • Gentle care during painful procedures e.g. swaddling, non-nutritive suckling • Avoid unnecessary disturbance and promote resting • Facilitate a smooth transition to care at home	• Teach parents/caregivers baby's signals and how to respond to them appropriately • Encourage caregivers to comfort, show tender loving care (affection) to the baby and guiding his/her exploration • Protect against injury and negative effects • Build trust and social relationships
Opportunities for early learning 	Encourage Early stimulation as early as the third month of pregnancy. Educate the parents/ caregivers to: • Communicate with the baby intrauterine through her/his movements establishing a relationship between certain stimuli e.g. sound and certain responses for the baby to recognize • Stimulate the baby's hearing, by talking or put a melodious music near her belly. • Communicate with her child through touch. • Initiate the dialogue with the baby, teaching how to associate words with actions. The mother/father	• Involve the parents in the care of the small and sick baby to stimulate the baby's brain gently through touch, voice or simply close contact • Empower and the parents with each step by observing how they provide the care to their small or sick baby, especially in the NICU/HDU • Use your observation to praise the parents to build their confidence	At this age learning is through seeing, hearing, feeling, smelling and moving (especially during breast feeding). • Educate mother to looks at her baby's eyes and smiles in response to the child's reaction, the child learns to communicate. • Educate the mother/ parents/families to talk to their children from birth • Train the baby to focus his/her attention • Show that sounds have meaning and can be used to communicate • Begin the first steps toward developing language through associating words and meaning • Teach the baby the concept of rhythm • Develop and

	should keep their tone of voice enthusiastic, entertaining and patient		exercise memory
Safety and Security 	Effective nurturing care depends on the mother's physical and mental well-being. Asses for: • GBV or any other maternal physical, psychological, social and emotional disturbances in every antenatal visit including • Maternal perinatal mental disorders like depression, anxiety and adjustment disorders Appropriate counseling to avoid: • Unnecessary travel • Exposure to hazardous pollutants • Smoking during pregnancy • Alcohol consumption during pregnancy • Unauthorized drug use	• **Minimizing stress and pain** by gentle handling and avoiding unnecessary noise, continuous bright light, and artificial smells in the neonatal care units • Avoid shaking and abrupt movements • Promote protected time for the child to sleep (compile procedures which can be done once and avoid unnecessary disturbances) • Enable the primary caregiver, most commonly the mother, to be with the baby.	• Educate mother/caregivers to maintain calm environment at home by avoiding noise, continuous bright light, artificial smells and shaking and/or abrupt movements of the baby • Counsel on screen time. **NO** screentime for children under 2 years is recommended • Assess GBV and VAC

Neurodevelopment Assessment

Early identification of babies at high risk of developmental delays or disorders is critical. Neurodevelopment screening should be done for babies at risk during follow up aiming at:

1. Early identification of disability
2. To enable timely referral for early intervention, usually multidisciplinary
3. To establish parental support
4. To improve functional outcomes of these babies and the well-being and quality of life of the entire family.

High-risk factors:

- Extreme preterm <28+0 weeks GA
- Extreme ow birth weight <1,000g
- Morphological brain damage/lesion e.g. grade 3 or 4 IVH, congenital brain malformation
- Moderate and severe HIE
- CNS infection
- Severe illness during neonatal period or intrauterine
- Hyperbilirubinemia (bilirubin >400 µmol/L or clinical evidence of bilirubin encephalopathy)
- High social risk (e.g., domestic violence, previous child abuse, severe poverty or homelessness, no antenatal care, intellectual disability or psychologic problem of caregiver, multicultural family)
- Diagnosis of genetic or neuromuscular disease (spinal muscular atrophy, myopathy, etc.)

Moderate risk factors

- Very preterm (28 – 32 weeks GA)
- Very low birth weight <1,500g
- Multiple pregnancy (more than twin, or twin discordance such as a significant birth weight difference in twins)
- Known sensory abnormality (hearing, vision [including severe retinopathy of prematurity], etc.)
- Small for gestational age: birth weight <10th percentile for gestational age
- Major surgery (brain, cardiac, thoracic, or abdominal)
- Any clinical event during perinatal period (seizure event, feeding problem etc.)

The neurodevelopmental assessment should be done at level two and above of care, and preferably by a Paediatrician/Paediatric Neurologist/Developmental Paediatrician. There are several assessment tools to be used, such as the MDAT (Malawian Developmental Assessment Tool), HNNE tool (Hammersmith Neonatal Neurological Examination), HINE (Hammersmith Infant Neurologic Examination) and PEDI-CAT (Paediatric Evaluation of Disability Inventory Computer Adaptive Test). Main four domains assessed are motor, language, cognition, and sensory-perception function

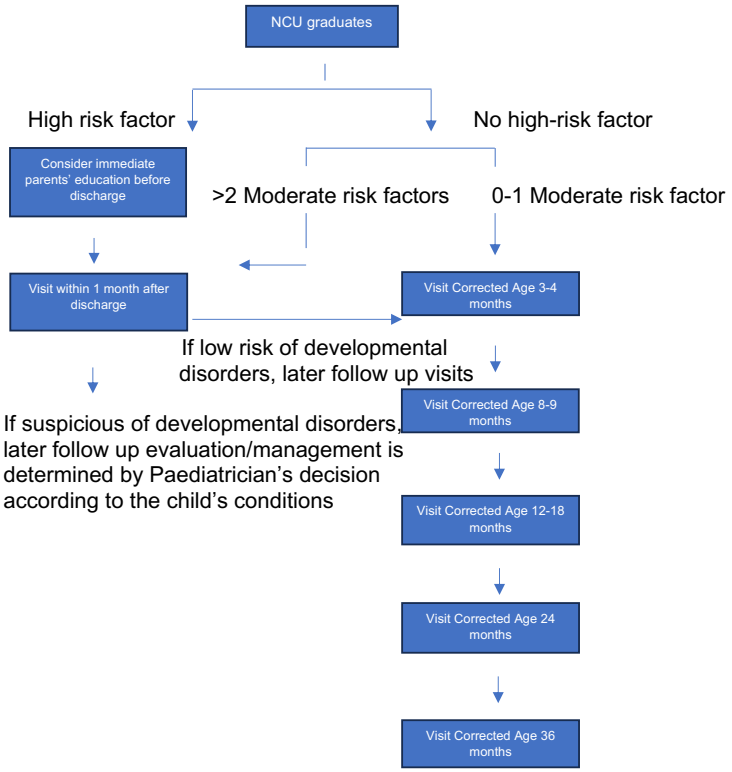


Fig. xxx Recommended screening schedule

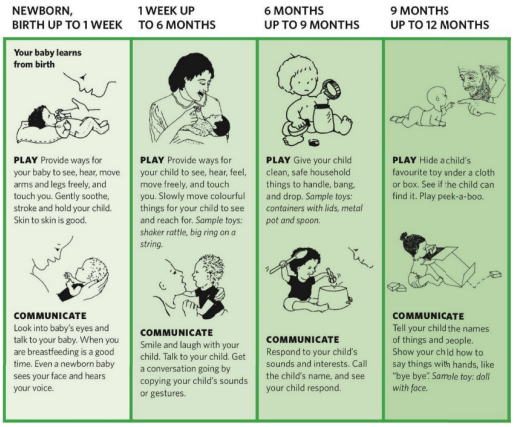


Fig. xxx Counselling Cards for Care for Child Development (WHO, UNICEF, 2012)

Growth and monitoring

Around 30% of children under the age of 5 in Tanzania are stunted, 3% are wasted, 12% are underweight and 4% are overweight (TDHS, 2022).

Growth monitoring to a neonate is crucial aspect which provides information regarding nutrition status and developmental progress. If well implemented it enables early detection of nutritional and developmental problems for early intervention. Anthropometry measurement is commonly used to measure child nutritional status, also used to report on child growth indicators. This Chapter describes important indicators for monitoring growth and development to a neonate including; head circumference, length/height for age, weight for age and weight for length/height. The parameters for growth monitoring described in this chapter should be measured and recorded whenever a neonate or an infant visits a health care provider, for example, for an immunization, a well-baby visit, or care during an illness. Recommended postnatal follow up schedule include a total of visits – first day (24 hours), day 3 (48 – 72 hours), between days 7 – 14 and at 6 weeks of life.

Because the growth pattern and velocity between girls and boys was significantly different, different assessment charts and child health booklets were developed and they exist into separate child health booklets (Pink for girls and blue for boys).

Use of the Growth Record

The booklet contains all of the charts needed to record and assess the growth of a child from birth up to 5 years of age.

- Use appropriate booklets for the corresponding sex.
- The booklet should be started for each child and kept by the mother.
- Ask the caretaker to carry the booklet with her/him every time he visits the health facility for care (growth monitoring visits or treatment when the child is sick)
- If the child already has a Growth Record, obtain it from the mother and record today's visit.
- If a child's Growth Record has been left at home, record information on whatever back-up registers or record is available at the health facility, and update the child's Growth Record at the next visit.
- Replace a child's booklet if lost or destroyed

Praise the mother/caretakers for having their child's growth assessed regularly and emphasize on reading the booklet to track growth and development.

NB: To the health care workers

- Plot the observed measurements appropriately in the booklet
- Clinically interpret the information measured
- Provide individual feedback/ counselling to the mother/caretaker.
- It has a schedule of immunizations to show when your child needs and receives immunizations, anti-helminths and vitamin A
- It has recommendations about feeding your child and important points about caring for your child at different ages.
- Keep this booklet in a safe place and bring it with you whenever you bring your child to a health facility

NOTE: (More information on child health booklets, its components, usage, services etc., refer to the neonatal guideline, section of continuum of care, Page…)

References

1. World Health Organization and the United Nations Children's Fund (UNICEF) Fund (2021). *Nurturing care for every newborn: thematic brief.*
2. World Health Organization (2018). *Nurturing care for early childhood development: a framework for helping children survive and thriv*e to transform health and human potential.
3. TDHS (2022). Demographic and Health Survey and malaria Indicator Survey. *Paper Knowledge. Toward a Meda History of Documents, 1-23.*
4. WHO, U., & Bank W. (2023). *Levels and trends in child malnutrition*

CHAPTER 12: NEONATAL SEPSIS

Neonatal sepsis is a clinical syndrome of bacteraemia with systemic signs and symptoms of infection in the first 28 days of life.

Neonatal sepsis can be differentiated into early-onset and late-onset sepsis, with manifestation **within the first 3 days** of life or **after 3 days** of life respectively.

- Early-onset sepsis is in most cases caused by an ascending infection of the amniotic fluid or during vaginal delivery from bacteria in the mother's genital tract.
- Late-onset sepsis is often caused by extension of early-onset neonatal sepsis, hospital environment or acquired from the community

Clinical presentation

The presence of **two or more** of the following criteria can be used for presumptive diagnosis:

- Fast breathing (> 60 breaths /min)
- Apnoea (<30 breaths/min)
- Grunting
- Severe lower chest wall in drawing
- Cyanosis
- Hyperthermia > 37.5 °C
- Hypothermia < 36.0 °C
- Prolonged capillary refill time (CRT) >3sec
- GIT symptoms (Poor feeding, vomiting and ileus)
- Convulsions
- Drowsiness or unconsciousness
- Movements only when stimulated or no movements at all
- Disseminated intravascular coagulation (DIC)
- Jaundice

Note: The symptoms are non-specific hence clinical features and a thorough history will assist in making the diagnosis. Extremely low-birth weight, very low-birth weight, and early preterm neonates may have similar symptoms of respiratory distress syndrome and poor feeding for reasons of prematurity.

Risk factors and Clinical diagnosis

EARLY ONSET NEONATAL SEPSIS

- Risk factors for early-onset neonatal infection, including **'red flags'**

Red flag risk factor:

• Suspected or confirmed infection in another baby in the case of a multiple pregnancy.

Other risk factors:

• Invasive group B streptococcal infection in a previous baby or maternal group B Streptococcal colonisation, bacteriuria or infection in the current pregnancy.

• Pre-term birth following spontaneous labour before 37 weeks' gestation.

• Confirmed rupture of membranes for more than 18 hours before a pre-term birth.

• Confirmed prelabour rupture of membranes at term for more than 24 hours before the onset of labour.

• Intrapartum fever higher than 38°C if there is suspected or confirmed bacterial infection.

• Clinical diagnosis of chorioamnionitis.

- Clinical indicators of possible early-onset neonatal infection (observations and events in the baby), including **'red flags'**

Red flag clinical indicators:

• Apnoea (temporary stopping of breathing)

• Seizures

• Need for cardiopulmonary resuscitation

• Need for mechanical ventilation

• Signs of shock (delayed capillary refill, cold hands/feet, fast feeble pulse, hypotension)

Other clinical indicators:

- Altered behaviour or responsiveness
- Altered muscle tone (for example, floppiness)
- Feeding difficulties (for example, feed refusal)
- Feed intolerance, including vomiting, excessive gastric aspirates and abdominal distension
- Abnormal heart rate (bradycardia or tachycardia)
- Signs of respiratory distress (including grunting, recession, tachypnoea)

- Hypoxia (for example, central cyanosis or reduced oxygen saturation level)
- Persistent pulmonary hypertension of newborns
- Jaundice within 24 hours of birth
- Signs of neonatal encephalopathy
- Temperature abnormality (lower than 36°C or higher than 38°C) unexplained by
- environmental factors
- Unexplained excessive bleeding, thrombocytopenia, or abnormal coagulation

Use the following framework, based on the risk factors and the clinical indicators above, to make antibiotic management decisions as directed:

In babies with **any red flag**, or **with 2 or more 'non-red flag'** risk factors or clinical indicators:

- Perform investigations accordingly before starting antibiotics and start antibiotic treatment. Do not wait for the test results before starting antibiotics

- In babies **without red flags** and **only 1 risk factor or 1 clinical indicator**, use clinical judgment to decide:
  - Whether it is safe to withhold antibiotics

and

  - Whether the baby's vital signs and clinical condition need to be monitored. If monitoring is needed, continue for at least 12 hours

- For babies without risk factors or clinical indicators of possible infection, continue routine postnatal care

Management of early-onset neonatal sepsis

- Use intravenous ampicillin with gentamicin as the first-choice antibiotic regimen for empirical treatment of suspected early-onset infection, unless microbiological surveillance data show local bacterial resistance patterns that indicate the need for a different antibiotic. (Refer to Annex for Drug dosage)
- Regularly reassess the clinical condition and results of investigations in babies receiving antibiotics.

Consider whether to change the antibiotic regimen, taking into account of:

- The baby's clinical condition (for example, if there is no improvement)
- The results of microbiological investigations
- Expert microbiological advice, including local surveillance data
- If there is microbiological evidence of Gram-negative bacterial sepsis, change to a regimen that is active against Gram-negative bacteria (for example, cefotaxime). If Gram-negative infection is confirmed, stop ampicillin

Investigations during antibiotic treatment for early-onset neonatal infection

- CRP-measure concentration 18 to 24 hours after presentation in babies given antibiotics because of risk factors for infection or clinical indicators of possible early-onset infection.
- LP-Consider performing a lumbar puncture to obtain a cerebrospinal fluid sample in a baby who did not have a lumbar puncture at presentation and who is receiving antibiotics, if it is thought safe to do so and if:
    - The baby has a positive blood culture (other than coagulase-negative staphylococcus) or
    - The baby does not respond satisfactorily to antibiotic treatment, or
    - There is a strong clinical suspicion of infection or
    - There are clinical symptoms or signs suggesting meningitis.

Decisions 36 hours after starting antibiotic treatment

- In babies given antibiotics because of risk factors for early-onset infection or clinical indicators of possible infection, consider stopping the antibiotics at 36 hours if:
    - The blood culture is negative

      and

    - The initial clinical suspicion of infection was not strong

      and

    - The baby's clinical condition is reassuring, with no clinical indicators of possible infection and
    - The levels and trends of C-reactive protein concentration are reassuring

Treatment duration for early-onset neonatal infection without meningitis

- Give antibiotic treatment for 7 days for babies with a positive blood culture, and for babies with a negative blood culture if sepsis has been strongly suspected.
- Consider continuing antibiotic treatment for more than 7 days if:
    - The baby has not yet fully recovered or
    - This is advisable because of the pathogen identified on blood culture (seek expert microbiological advice if necessary).
- If continuing antibiotics for longer than 36 hours despite negative blood cultures, review the baby at least once every 24 hours. Consider at each review whether it is appropriate to stop antibiotic treatment, taking into account:
    - The level of initial clinical suspicion of infection and
    - The baby's clinical progress and current condition and
    - The levels and trends of C-reactive protein concentration.

LATE-ONSET NEONATAL SEPSIS

Clinical indicators of possible late-onset neonatal infection (observations and events in the baby)

Category	Indicators
Behaviour	• Parent or caregiver concern for change in behavior • Appears ill to a healthcare professional • Does not wake, or if roused does not stay awake • Weak high-pitched or continuous cry
Respiratory	• Raised respiratory rate: 60 breaths per minute or more Grunting • Apnoea • Oxygen saturation of less than 90% in air or increased oxygen requirement over baseline
Circulation and hydration	• Persistent tachycardia: heart rate 160 beats per minute or more • Persistent bradycardia: heart rate less than 100 beats per minute
Skin	• Mottled or ashen appearance Cyanosis of skin, lips or tongue • Non-blanching rash of skin
Other	• Temperature 38°C or more unexplained by environmental factors Temperature less than 36°C unexplained by environmental factors Alterations in feeding pattern • Abdominal distension Seizures • Bulging fontanelle

Antibiotics for late-onset neonatal infection

- For babies with suspected late-onset neonatal infection who are already in a neonatal unit:
  - Give antibiotics start with ampicillin and gentamycin while continuing to monitor clinical response and blood culture results)
  - Use local antibiotic susceptibility and resistance data (or national data if local data are inadequate) when deciding which antibiotics to use

Decisions 48 hours after starting antibiotic treatment

- For babies given antibiotics because of suspected late-onset infection, consider stopping the antibiotics at 48 hours if:
  - The blood culture is negative and
  - The initial clinical suspicion of infection was not strong and
  - The baby's clinical condition is reassuring, with no clinical indicators of possible infection and
  - The levels and trends of C-reactive protein concentration are reassuring.
- Healthcare professionals with specific experience in neonatal infection should be available every day to give clinical microbiology or paediatric infectious disease advice.

Treatment duration for late-onset neonatal infection without meningitis

- Give antibiotic treatment for 7 days for babies with a positive blood culture. Consider continuing antibiotic treatment for more than 7 days if:
  - The baby has not yet fully recovered or
  - Longer treatment is needed because of the pathogen identified on blood culture (for example, Gram-negative bacteria or Staphylococcus aureus; seek expert microbiological advice if necessary) or
  - Longer treatment is needed because of the site of the infection (such as intra-abdominal co-pathology, necrotising enterocolitis, osteomyelitis or infection of a central venous catheter).
- Use a shorter treatment duration than 7 days when the baby makes a prompt recovery, and either no pathogen is identified or the pathogen identified is a common commensal (for example, coagulase negative staphylococcus).
- If continuing antibiotics for longer than 48 hours for suspected late-onset neonatal infection despite negative blood culture, review the baby at least once every 24 hours. At each review, decide whether to stop antibiotics, taking into account:
  - The level of initial clinical suspicion of infection and
  - The baby's clinical progress and current condition and
  - The levels and trends of C-reactive protein.

Investigations

The following investigations should be performed on newborns suspected of early or late-onset neonatal sepsis;

- Blood culture and sensitivity are crucial for confirming diagnosis in settings where it can be done and must be done to isolate pathogens.
- FBP
- CRP

Other investigations should be tailored to the clinical presentation of the neonate, may include.

- Blood gas analysis
- Serum electrolytes especially in those babies admitted in ICU, HDU

- Consider lumbar puncture to the newborn with features of meningitis (CSF for microscopy, biochemistry, and cell count) or if CRP ≥20mm/dl
- Urine culture for late-onset neonatal sepsis or those with symptoms but have negative blood or CSF culture
- Chest X-ray (in case of respiratory symptoms)
- PT, PTT, and INR if DIC is suspected.



Attention:

- Antibiotic treatment should NEVER be delayed for investigations or waiting for results

Management

- As the infection can spread very fast all over the body, immediate start of treatment is crucial.
- Antibiotics are indicated in confirmed/presumptive sepsis and in newborns with a risk of infection
- For **Early Onset Neonatal Sepsis**:

  Give antibiotics:(Refer antibiotics XXX)

- **For late-onset neonatal sepsis**

  Give antibiotics (Refer antibiotics XXX)

  If cultures are negative and the newborn is clinically stable antibiotics can be stopped after 48 hours (up to 72 hours in preterm newborns)

- In haemodynamically unstable newborns, start fluid resuscitation immediately: Infuse Normal saline or Ringer's lactate 10 ml/kg body weight over 10 minutes and repeat once after 10 minutes if signs of shock continue

Refer to the management of shock on page xxx

- Encourage breastfeeding, if not possible give expressed breast milk via cup feeding or NGT
- If enteral feeding is not possible give IV fluid at maintenance volume according to weight and age (see Chapter 2) until the newborn is stable to receive breast milk
- Maintain blood glucose within the normal range
- Maintain temperature in normal range (by exposing if febrile or use of radiant warmer if hypothermic)

Refer to hypothermia and hyperthermia management on page XXXX

Prophylaxis

- Antibiotics to newborns with a risk of infection (asymptomatic babies born to mothers with untreated chorioamnionitis) if no bacteria growth for 48 hours consider stopping antibiotics.

Prevention

- Strict implementation of IPC
- Encourage breast milk (secretory IgA, Lactoferrin, Lysozyme)
- Antibiotics stewardship

Note:

The baby should be investigated before starting antibiotics.

Suggested Readings:

1. Neonatal infection: antibiotics for prevention and treatment. NICE guideline Published: 20 April 2021. Last updated: 19 March 2024 www.nice.org.uk/guidance/ng195
2. Hayes, R., Hartnett, J., Semova, G. et al. Neonatal sepsis definitions from randomised clinical trials. Pediatr Res 93, 1141–1148 (2023). https://doi.org/10.1038/s41390-021-01749-3
3. Seyoum K, Sahiledengle B, Kene C, Geta G, Gomora D, Ejigu N, et al. Determinants of neonatal sepsis among neonates admitted to neonatal intensive care units in ethiopian hospitals: A systematic review and meta-analysis. Heliyon [Internet]. 2023 Sep 1 [cited 2024 Nov 6];9(9). Available from: https://doi.org/10.1016/j.heliyon.2023.e20336
4. Korang SK, Safi S, Nava C, Gordon A, Gupta M, Greisen G, Lausten-Thomsen U, Jakobsen JC. Antibiotic regimens for early-onset neonatal sepsis. Cochrane Database of Systematic Reviews 2021, Issue 5. Art. No.: CD013837.DOI: 10.1002/14651858.CD013837.pub2.
5. Guideline: Managing possible serious bacterial infection in young infants when referral is not feasible.I.World Health Organization. WHO Library Cataloguing-in-Publication Data. 2015. ISBN 978 92 4 150926 8
6. Procianoy RS, Silveira RC. The challenges of neonatal sepsis management. J Pediatr (Rio J). 2020 Mar-Apr;96 Suppl 1(Suppl 1):80-86. doi: 10.1016/j.jped.2019.10.004. Epub 2019 Nov 17. PMID: 31747556; PMCID: PMC9432313.
7. Majigo M, Makupa J, Mwazyunga Z, Luoga A, Kisinga J, Mwamkoa B, Kim S, Joachim A. Bacterial Aetiology of Neonatal Sepsis and Antimicrobial Resistance Pattern at the Regional Referral Hospital, Dar es Salam, Tanzania; A Call to Strengthening Antibiotic Stewardship Program. Antibiotics (Basel). 2023 Apr 16;12(4):767. doi: 10.3390/antibiotics12040767. PMID: 37107129; PMCID: PMC10135403.
8. Kayange N, Kamugisha E, Mwizamholya DL, Jeremiah S, Mshana SE. Predictors of positive blood culture and deaths among neonates with suspected neonatal

sepsis in a tertiary hospital, Mwanza-Tanzania. BMC Pediatr. 2010 Jun 4;10:39. doi: 10.1186/1471-2431-10-39. PMID: 20525358; PMCID: PMC2889942.

12.1 Neonatal meningitis

Meningitis is an inflammation of the meninges (the protective membranes of the central nervous system). The presentation can be very similar to neonatal sepsis and differentiation is difficult.

Risk factors

As for neonatal sepsis

Clinical presentation

As for neonatal sepsis, though can be more focussed on neurological signs like:

- Irritability or lethargy
- Tone abnormalities
- Convulsions
- Bulging of anterior fontanelle
- Feeding difficulties
- Vomiting
- Apnoea
- Bradycardia

Investigations

- As in neonatal sepsis
- Cranial ultrasound
- Perform lumbar puncture, if PLT >50 X 10^9/L, CRP >20mg/dl send CSF to the laboratory immediately (but don't delay antibiotic treatment because of waiting for lumbar puncture to be done)

Note: Antibiotic treatment should never be delayed for investigations or results

Management

- Give ampicillin IV (100mg/kg per dose) and gentamicin IV (depending on GA 3.5mg/kg -5mg/kg) immediately according to the newborn's age and weight for 14 days (Refer Annex XXXX on drug dosing).
- Further management see neonatal sepsis section
- Confirm the diagnosis of meningitis if:
    - White blood cell count in the cerebrospinal fluid (CSF) is ≥ 20 /mm^3, if the newborn is less than seven days old
    - White blood cell count in the cerebrospinal fluid (CSF) is ≥10 /mm^3, if the newborn is seven days or older

- Culture or gram stain of the CSF is positive

Note: Meningitis may be present despite normal CSF

- Manage convulsions, if present
- If the newborn's condition is not improving after 48 hours of treatment with antibiotics, discontinue Ampicillin and gentamicin. Give cefotaxime or ceftriaxone IV according to the newborn's weight and age, in addition to ampicillin for 14 days in case of gram-positive meningitis.
- Alternative medications
- Ceftriaxone 50mg/kg/dose IV/IM 24 hourly for sepsis, 100mg/kg/dose IV/IM 24 hourly as loading dose then maintenance dose of 80mg/kg/dose. Caution with babies who have jaundice

OR

- Ciprofloxacin 10mg/kg/dose IV infusion over 30 minutes for severe sepsis, especially with multi drug resistant organisms (both term and preterm)

Gram-negative meningitis should be treated for 21days

- Third line antibiotics
  - Meropenem 40mg/kg/dose IV 8hrly IV infusion for suspected meningitis, necrotizing enterocolitis (NEC) or pseudomonas infections.
  - The use of Vancomycin should be cautiously applied due to the poor blood-brain barrier, it can be used in MRSA-identified meningitis and other susceptible organism.

These drugs are reserved therefore, CSF and/or blood culture confirmation.

- Re-check haemoglobin if clinical signs of anaemia or low Hb in initial FBP
- Observe the newborn for 24 hours after discontinuing antibiotics and then discharge if well

Follow up

- Vision screening
- Head circumference twice weekly while still in the ward, once weekly after discharge
- Hearing screening
- Neurodevelopmental follow-up

Suggested Readings:

1. Neonatal infection: antibiotics for prevention and treatment. NICE guideline Published: 20 April 2021.Last updated: 19 March 2024 www.nice.org.uk/guidance/ng195

2. Schneider F, Gessner A, El-Najjar N. Efficacy of Vancomycin and Meropenem in Central Nervous System Infections in Children and Adults: Current Update. Antibiotics. 2022; 11(2):173. https://doi.org/10.3390/antibiotics11020173
3. Sharma A, Leaf JM, Thomas S, Cane C, Stuart C, Tremlett C, Fitzgerald J, Clarke P. Sensorineural hearing loss after neonatal meningitis: a single-centre retrospective study. BMJ Paediatr Open. 2022 Sep;6(1):e001601. doi: 10.1136/bmjpo-2022-001601. PMID: 36645772; PMCID: PMC9490614.

12.2 Neonatal pneumonia

Pneumonia is an inflammatory pulmonary process that may originate in the lung or be a focal complication of a systemic inflammatory process.

The presentation can be very similar to neonatal sepsis and differentiation is difficult.

The causes of are similar to those of neonatal sepsis

Risk factors

As for neonatal sepsis

Clinical presentation

As for neonatal sepsis, however, chest symptoms predominate and these include:

- Respiratory rate > 60 breaths /min (persisting longer than expected in transient tachypnoea of the newborn)
- Grunting, nasal flaring, and severe chest indrawing
- Cyanosis (Spo2 ≤90%)
- On auscultation asymmetrically decreased breath sounds, crackles, and rhonchi are possible but not specific

Investigations

- FBP
- CRP
- RBG
- Blood gas analysis
- Serum electrolytes especially in those admitted in ICU, HDU
- Blood culture and sensitivity
- Chest X-ray
- Lung ultrasound

Antibiotic treatment should never be delayed for investigations or waiting for results

Management

- Give antibiotics:

- Ampicillin, Gentamicin as directed above
- Duration 7 - 10 days
- Always give intravenous (or intramuscular until a venous access is established)

- Give oxygen according to oxygen saturation (Refer oxygen therapy on chapter 3).
- Position in semi-upright position and change position frequently
- Suction as required
- In severe respiratory distress consider CPAP therapy
- Further management see neonatal sepsis

Suggesting readings:

1. Nair NS, Lewis LE, Dhyani VS, Murthy S, Godinho M, Lakiang T, Venkatesh BT. Factors associated with neonatal pneumonia and its mortality in India: a systematic review and meta-analysis. Indian Pediatrics. 2021 Nov;58:1059-66.

12.3 Necrotizing Enterocolitis (NEC)

It is an ischaemic and inflammatory necrosis of the bowel, primarily affecting the premature infants at a later age (>7 days) after the neonate has started to feed. It is characterized by variable damage to intestinal tract from mucosal injury to full thickness necrosis and perforation.

Term babies usually present in the first few days of life while preterm infants tend to present later (11-23 days), inversely proportional to their gestational age

Risk factors

- Bacteria dysbiosis due to prolonged broad spectrum antibiotic use
- Prematurity
- Birth asphyxia
- Congenital heart disease affecting mesenteric blood flow (Example coarctation of aorta, hypoplastic left heart syndrome)
- Polycythaemia
- Early formula feeding

Clinical presentation

- Abdominal distention with or without abdominal wall erythema
- Feeding intolerance, increasing gastric residuals (bilious)
- Vomiting (bile, blood or both)
- Occult or gross blood in stool
- Abdominal tenderness
- Apnoea, bradycardia, temperature instability



- If not treated, NEC may progress into peritonitis and intestinal bowel perforation with a likely lethal outcome.

Investigation

- Investigation include Abdominal X-ray (AP and lateral decubitus view): Pneumatosis intestinalis (intramural gas) is pathognomonic. Other findings include portal venous gas (PVT) or pneumoperitoneum (free air in peritoneum due to bowel perforation).
  X ray can be repeated based on clinical picture of the neonate since there is a risk of significant radiation exposure
- Abdominal ultrasound: Identifies bowel thickness (normal 1-2.7 mm), decreased peristalsis, pneumatosis intestinalis, portal venous gas, pneumoperitoneum, ascites, and intraluminal and extraluminal fluid collection. Expert opinion should into consideration.
- Doppler ultrasound allows real-time visualization of bowel wall thickness, peristalsis and perfusion however; it is limited by variability of expertise and limited availability.
- FBP (thrombocytopenia is often present)
- Blood culture and sensitivity
- CRP
- Serum electrolytes
- Arterial blood gas analysis (Metabolic acidosis)

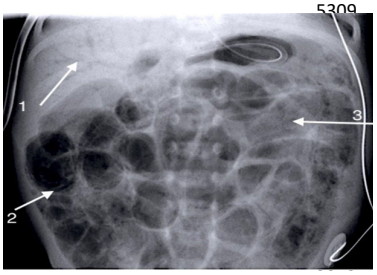
Bell staging criteria

This allows uniformity of diagnosis across centers

Stage I (suspect) includes abdominal signs and nondiagnostic radiographs

Stage II (definite) includes clinical and laboratory signs and pneumatosis intestinalis and or portal vein gas on radiographs

Stage III (advanced) has more severe clinical signs and laboratory abnormalities



1-portal venous gas

2-intramural gas

3-Tram trac sign

Modified Bell staging for NEC in neonates

Stage	Classification of NEC	Systemic signs	Abdominal signs	Radiographic signs
IA	Suspected	Temperature	Gastric	Normal or mild

		instabilit, apnea, bradycardia, lethargy	retention, abdominal distension, emesis, heme-positive stool	intestinal distension, mild ileus
IB	Suspected	As above	Grossly blood in stool	As above
II A	Definite, mildly ill	As above	As above, plus absent bowel sounds with or without abdominal tenderness	Intestinal dilatation, ileus, pneumatosis intestinalis
II B	Definite, moderately ill	As above, plus mild metabolic acidosis and thrombocytopenia	As above, plus absent bowel sounds, definite tenderness, with or without abdominal cellulitis or right	Same as IIA plus ascites

			lower quadrant mass	
IIIA	Advanced, severely ill, intact bowel	As IIB, plus hypotension, bradycardia, severe apnea, combined respiratory and metabolic acidosis, DIC and neutropenia	As above, plus signs of peritonitis, marked tenderness, and abdominal distension	Same as IIA, plus ascites
IIIB	Advanced, severely ill, perforated bowel	Same as IIIA	Same as IIIA	As above, plus pneumoperitoneum

For the nutritional management of NEC

Stage 1: Bowel rest for 3 days and stop antibiotics in 48-72 hours if FBC and CRP are normal, and blood culture negative. Consider starting on parenteral nutrition.

Stage II: Bowel rest and antibiotics for 5-7 days, start on parenteral nutrition

Stage III: Bowel rest for 7-10 days, antibiotics for 7-10 days (including metronidazole), start on parenteral nutrition

Long-term management

Starting of feeds should be considered as soon as fluid from free drainage is clear in colour and small in volume; no vomiting; the abdomen is soft, not distended, and non-tender and bowel sounds are present and normal.

Otherwise, restart feeds after completion of treatment, starting at 20mls/kg/d and increasing daily by the same volume and weaning parenteral nutrition by the same volume

Treatment

Lower levels: Refer to District Hospital or Regional Hospital

NB: Before referral from the primary health facility neonate should be stabilized and given first dose of Cefotaxime and Metronidazole as per weight.

Management at District or Regional Hospital

- Nil per oral
- Put NGT and leave open for decompression
- Resuscitate: support breathing
- Assess and monitor perfusion, treat hypotension if present
- Give IV fluids/total parenteral nutrition based on the weight and age of the newborn. Total parenteral nutrition is considered at the tertiary level.
- Monitor fluid input and output
- Cefotaxime 50 mg/kg IV BD for 14 days and Metronidazole 7.5 mg/kg IV 8 hourly for 14 days
- Alternatively, monotherapy with Piperacillin tazobactam or Meropenem (culture-based)
- Give vitamin K when suspecting GIT bleeding
- Consider pain management: Paracetamol IV dose as below
  28-32 weeks: 7.5mg/kg/dose 8 hourly infused over 15 minutes
  33-36 weeks: 10mg/kg/dose 8 hourly infused over 15 minutes
  ≥ 37weeks: 10mg/kg/dose 6 hourly infused over 15 minutes
- Might need intubation and respiratory support (tertiary level)
- Surgical consultations in case of peritonitis following bowel perforation

Prevention

- Breast milk unless contra-indicated
- Avoid prolonged antibiotic use
- Avoid use of H2 blockers example ranitidine
- Prevent prematurity
- Antenatal steroids

12.4 Spontaneous Intestinal Perforation (SIP)

It is a single intestinal perforation that is classically found at the terminal ileum, especially in preterm with very low birth weight (VLBW) and extremely low birth weight (ELBW). The risk increases with decreasing gestation age. SIP occurs earlier than NEC. Most of the time NEC is unlikely in neonates less than five days of life.

Protective factors: Early enteral feeds with breast milk (Arginine, glutamine, and polyunsaturated fatty acids in colostrum).

Risk factors

- Prematurity
- Chorioamnionitis
- Early postnatal glucocorticoid administration has increased risk for SIP
- Exposure to indomethacin

Clinical presentation

- Occurs earlier than NEC (Median age at perforation is 7days with a range of 0-15 days)
- Acute onset of abdominal distension, usually without abdominal wall erythema, crepitus and induration).
- Black-bluish discoloration of abdominal wall, may extend to groin or scrotum
- Tachycardia, hypotension and signs of peritonitis (less common than in NEC)

Investigations

- Abdominal Xray, supine and lateral decubitus views: Pneumoperitoneum. Serial abdominal X-ray may be required if clinically deteriorating.
- Abdominal ultrasound: Detect echogenic fluid collections in peritoneal cavity.
- FBP
- ALP and bilirubin levels
- Serum glucose level (hyperglycaemia)

Presumptive diagnosis of SIP

Preterm infant presenting with abdominal distension, usually with bluish discoloration of the wall and pneumoperitoneum **without** pneumatosis intestinalis or portal venous air.

Definitive diagnosis of SIP

Confirmation is made by operative findings of an isolated bowel perforation in the setting of otherwise normal bowel, and confirmed by histopathologic examination

Management

- Keep NPO (stop feeds and all enteral medications)
- Insert NGT for decompression
- Give Fluid for resuscitation and inotropic medications to correct diagnosed hypotension
- Give IV broad-spectrum antibiotics to treat infection
- Provide Nutrition management, including total parenteral nutrition
- Consult Surgical team for definitive management

Importantly: All neonates with SIP should have blood cultures obtained and should receive empiric antibiotics

Note: If respiratory support needed use low flow oxygen, or mechanical ventilation. Do not use CPAP because will worsen distention and pneumoperitoneum.

Suggested readings

1. American Academy of Paediatrics: Standardizing the Evaluation and Management of Necrotizing Enterocolitis in a Level IV NICU, 2022
2. Neu J, Walker WA. Necrotizing enterocolitis. N Engl J Med 2011; 364:255 Erick CE, Anne RH, et al. Cloherty and Stark's manual of neonatal care, 8th Edition
3. Holland AJ, Shun A, Martin HC, et al. Small bowel perforation in the premature neonate: Congenital or aquired? Pediatr Surg Int 2003; 19:489
4. Thakkar PV, Sutton KF et al. Risk factors and epidemiology of spontaneous intestinal perforation among infants born at 22-24 weeks gestational age. J Perinatol 2024; 44:94

12.5 Neonatal tetanus

Neonatal tetanus is an acute and potentially lethal disease of the nervous system caused by a toxin produced by the bacterium Clostridium tetani. It occurs as a result of the failure to use aseptic techniques such as use of unclean hands and instruments or contamination by dirt, straw, or other nonsterile materials in the delivery field and application of ghee or clarified butter, juices, and cow dung.

In neonates initial symptoms appear within 5 to 7 (Range 3 to 24) days of birth.

Risk factors

- Inadequate immunisation of the mother
- Unsterile cutting or care of the umbilicus
- Application of foreign material on umbilicus, e.g. animal dung

Clinical presentation

- Poor sucking (rigidity of lips), difficulty in swallowing, then followed by
- Generalized muscle rigidity and painful spasm (e.g. opisthotonus position, stiffness of the jaw, laryngospasm)
- Risus sardonicus (sardonic smile due to spasms of facial muscles)
- Restlessness, irritability
- Weak cry
- Difficulty in breathing, fast breathing, apnoea, cyanosis

Note: spasms can be set off by slight disturbances such as noises, light and touch.

Management

Initiate intensive nursing care in a quiet and dark room preferably NICU

The goals of treatment include:

1. Management of airway and breathing
2. Halting toxin production
    a. Wound management: all neonates with tetanus should undergo wound debridement to eradicate spores in necrotic tissue which could lead to conditions ideal for germination.
    b. Antimicrobial therapy: Give iv metronidazole and penicillin (see section on drugs for dosage).

3. Neutralization of unbound toxin
    a. Give human tetanus immunoglobulin 500IU intramuscular single dose as soon as the diagnosis is made
4. Active immunization: Continue with tetanus toxoid

Give tetanus vaccine (tetanus toxoid) 0.5 ml IM at a different site from the immunoglobulin (don't forget subsequent doses later)

Control of muscle spasms/sedation: (muscle spasms are life threatening since they can cause respiratory failure, aspiration and generalized exhaustion).

- Drugs to control spasms (diazepam, see below)
- Control of light or noise in the room to avoid provoking spasms

Diazepam dosage:

Risk of respiratory depression: Constant and close monitoring of the patient 's respiratory rate (RR) and oxygen saturation (SpO_2) is essential, also availability of ventilation bag, face mask and suction at the bed side.

- Diazepam 0.1 to 0.3 mg/kg by slow IV injection (over 3 to 5 minutes) every 1 to 4 hours depending on the severity and the persistence of the spasms (as long as respiratory rate is ≥ 30 /min).
- If despite hourly diazepam the spasms persist, start continuous infusions of diazepam with a syringe pump: 0.1 to 0.5 mg/kg/hour (total of 2.4 to 12 mg/kg in 24 hours). Start with 0.1 mg/kg/hour and if symptoms persist, increase by 0.1 mg/kg/hour as long as respiratory rate is ≥ 30 /min.
- If a syringe pump is not available, diluting the diazepam in an IV solution bottle for continuous infusion may be considered.
- Weigh the risks associated with this mode of administration (accidental bolus or insufficient dose).
- The infusion should be monitored closely to avoid any change, however small, of the prescribed rate.
- When spasms have decreased, start weaning the diazepam (gradually decrease the rate of infusion)
    - Calculate the total daily dose of IV diazepam and administer this amount orally in 4 divided doses via nasogastric tube.
    - Give first oral dose and decrease rate of IV infusion by 50%
    - Give second oral dose and stop IV diazepam infusion
    - If withdrawal signs appear, wean more slowly
- Wean oral diazepam by 10 to 20 % of the original dose daily
- When reached a dose of 0.05 mg/kg every 6 hours, increase the interval from every 6 hours to every 8 hours to every 12 hours and then to every 24 hours before stopping the diazepam.
    - Each step should be for 24 hours or more if withdrawal signs appear.
- Do not stop treatment abruptly, an abrupt stop can cause spasms

Supportive care:

- Give IV fluids at maintenance volume according to weight and age (refer to chapter 2) until the newborn is stable to receive breast milk
- Give intravenous penicillin and metronidazole, avoid IM injections
- Insert a nasogastric tube for feeding and oral medication
- Start slowly, increasing amount of expressed breast milk every 3 hours according to feeding calculations (refer chapter 2) while reducing IV fluids accordingly
- Give oxygen, if SpO_2 is < 90 % (titrate the flow so that saturation is 90 – 95 %)
- Handle the patient carefully and as little as possible; change position every 3 to 4 hours to avoid bedsores; suction only gently and if needed
- Cover the new-born's eyes with a cloth bandage
- Teach family the danger signs and instruct them to call the nurse for the slightest respiratory symptom (cough, difficulty breathing, apnoea, excessive secretions, cyanosis, etc.)
- Start physiotherapy after cessation of spasms

Give the mother tetanus vaccine (tetanus toxoid) 0.5 ml (to protect her and any new-born she may have in the future) and give her appointments

NOTE: Neonatal tetanus is a notifiable disease and therefore, it should be reported as soon as possible

12.6 Urinary tract infections (UTI)

UTIs may occur secondary to bacteremia, or bacteremia may occur secondary to primary UTI. It is one of the common causes of infection among febrile infants < 3 months of age and can have an increased risk of hypertension and chronic renal disease due to renal parenchymal scarring.

Risk factors

- Neonates with vesicoureteral reflux or congenital anomalies of kidneys and urinary tract (e.g. posterior urethral valve, vesicoureteral reflux, pyelo-ureteral junction obstruction, pelviectasis, ectopic ureter, polycystic diseases and renal dysplasia)
- Very low birth weight babies
- Uncircumcised male infant

Clinical presentation

- Fever
- Lethargy
- Irritability
- Poor feeding/weight gain
- Vomiting

- Jaundice
- Preterm babies have feeding intolerance, apnea and bradycardia, lethargy, tachypnea, abdominal distension and hypoxia.

Investigations

Diagnosis is made by urinalysis and urine culture

- Urinalysis: Dipstick analysis- leukocyte esterase (indicate pyuria= >5 WBC/ hpf) and nitrite (indicate Enterobacteriaceae)
  Microscopic assessment of unspun urine sample
- Urine culture: Confirmatory of UTI in neonates

Urine sample collection

Samples should be collected by bladder catheterization or suprapubic aspiration (SPA). Time from sample collection to analysis should be done as soon as possible (less than 30 minutes if the analysis is to be done later then the sample should be refrigerated).

For bladder catheterization, UTI is defined as the growth of a single uropathogenic organism with a colony count of ≥ 50,000 CFU/ml **or** a colony count between 10,000 and 50,000 CFU/ml with pyuria on urinalysis. For SPA, any growth of a urinary pathogen is significant

Further evaluation

- Sepsis evaluation: Blood culture (for suspected/confirmed UTI)

  LP in ill-appearing neonates or those with neurologic features
- Radiologic evaluation is recommended for all neonates with UTI
  Renal ultrasound (Kidneys, ureters, and bladder): Identify structural abnormalities
  Voiding cystourethrogram (VCUG): Recommended for neonates with abnormal ultrasound findings and those with recurrent UTIs

Treatment:

- Ampicillin and Gentamicin (Refer to the antibiotic dosage XXX)
- Definitive treatment that is organism isolated depends on your culture results.

Suggested readings:

1. Laura Walawender, David S. Hains, Andrew L. Schwaderer, Diagnosis and imaging of neonatal UTIs, Pediatrics & Neonatology,Volume 61, Issue 2, 2020, Pages 195-200, ISSN 1875-9572, https://doi.org/10.1016/j.pedneo.2019.10.003.(https://www.sciencedirect.com/science/article/pii/S1875957219305261)
2. Nama N, Donken R, Pawliuk C, Leache L, Sadarangani M, Carwana M; INSIGHTSCOPE TEAM. Treatment of UTIs in Infants <2 Months: A Living

Systematic Review. Hosp Pediatr. 2021 Sep;11(9):1017-1030. doi: 10.1542/hpeds.2021-005877. PMID: 34446534.
3. Boon HA, Van den Bruel A, Struyf T, Gillemot A, Bullens D, Verbakel JY. Clinical Features for the Diagnosis of Pediatric Urinary Tract Infections: Systematic Review and Meta-Analysis. Ann Fam Med. 2021 Sep-Oct;19(5):437-446. doi: 10.1370/afm.2684. PMID: 34546950; PMCID: PMC8437566.
4. Hikmat S, Lawrence J, Gwee A. Short Intravenous Antibiotic Courses for Urinary Infections in Young Infants: A Systematic Review. Pediatrics. 2022 Feb 1;149(2):e2021052466. doi: 10.1542/peds.2021-052466. PMID: 35075480.

12.7 Umbilical infection (Omphalitis)

- Umbilical infection is characterised by erythema and/or induration of the periumbilical area with purulent discharge from the umbilical stump.
- The umbilicus usually separates around one week after birth and the wound heals within 15 days.
- Until the wound is healed, this is an important entry point for infection, which can quickly lead to peritonitis, umbilical arteritis or phlebitis, hepatic abscess, hepatic vein thrombosis and sepsis.
- Early recognition and treatment of an infected umbilicus are essential to prevent sepsis.

Risk factors

- Unclean delivery and cord-cutting
- Application of unclean or harmful substances (e.g. animal dung) to umbilicus
- Unhygienic cord care (e.g. covered by diapers or unclean clothes)

Classification of severity and clinical presentation

Local infection of umbilicus (mild infection)

- Umbilicus red and swollen
- Redness and swelling of skin extending less than 1 cm beyond umbilicus
- There should not be any systemic sign and/or symptom of sepsis

Management

- Give oral ampiclox syrup (50 mg/kg 8 hourly for 5 days) for stable neonates
- Febrile or ill-appearing infants≤21 days of age should be admitted to the hospital and treated with IV antibiotics.
- Wear clean examination gloves and wash the umbilicus using an antiseptic solution and clean gauze
- Teach the mother to care for the umbilicus at home and have the mother do this (insist hygiene especially hand washing before and after procedure)

- Ask the mother to come for follow-up after 2 days

Severe infection of umbilicus

- Umbilicus red and swollen
- Umbilicus draining pus
- Foul-smelling umbilicus
- Skin around umbilicus is red, hardened and/or swollen
- Abdominal distension

Plus, or minus any unspecific systemic signs and/or symptoms of sepsis as described above

Management

- Give ampicillin, gentamicin and cloxacillin IV according to age and weight (Refer to Annex 5)
- Wear clean gloves and swab the umbilicus using an antiseptic solution and clean gauze
- Treat the umbilical infected site with gentian violet 0.5% four times daily until there is no more pus coming from the umbilicus. The use of topical iodine application is not recommended in newborns as this will affect thyroid hormone production.

Hand washing/disinfection before handling the cord is essential for cord sepsis prevention

Suggested readings

1. Kaplan RL, Cruz AT, Freedman SB, et al. Omphalitis and Concurrent Serious Bacterial Infection. Paediatrics. 2022;149(5):e2021054189

12.8 Umbilical granuloma

Is an umbilical mass, soft, moist, pink usually pedunculated friable lesion of granulation tissue. Usually forms in the few weeks of life after cord separation

Management:

- 75% silver nitrate, once or twice a week (caution is needed when applying because can cause chemical burns or staining of the surrounding skin).



12.9 Ophthalmia neonatorum

This is acute inflammation of the eyes that affects newborns during the first 28 days of life (also called neonatal conjunctivitis).

The cause can be chemical, viral or (most common) bacterial including; Neisseria gonorrhoeae, Chlamydia trachomatis and Staphylococcus species.

The eye infection can lead to serious complications, e.g. blindness.

Risk factors

- Newborns delivered by mothers with untreated STIs like gonorrhoea or chlamydia infection

Prophylaxis

- Screening for STIs during pregnancy and management according to findings (including the partner)
- Give 1 % tetracycline eye ointment (1cm strip to each eye) to all newborns after delivery
- Alternative; 0.5% erythromycin ophthalmic ointment.

Clinical presentation

- Mild-moderate conjunctivitis
  - Reddish conjunctiva
  - Eyes swollen or draining some pus
- Severe conjunctivitis
  - Purulent and copious discharge from the eyes
  - Massive oedema and redness of eyelids
- Gonococcal infection often becomes symptomatic within the first 5 days of life,
- Chlamydial infection takes longer to become symptomatic (usually 5 days to 2 weeks).
- But still differentiation is difficult without microbiologic evaluation

Investigation

- Eye swab for gram stain, culture and sensitivity

Management

General management

- Wash hands before and after the procedure and instruct the mother to do the same
- Irrigate eyes with normal saline or boiled water 1-2 hourly until discharge is cleared
- Show the mother how to irrigate the eyes
- If ointment will be prescribed; show the mother how to put in eye ointment
- Check mother and her partner for gonorrhoea or chlamydia infection and treat accordingly
- Review all patients after 3 days, no matter what specific treatment they receive. If no more discharge on the 3rd day stop systemic treatment (erythromycin).

Specific management

- Bilateral or unilateral reddish and swollen eyelids with purulent discharge (and no microbiology results available):
    - As clinical manifestations and possible complications of gonococcal and chlamydial infections are similar, in settings where it is impossible to differentiate the two infections, treatment should be provided to cover both infections (ceftriaxone and erythromycin, details see below)
- Known maternal **gonococcal infection** or Gram-negative intracellular diplococci identified in conjunctival swab of the newborn:
    - **Ceftriaxone 25-50 mg/kg IV/IM** as a single dose, to a maximum of 125 mg (not indicated in case of jaundice)

    (Alternatives if ceftriaxone is not available: cefotaxime 100mg/kg IV/IM single dose)
- **Chlamydial ophthalmia**:
    - **Erythromycin syrup 15-20mg/kg orally** 8 hourly for 14 days

      (Alternative: Azithromycin 20mg/kg orally OD for 3days or trimethoprim 40 mg with sulfamethoxazole 200 mg orally, twice daily for 14 days)

NB: Once on systemic treatment addition of tetracycline eye ointment to this regimen is of no documented benefit

Conjunctivitis due to **other bacteria** usually responds to topical ointments like tetracycline, erythromycin (give at least 4 times /day in both eyes, for 7-14 days)

12.10 Skin and mucous membrane problems

Newborn skin is fragile and more susceptible to infections that are extremely contagious and therefore all health care workers and all those handling the newborn must observe strict infection prevention and control practices at all times so as to prevent spreading infections.

Look for the following problems on the newborn's skin or soft tissues:

- Redness or swelling
- Pustules or blisters
- White patches on the tongue or inside the mouth (oral thrush)

Common neonatal skin infections

- Skin pustules
- Cellulitis/abscess
- Thrush in diaper area
- Thrush in mouth

Table 16: Differential diagnoses of skin conditions

Findings		Probable diagnosis
History	Examination	
Time of onset: day 1 or later Lesions solitary at first, then spreading to other areas	Pustules or blisters Lesions prevalent on head, back of hands, around neck, in axillae, around umbilicus and groin	Bacterial skin infection
Time of onset: day 3 or later	Red skin and swollen subcutaneous tissue anywhere on body (cellulitis) Tender and/or fluctuant swelling (abscess)	Cellulitis/abscess
Time of onset: day 3 or later	Bright red patches in diaper area with slightly raised border, often with scaly areas	Thrush in diaper area
Time of onset: day 3 or later	Thick white patches on tongue/mucous membranes of the mouth (not easy to wipe off)	Oral thrush
Time of onset at birth (or symptomatic any time later) Mother had positive syphilis test during pregnancy Mother not treated or treated inadequately for syphilis	Red rash, grey patches, blisters or skin peeling on palms and soles Profuse nasal discharge ("snuffles") More details see section on Syphilis	Congenital syphilis

12.11 Bacterial skin infection

Is a skin infection characterized by skin lesions containing pus and predominately caused by staphylococcus. This is a contagious condition; IPC guideline has to be followed strictly

for prevention. The lesions are prevalent on head, back of hands, around neck, in axillae, around umbilicus and groin.

Management

- Wear clean examination gloves:
  - Wash the affected area using an antiseptic solution and clean gauze
  - Swab the pustules with 0.5 % gentian violet solution
  - Repeat four times daily until the pustules are gone. Have the mother do this whenever possible
- Observe for signs of sepsis (e.g. poor feeding, vomiting, breathing difficulties) and admit the new-born and treat for sepsis if found
- The newborn has to be admitted in the isolation room of NCU (or cohort isolation with other newborns with bacterial skin infection)

Antibiotic treatment

- IV Ampicillin & cloxacillin and gentamicin for 7 days.

12.12 Cellulitis/Abscess

Localized erythema and /or drainage example scalp electrode sites or any other traumatized skin site

Management

Can be treated with careful washing and local antisepsis with antibiotic ointment example mupirocin.

- If there is fluctuant swelling, incise and drain the abscess
- Give antibiotics IV as for skin pustules (see bacterial skin infection)

12.13 Thrush in diaper area

It can co-exist with oral thrush and is caused by a fungal infection (candida).

Management

- Counsel the mother not to apply powder on newborn's perineal area
- Ensure that the diaper is changed whenever it is wet or soiled
- Apply antifungal cream (e.g. miconazole, clotrimazole) twice daily for 14 days

12.14 Oral thrush

It can co-exist with thrush in diaper area and is caused by a fungal infection (candida).

Management

- Swab the mouth with nystatin oral suspension 100,000 IU 6 hourly or miconazole oral gel, 6 hourly (given before breastfeeding), continuing for two days after the lesions have healed.
- Have the mother put nystatin or miconazole gel on her breasts after breastfeeding for as long as the newborn is being treated.
- for further doses.

12.15 New-borns delivered by a mother with infection

12.15.1 Human immunodeficiency virus (HIV) infection

An exposed newborn is an infant born to a HIV positive mother. The risk of transmission is during pregnancy 10-15 %, during labour and delivery 10-15 % and during breastfeeding 5-20 %.

Management

Prophylaxis for HIV exposed infants: (follow National Guidelines for HIV)

- In low-risk infants Nevirapine (NVP) syrup immediately after birth to all HIV exposed newborns for the first 6 weeks of life
- In high-risk infants, **additional** AZT syrup should be given for the first 6 weeks of life. After 6 weeks continue with daily NVP alone up to 12 weeks of life.

High-risk infants a;

- Born to a mother with established HIV infections who has received less than four weeks of ART at the time of delivery
- Born to a mother with established HIV infection with viral load > 1000 copies/ml in the four weeks before delivery
- Born to a mother with incident HIV infection during pregnancy or breast-feeding
- Identified for the first time during the postpartum period, with or without a negative HIV test prenatally

- Infant prophylaxis is most effective when given as soon as possible after birth, preferably within 6 to 12 hours
- Infants identified beyond the age of four weeks should not be given ARV prophylaxis
- Regular follow up at RCH or CTC according to national guideline on HIV
- Do DBS (dried blood spot) immediately after birth (collection at 6 weeks for DNA PCR (polymerase chain reaction) and again six weeks after complete cessation of breastfeeding)
- From 6 weeks of age until HIV infection is excluded: give cotrimoxazole syrup 6 – 8 mg/kg
- Give immunizations according to standard for all newborns

Table 17: Infant Nevirapine (NVP) dosing recommendations

From birth to 6 weeks	NVP
• **Premature/LBW infants < 2000 g**	2 mg/kg once daily(0.2ml/kg)
• **Birth weight 2000 – 2499 g**	10 mg once daily (1ml)
• **Birth weight ≥ 2500 g**	15 mg once daily (1.5 ml)

Table 18: Infant Zidovudine (AZT) dosing recommendations

From birth to 6 weeks	AZT

• **Premature/LBW infants < 2000 g**	4 mg/kg twice daily
• **Birth weight 2000 – 2499 g**	10 mg twice daily
• **Birth weight ≥ 2500 g**	15 mg twice daily

If AZT syrup is not available use fixed combination (Combivir, combination of Lamuvidin and Zidovudin)).

Table 19: Fixed dose combination dosing recommendations

Dosage form	**Dose 0-6 weeks** **AZT and NVP**	**Dose 6-12 weeks** **NVP only**
Fixed dose combination	Combivir ¼ tab twice daily **plus** NVP syrup according to weight	NVP syrup 15 mg OD

Feeding

- Women living with HIV are advised to exclusively breastfeed their newborn first 6 months of the life.
- Although not recommended, replacement feeding with commercial infant formula can be used if it is acceptable, feasible, affordable, sustainable and safe (AFASS).
- Current recommendations advises that if a mother is critically ill or unable to breastfeed due to unavoidable reasons, the infant should be given formula milk and breastfeeding should commence when the mother is able to do so.
- Inform the mother accordingly so that she can choose from these two options, best if decision was already taken before delivery.

NOTE: For current recommendations regarding the management of high/low risk infants or HIV in infants refer to the national guidelines for the management of HIV/AIDS.

12.15.2 Tuberculosis

- Infant considered TB exposed if;
  - Born to a mother with known TB disease who has received <2months of treatment
  - Born to a mother who has been on TB treatment for >2months but is non-compliance or still has signs, symptoms or laboratory test indicating persistent TB
- TB can be transmitted in utero, during delivery or the newborn can be infected after birth (due to exposure to an infectious case of TB, usually the mother or another close contact person).

Clinical presentation of neonatal TB

Can be asymptomatic or symptomatic

Usually non-specific signs and symptoms like:

- Lethargy
- Low birth weight and poor weight gain
- Poor feeding
- Respiratory distress
- Non-resolving pneumonia
- Hepatosplenomegaly
- Lymphadenopathy
- Abdominal distension with ascites
- Clinical presentation of disseminated TB resembles features of neonatal sepsis

Think of congenital/neonatal TB if:

- Maternal history of TB or TB/HIV co-infection
- Chronic neonatal infection with poor response to antibiotics and atypical pneumonia

Investigations

- Gene Xpert of collected sample (gastric aspirate, CSF, tracheal aspirate stool)
- Blood, CSF and gastric aspirate cultures, performed promptly
- Tuberculin Skin Test TST (Positive induration of ≥ 5mm for newborn without BCG vaccination and ≥10mm for those with BCG vaccine).
- Chest X-ray
- Lumbar puncture (If TB meningitis suspected)
- Examination of placenta histologically for granulomata and AFB, and culture for mycobacteria
- Urine antigen detection (urine LAM assay)

Breastfeeding recommendations

- Breastfeeding is recommended for all infants irrespective of the mother's TB status
- The only exception is when the mother has DR-TB
- Separation from the mother is not advisable where the establishment of breastfeeding is critical for child survival

BCG vaccine recommendations

- All infants should be given BCG vaccine at birth regardless of HIV status
- However, BCG should not be given to HIV exposed infants who present with clear signs and symptoms of HIV disease or full-blown AIDS.

Management of newborns exposed to TB

If findings suggest neonatal TB (see above):

- Start anti-TB treatment according to National guideline.
- Give BCG vaccination 2 weeks after treatment is completed

If no findings are suggestive of neonatal TB:

- Daily Isoniazid plus Rifampicin (HR) for 3 months and delay BCG vaccination until TPT is complete. Administer pyridoxine 5–10 mg/day

- Isoniazid daily for six months is given as an alternative regimen to all clients not eligible for 3HR
- If the infant is exposed to HIV (e.g. mother living with HIV) and is on nevirapine, IPT should be started. TPT with rifamycin (3HR) should not be given with nevirapine prophylaxis
- At the end of TPT, do TST or IGRA. If the test for TB infection is negative or not available, give BCG (unless the baby is living with HIV). If the test is positive, BCG is not required. If the mother is taking TB medicines, she can safely breastfeed. The mother and baby should stay together, and the baby may be breastfed while on TPT
- Re-evaluate the new-born every 4 weeks or in case of adverse effects or in case of TB symptoms

Drug regimen	**Population**	**Dose per kg body weight per day**
Daily isoniazid Plus rifampicin for three months (3HR)	Children < 10 years	Rifampicin: 15 mg (range 10-20 mg) Isoniazid: 10 mg (range 7-15 mg)
Isoniazid alone, daily for 6 months (6H)	Age < 10 years	Isoniazid:10mg/kg/day (range,7–15 mg)

Adopted from WHO https://tbksp.org/en/node/1268

Neonatal TB treatment

For drug susceptible TB, the treatment is 2 months rifampicin, isoniazid, pyrazinamide (RHZ), ethambutol (E) and 4 months rifampicin and Isoniazid (RH)

Weight-based dosing of anti-TB drugs

	Intensive phase (2months)		Continuation phase (4months)
Weight (kg)	RHZ (Pediatric) 75/50/150 mg	Ethambutol 100mg	RH (Pediatric) 75/50 mg
< 4kg	For infants below 4 kg, consult a pediatric specialist, DTLC, and RTLC for treatment advice		
2 - 2.9 kg	½ tablet	½ tablet	½ tablet
3 – 3.9 kg	1 tablet	½ tablet	1 tablet
4 – 7.9	1 tablet	1 tablet	1 tablet

Multidrug-resistant TB:

- If the mother has multidrug-resistant TB (untreated or still smear-positive), the newborn should be separated from the mother until she is no longer contagious.
- Advise the mother to use formula milk to avoid possible adverse effects, because most second-line TB medications are excreted in breast milk.

Consider infection prevention control measures for mothers with TB or suspected TB infection in the nursery
Note: Refer NTLP guidelines for the management of neonatal TB

12.15.3.Hepatitis B

All newborns delivered by a mother with Hepatitis B virus (HBV), are at risk to be infected with hepatitis B.
The majority of mothers don't know their hepatitis B status therefore, there is a need for Hepatitis B viral infection universal screening.
Infants infected at birth have 90% chance of chronic infection where 15-45% will develop cirrhosis and/or hepatocellular carcinoma.

Clinical presentation

- The infants are asymptomatic at birth only presenting at 2-6 months of age.
- A small number will develop acute hepatitis by 2 months with jaundice and, rarely fulminant hepatitis

Investigation of the mother during pregnancy

- Serum for hepatitis B surface antigen (HBsAg), hepatitis B e antigen (HBeAg), and antibodies to these viral proteins. HBsAg in infant after 1-2 months of age is indicative of vertically acquired HBV infection

Management

All newborns of HBsAg positive mothers should receive:

- Hepatitis B immunoglobulin (HBIG):500IU (0.5 ml) intramuscularly (in the thigh) in the first 12 hours of life

AND

- Hepatitis B vaccine: first dose is given at birth (preferably within 12 (Go for 24hrs this agreed on discussion) hours after birth, together with HBIG (in the contralateral thigh), and the remaining two, doses will be given with the normal immunization schedule
- **NB:** If more than 7 days have passed after birth both Hepatitis B vaccine and HBIG are not effective in preventing hepatitis B transmission.

Follow-up

- Test the newborn between 9– 15 months for hepatitis B surface antigens and antibody to HBsAg.
- If found positive start on antiviral treatment according to guideline.

12.15.4 Human Herpes Virus 3 (Varicella Zoster Virus VSV)

Neonatal VZV infection is a serious illness associated with mortality rate up to 30%.

Risk factors

- Neonate of a mother with symptoms of VZV infection from five days before delivery to 2 days after delivery

- Prematurity
- Newborns of mothers who are exposed to VZV or have clinical disease manifestations within the first 2 weeks after birth are at the highest risk of developing symptomatic disease.

Clinical presentation

- Ocular defects
- Skin lesions
- Limb abnormalities
- IUGR
- CNS abnormalities

Investigations

- PCR of samples is highly recommended

Management

Management of newborn infants who are exposed to VZV by maternal infection or contact with affected individuals includes isolation and postexposure prophylaxis.

- It is recommended to administer varicella zoster immunoglobulin to neonates who have had exposure to VZV.
- Neonatal varicella can be suspected based on the characteristic appearance of generalized vesicular skin lesions
- Newborn with severe disseminated VZV infection (pneumonia, encephalitis, thrombocytopenia) are treated with IV acyclovir 60mg/kg per day in 3 divided doses for 10 days. Should be initiated as soon as possible (within 72 hours) after onset of symptoms.
- Breast feeding should continue and is encouraged in exposed as well as infected newborns.

12.15.5 Congenital Rubella

Rubella virus causes mild self-limited illness, but foetal infection can be devastating

Presentations

- Has Triad of cataracts, sensorineural hearing loss (SNHL) and congenital heart disease
- Other features include; microcephaly, IUGR, hepatosplenomegaly, jaundice, pigmentary retinopathy and radiolucent bone lesions among others

Diagnosis (CDC criteria)

- Isolation of rubella virus (PCR of oropharynx or urine sample)
- Detection of rubella-specific IgM in cord or neonatal blood
- Persistent rubella-specific titers over time (no decline in titers)

12.15.6 Cytomegaly Virus (CMV)

- Is a leading cause of nonhereditary sensorineural hearing loss if left untreated especially for those with asymptomatic disease
- Congenital symptomatic CMV disease has high mortality of up to 30% and can present with petechiae/purpura, hepatosplenomegaly, jaundice, pneumonitis and blueberry muffin spots
- Can be transmitted through blood transfusion or breast milk
- Diagnosis – Isolation of the virus in urine, saliva, blood or respiratory secretions within the first 3 weeks of life by PCR
- Treatment: Ganciclovir 6mg/kg IV12 hourly over 1 hour, transition to oral valganciclovir 16 mg/ kg 12 hourly when clinically stable for 6 months

12.15.7 Toxoplasmosis

Infection is typically asymptomatic in immunocompetent hosts but it can be serious disease in immunosuppressed individuals or in case congenital infection.

Clinical findings

- Maculopapular rash
- Lymphadenopathy
- Hepatosplenomegaly
- Thrombocytopenia
- Chorioretinitis
- CNS disease (cerebral calcification, hydrocephalus, seizures)

Investigations

- Serological test (IgM, IgA, IgG)
- PCR of blood CSF or urine is a confirmatory test
- FBP
- Liver function test
- Renal function test
- Brain imaging (brain US / CT scan)

Management

- Multidisciplinary consultation with Ophthalmologist, Infectious disease, neurodevelopmental and neurosurgeons.
- Pyrimethamine 2mg/kg once daily for 2days then 1mg/kg once daily for 6months then 1mg/kg three times a week (to complete 1yr) in combination with Sulfadiazine 50mg/kg BD for 1yr PLUS
- Folinic acid(leucovorin) 10mg three times per week
- Prednisolone (or prednisolone) 0.5mg/kg BD, maximum 40mg/day (given if CSF protein is 1gm/dl or active chorioretinitis).

12.15.8 Neonatal Herpes Simplex Virus infection

Usually causes localized disease of the skin, eye and mouth (SEM) but may disseminate and cause viremia.

Risk factor

- Active maternal genital lesions (30-40times higher risk of transmission to newborn)

Clinical presentation

- Meningoencephalitis (Seizures, lethargy, irritability, and poor feeding)
- Disseminated disease (hepatitis, pneumonia, myocarditis, NEC, Kidney problems, and bone marrow suppression).

Investigations

- IgM is unreliable
- Send blood, CSF, +/- Vesicular fluid for PCR
- Viral culture may be taken

Management

- IV acyclovir 20mg/kg/dose 8hly, minimum of 14/7 for SEM and 21/7 for CNS and disseminated disease

Prevention

- Preferred mode of delivery is cesarean section to reduce risk of infection

12.15.9 Congenital Syphilis

- Congenital syphilis occurs when a mother's syphilis goes untreated during pregnancy and is passed to the newborn through the placenta.

Clinical presentation

- Risk of stillbirth and neonatal death is increased
- Can be asymptomatic (60 %) or symptomatic
- Risk of congenital anomalies
- Symptoms develop over 2 months;
  - Low birth weight, failure to thrive
  - Palms and soles: red rash, grey patches, blisters or skin peeling
  - Snuffles: rhinitis (which is highly infectious and can be blood-stained) with nasal obstruction
  - Perioral fissures
  - Abdominal distension due to big liver and spleen
  - Jaundice
  - Anaemia
  - Signs of severe sepsis: lethargy, respiratory distress, petechiae or other bleeding

Investigation of the mother during pregnancy

- VDRL or RPR screening at first antenatal contact, at GA of 26 weeks, then at GA of 34 weeks

Investigations of the newborn

- VDRL or RPR
- FBP
- Dark field microscopy of skin lesions

Management

- All neonate born to mothers with syphilis should have treatment with Benzathine penicillin 50,0000 IU/Kg as single dose regardless of whether the mother had treatment or not during ANC contacts
- Newborns with confirmed congenital syphilis need to be admitted and treated with:
  - Procaine penicillin 50.000 U/kg/day IM once daily for 10–15 days
    OR
  - Benzyl penicillin 50.000 U/kg IV 12 hourly for 14 days,
    OR
  - Benzathine benzyl penicillin 50,000 IU/Kg in a single dose.
  - For babies who are allergic to penicillin give Erythromycin syrup 7.5 to 12.5Mg/Kg orally 8hourly for 7 days

IF ≥ 1 day of therapy is missed, the entire course must be repeated

Follow-up

- All seropositive infants and those whose mothers were seropositive should have VDRL or RPR titres every 2-3 months until the test is non-reactive or the titre has decreased 4-fold.
- If treatment is successful, antibody titres are usually non-reactive by 6-12 months.
- If VDRL or RPR remain reactive past 6-12 months of age or titres increase, the infant should be re-evaluated (including lumbar puncture for CSF analysis, FBP with platelet count, long-bone x-rays and other tests as clinically indicated) and treated accordingly.

Suggested Readings

1. NICE guideline on neonatal infections: antibiotics for prevention and treatment, 2021 WHO AWaRe antibiotic classification, 2023
2. National Tuberculosis and Leprosy program: Guidelines for The Management of Tuberculosis in Children and Adolescents, July 2024
3. Gian MP, Giovanna M, et al. Clinical pharmacology of ciprofloxacin in neonates: Effects and Pharmacokinetics. International Journal of Pediatrics
4. National AIDS Control Program: Guidelines for the management of HIV and AIDS, 2019.
5. American Academy of Pediatrics. Clinical guideline: Evaluation and Management of Well-Appearing Febrile infants 8 to 60 Days Old, August 2021
6. Erick CE, Anne RH, et al. Cloherty and Stark's manual of neonatal care, 8th Edition Uptodate,2024

CHAPTER 13: BLOOD DISORDERS

13.1 Anemia

It is defined as hemoglobin or hematocrit that is at least two standard deviations below the mean at a particular gestational and/or chronological age, secondary to a reduction in red blood cell (RBC) mass from multiple etiologies

Anemia is the most common hematologic abnormality in the newborn.

Etiologies of anemia:

Prenatal factors: maternal malnutrition, iron-deficiency anemia, and infections, twin to twin transfusion, RH Incompatibility

Natal and postnatal factors: Iatrogenic causes (bleeding from umbilicus, multiple phlebotomies, prematurity, vitamin K deficiency, cephalohematoma, subgaleal hemorrhage

***Symptoms and signs of anaemia*:**

This is determined by one of the following factors: age at presentation of anemia, associated clinical features at presentation, hemodynamic status of the infant, and presence or absence of compensatory reticulocytosis

***Severe symptomatic anemia*:**

Infant may present with pallor, tachypnoea, tachycardia, hepatomegaly, high cardiac output shock/hypovolemic shock, systolic ejection murmur, need for respiratory support and oxygenation, and signs of sepsis.

Investigations:

- Measure Hb level
- Complete blood count
- Blood grouping and cross matching

Peripheral smear when indicated

- Coombs's test
- Reticulocyte count.
- Septic screening (Blood culture, CRP at 48hrs, urine analysis, LP)

Suggested transfusion threshold Hb(g/dl)

Postnatal age	**ventilated**	**On o2 or CPAP /NIPPV**	**NO Supplemental oxygen**
First 24hour	<12	<12	<10
Days 2-7	<12	<10	<10
Day 8-14	<10	<9.5	<8.5
Day 15 onwards	<10	<8.5	<7.5

Adopted from British committee for standard in hematology, guidelines on transfusion for fetus, neonates and older children 2016

***Note**: Transfuse asymptomatic infant with Hb level of <6g/dl or reticulocyte count of <2%*

Volume/Dose

- RBC volume 20 ml/kg or whole blood 20 ml/kg for 4 hours
- Give bolus or rapid infusion up to 2 hours in case of shock

Obtain consent for blood transfusion from the mother, if not possible a doctor in charge in the neonatal unit

NOTE

- Feed: Can be continued for a stable baby
- Fluid: Withhold the maintenance fluid unless the baby is being treated for hypoglycemia or is on inotropes
- Maintain strict asepsis, meticulous monitoring of input, output and vital signs during transfusion
- Restrict number of donors
- Ideally irradiated RBCs Should be used for premature infants
- Furosemide should not be given routinely

Other transfusion thresholds in neonate

Platelets Transfusion

Indications

Platelet count	Condition
<25,000/mm³	• Neonates with no bleeding
<50,000/mm³	• Neonates with bleeding • Evidence of coagulopathy • Before surgery • NAIT if previously affected sibling with ICH
<100,000/mm³	• Major bleeding • Major surgery

**NAIT – Neonatal Alloimmune Thrombocytopenia, ICH – Intracranial Haemorrhage, IVH – Intraventricular Haemorrhage.*

- Platelets volume **10ml/kg** for 30 minutes, extremely premature for 1 hour

C: Fresh Frozen Plasma (FFP)

Indications

- Abnormal coagulation profile
- Vitamin K deficiency if bleeding
- Neonates with clinically significant bleeding or prior to invasive procedure with a risk of significant bleeding
- Clotting factor deficiency when specific factor replacement is not available
- Disseminated intravascular coagulopathy (DIC)
- FFP volume **15mL/kg** for 30 minutes

Acute transfusion reaction

Is the presence of adverse signs and symptoms during or within 24 hours after completion of a transfusion. Many of the most severe reactions occur within the first 15 minutes of initiating the transfusion.

Clinical manifestation

Fever-Is most common signs and symptoms are fever (a 1°C rise in temperature above baseline), chills,pruritus, and urticaria. These resolve promptly without specific treatment or complications.

More severe, potentially fatal reaction include: Respiratory distress, hemoglobinuria, loss of consciousness, hypertension, hypotension, jaundice, abnormal bleeding, or oliguria/anuria.or disseminated bleeding, including oozing from intravenous sites.

Immediate action to be taken:

- Immediately stop the transfusion; save the remaining bag and tubing for potential analysis.
- Maintain a patent intravenous line with normal saline
- Confirm the correct product was transfused to the intended patient based on product labeling and patient identification; also assess the product for gross color changes or bubbles suggestive of bacterial contamination.
- Assess the patient, including symptoms of fever, respiratory distress, itching, angioedema and measure vital signs
- The transfusion service should be contacted immediately to discuss the appropriate evaluation and initial management.
- The transfusion service may request return of the remaining (untransfused) component, associated intravenous bags and tubing, and blood and urine testing.
- The transfusion service laboratory will perform a clerical check to assess whether the patient received a product intended for a different patient. In addition to helping with the diagnosis, the check will determine whether another patient may also be at risk of receiving an incorrect product.
- Transfusion of the original product should **not** be continued in cases of suspected acute hemolytic transfusion reaction (AHTR), anaphylaxis, sepsis, or transfusion-related acute lung injury (TRALI).
- Reactions in which transfusion of the same product may be possible include minor allergic reactions and transfusion-associated circulatory overload (TACO) that has resolved with diuresis or other measures.

13.2 Anaemia of Prematurity (AOP)

Is a hypo-regenerative normocytic, normochromic anemia that occurs in neonates born before 32weks gestation age before placental iron transport and fetal erythropoiesis are complete. It is usually occurs in 3rd and 4th weeks of life

It is accompanied by an inappropriate low level of reticulocytes count and low level of erythropoietin used for severity of anemia. AOP is the most common cause of anemia at discharge. About 50% of infants born less than 32weeks GA develop AOP. It is inversely related to Ga +birth weight.

Clinical features of AOP

Tachycardia, pallor, flow murmur

Tachypnea, Respiratory irregularity (Apnea, bradycardia),

Lethargy, poor feeding, poor weight gain despite adequate calories and metabolic acidosis/tissue hypoxia

Causes of AOP

- Impaired erythropoietin production
- Blood loss from phlebotomy - This is a major contributor to anemia in preterm neonates. The volume of blood loss increases with illness severity and decreasing gestational age.
- Reduced red blood cell life span - Red blood cell (RBC) survival in newborn preterm infants is a range of 45 to 50 days in extremely low birth weight infants. Increased susceptibility to oxidant injury may contribute to shortened RBC survival in the neonate
- Iron depletion- Preterm infant have rapid growth rate hence have increased utilization of iron and also, they have depletion of iron stores from the phlebotomy. Iron depletion may impair recovery from AOP.

Diagnostic criteria to make the diagnosis of AOP in infants has to include all the following features:

1. Clinical features:
   - ELBW or VLBW infant
   - Four to eight weeks old post delivery.
   - Clinically stable
2. Laboratory findings:
   - Hb 6.5 to 9 g/dL (HCT 19.5 to 27 percent)
   - If a complete blood count and/or reticulocyte count was tested:
     - Normocytic/normochromic RBC
     - Non-elevated reticulocyte count
     - No nucleated RBC

Management Of AOP

Non pharmacologic interventions to prevent AOP includes

- Delayed cord clamping or cord milking
- Blood sampling from the umbilical cord or from the placenta
- Devices to monitor glucose level subcutaneously
- Devices to monitor CO level with transcutaneous or end -tidal device
- Transcutaneous measurement for 02 levels
- Micro -methods for analysis

Pharmacological interventions to prevent AOP includes

- Routine iron supplementation. All preterm infants require iron supplementation. The target for total daily intake is approximately 4 mg/kg per day

Breastfed infants – Breastfed infants should receive iron supplementation of 2 to 4 mg/kg per day through the first year of life

Formula-fed infants – All formula-fed infants should receive iron supplementation of 1 to 3 mg/kg per day

Note: Use restrictive guideline for PRBC transfusions

EPO is not recommended for AOP

References:

1. John. A. Widness .Pathophysiology,diagnosis and prevention of neonatal anaemia .neureviews 2000.doi.org/10.1542/neo.1-4-e61.
2. Kirpalani H.et al. Eunice kennedy shriver NICHD neonatal Research network. Higher level or lower hemoglobin tranfsuion threashold for preterm infants.N Engl JMed 2020 dec 31;383(27):2639-2651(multi center RCT).
3. Franz AR et al.The ETTNO RCT JAMA.2020(36NICU)
4. Benavides A,et al.Long term outcome of brain structure in female preterm infants:possible association of liberal versus restrictive red blood cell transfusion .J Matern fetal neonatal med2021 octo:34(20):3292-3299.
5. Ohlsson A,Aher SM.Early erythropoiesis--stimulating agents in preterm or low birth weightinfants.Cochrane Database of systematic reviewa 2020.
6. Sandra E.Juul,MD,JAMApediatr.2020;174(10):933-943.doi:10.1001/jamapedatrics.2020.2271.

13.3 Haemorrhage

Haemorrhage is a significant loss of blood, which can be internal or external, and can compromise organ or tissue perfusion and can be life threatening.

Risk factors and aetiology

- Vitamin K deficiency bleeding (most common cause)
- Premature newborn (e.g. intraventricular haemorrhage)
- Disseminated intravascular coagulopathy (due to sepsis, severe birth asphyxia)
- Thrombocytopenia, congenital platelet dysfunction
- Liver failure
- Haemophilia and congenital bleeding disorders

Clinical presentation

- Active bleeding e.g. cord bleeding, bloody stools, bloody vomitus and excessive bleeding from punctured sites.
- Pallor, hypotension, tachycardia, capillary refill time (CRT) > 3 sec, lethargy, poor feeding.
- Features of intracranial bleeding e.g. bulging anterior fontanelle, altered level of consciousness, bradycardia, irregular breathing, hypoventilation, apnoea, seizures, fixed pupils.

Investigations

- Full blood picture and Sepsis screening
- Blood group and cross matching
- Bleeding indices (PT, PTT, INR)
- Cranial ultrasound when IVH is suspected

Management

- Stop visible bleeding (e.g. by compression).
- Follow ABC of resuscitation, consider oxygen.
- If there are signs of shock, give normal saline or Ringer's lactate 10 ml/kg body weight over 10 minutes and repeat once after 20 minutes if signs of shock persist.
- Transfuse whole blood 20 ml/kg if indicated. In case of shock transfuse rapidly, otherwise over 4 hours.
- If blood transfusion is required urgently, give blood group O negative without cross-matching.
- Give vitamin K1 (phytomenadione) 2 mg IV once per day for 3 days.
- If disseminated intravascular coagulation (DIC) is suspected, give fresh frozen plasma, for dose and further details see chapter on anaemia.
- Transfuse platelets in case of thrombocytopenia, for dose and further details see chapter on anaemia.
- Avoid hypothermia.
- To determine the cause, take proper history and do physical examination:
    - Is there bloody stool or urine?
    - Family history of bleeding?
    - History of bleeding from umbilical cord?
    - Bloody vomitus?

- Continue feeding/IV fluids as indicated.
- Proton pump inhibitors (e.g. pantoprazole) if upper GI bleeding (doses see annex).

13.4 Intraventricular Haemorrhage (IVH)

Bleeding inside or around the ventricles of the brain that occurs most often during the first few days of life.

IVH is more common in preterm babies as compared to term babies

In preterm, bleeding originates from fragile involuting vessels of the subependymal germinal matrix that is highly affected by sudden changes in cerebral blood flow. In term babies IVH typically originates in the choroid plexus or association with venous thrombosis and thalamic infarction.

50% of IVH occurs in the first 24 hours of life and 90% by day 3-7 of life

There are four grades of IVH depending on the degree/extent of bleeding.

Grade 1 and 2 IVH are common and regarded as mild/low grade and present without complications while Grades 3 and 4 are defined as severe and may result in major complications

Risk factors

- Prematurity or VLBW
- Hypothermia
- Perinatal asphyxia
- Severe sepsis (meningitis/NEC) with DIC
- Coagulopathies
- Administration of hyperosmolar solutions i.e sodium bicarbonate
- Trauma or difficult delivery
- Neonatal transport

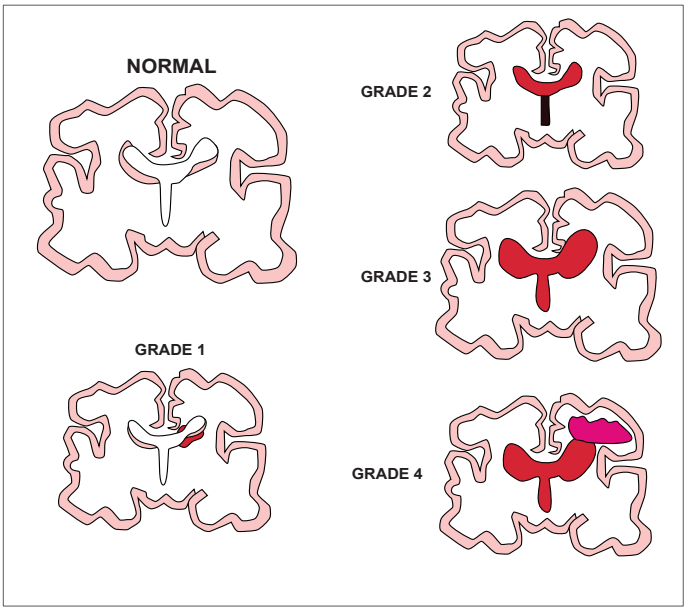
Symptoms

Usually asymptomatic but can present with non-specific signs including Seizures, Apnoea, pallor/anaemia or cyanosis, poor sucking, irritability/lethargy, hypotonia/reduced reflexes, full/bulging fontanelle, hyperglycemia, hypotension

Diagnosis

- Cranial ultrasound is the gold standard for diagnosis and grading IVH
- MRI may be used to exclude other lesions associated with IVH

GRADING



Grade	Papile Criteria	Volpe Criteria
I	unilateral/bilateral germinal matrix hemorrhage	germinal matrix hemorrhage with no IVH or IVH occupying <10% of the ventricular area on parasagittal view
II	IVH without ventricular dilatation	IVH occupying 10-50% of the ventricular area on parasagittal view
III	IVH with ventricular dilatation	IVH occupying ≥50% of the ventricular area on parasagittal view
IV	IVH extending into adjacent brain parenchyma	periventricular venous hemorrhagic infarction (PVHI); cystic periventricular leukomalacia

Management

Prevention is the primary goal through neuroprotective care

- Elevate the head of the bed to 15-30 degrees
- Maintain midline positioning (supine or lateral) may use a prone position if in distress
- Minimal handling (cluster service not to interrupt frequently)
- Avoid lifting legs higher than head during diaper changes
- Provide containment i.e hand hugs during handling

Supportive care is directed toward maintaining stable cerebral perfusion by ensuring normal blood pressure, circulating volume, electrolytes and blood gas (pH)

- Transfusion of blood (Packed RBC) if indicated
- Correction of thrombocytopenia or coagulation disturbances
- Treatment of seizures
- Respiratory support with oxygen if required

Complications

- Periventricular hemorrhagic infarction (PVHI)
- Post-hemorrhagic ventricular dilation/hydrocephalus
- Anaemia
- Death
- Long-term: Neurodevelopment impairment and Cerebral palsy

Screening cranial ultrasound

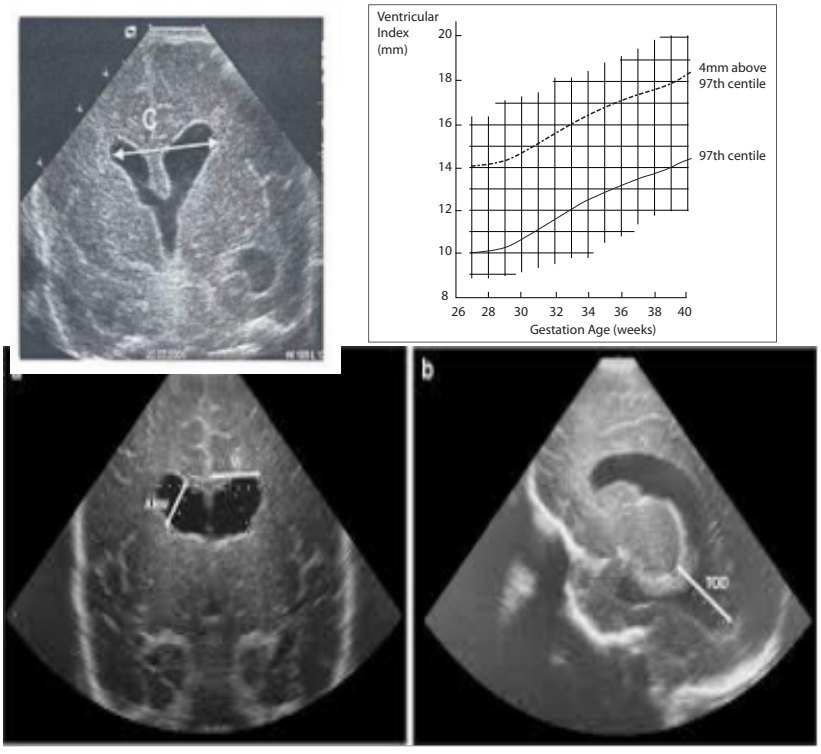
Indication

- Gestational age (GA) <32 weeks or Birth weight <1500gm
- Babies with Moderate and severe HIE
- Preterm with acute clinical deterioration (apnoea & bradycardia, drop in Hb/Plt)

When to screen

- Within 72hours of life
- On day 7 of life
- On day 28 of life or before discharge
- Whenever sudden clinical deterioration in preterm

NOTE: If abnormality found during screen; Repeat Cranial USS twice a week until abnormality stable or resolving, then continue routine screening as scheduled



CHAPTER 14: CARDIOVASCULAR DISORDERS

14.1 Shock

- Shock is defined as acute circulatory dysfunction resulting in an imbalance between tissue demand and supply of substrates leading to tissue hypoxia and cellular dysfunction
- Its prognosis depends on the duration, severity and the extent of vital organ damage
- Shock is an independent predictor of mortality, and survivors have a greater risk for neurological impairment
- Immediate management and active monitoring is crucial

Types and Etiology of shock

- ***Hypovolemic shock:*** Caused by acute blood loss (antepartum/ postnatal blood loss) or fluid and electrolyte losses
- ***Distributive shock:*** Caused by sepsis **(most common)**, adrenal insufficiency, neurogenic or anaphylactic causes, hydrops fetalis
- ***Cardiogenic shock:*** Caused by congenital heart disease (CHD), severe birth asphyxia, cardiomyopathy, metabolic problems (severe hypoglycemia [e.g.infant of diabetic mother], inborn errors of metabolism (IEM)), persistent pulmonary hypertension (PPHN), PDA in a premature infant or arrhythmia/dysrhythmia
- ***Obstructive shock:*** Caused by tension pneumothorax, pericardial tamponade, diaphragmatic hernia, specific obstructive CHD (e.g. coarctation of the aorta)
- ***Dissociative shock:*** Caused by inadequate oxygen-releasing capacity such as in severe anemia or methemoglobinemia
- ***Mixed shock:*** Can occur in various disease conditions like sepsis, where there may be distributive shock to begin with and then cardiogenic shock develops later

Clinical presentation

Signs and symptoms of shock include:

- Pallor and/ mottling of the skin
- Tissue hypoperfusion (cold extremities, acrocyanosis, prolonged capillary refill >3 secs)
- Tachycardia, weak and fast pulse rate
- Tachypnoea
- Hypotension
- Extreme lethargy, irritability or loss of consciousness
- Decreased urine output
- Metabolic acidosis

Investigations

Investigations **(from level 2b of care and above)** should focus on identifying the underlying etiology of shock based on clinical and physiologic findings

Blood pressure (BP): If the infant is hypotensive without shock aggressive treatment is usually not necessary, regardless of the BP. Close observation and re-evaluation of the patient is necessary (Refer to Blood pressure values table ….)

Central venous pressure (CVP) monitoring can be done at **level 3**: Normal values are 4–6 (VLBW) and 5–8 (newborn) mm Hg. If the readings are low, hypovolemia is present. CVP can be high in cardiogenic, obstructive and late septic shock.

Transillumination test can be done if pneumothorax is suspected

Laboratory investigations

- Full blood picture (FBP): Hb level or hematocrit - low/ can be normal in acute blood loss. ↑/↓ WBC and differential may help to identify cause of sepsis
- Culture (blood/urine/CSF) and CRP: If sepsis is suspected
- Blood group and cross matching: When blood transfusion product is required
- PT/PTT: If DIC is suspected
- Creatinine and urea: To assess kidney function
- Blood gas analysis: To assess for hypoxia or acidosis
- Serum glucose and electrolytes: May reveal a metabolic disorder

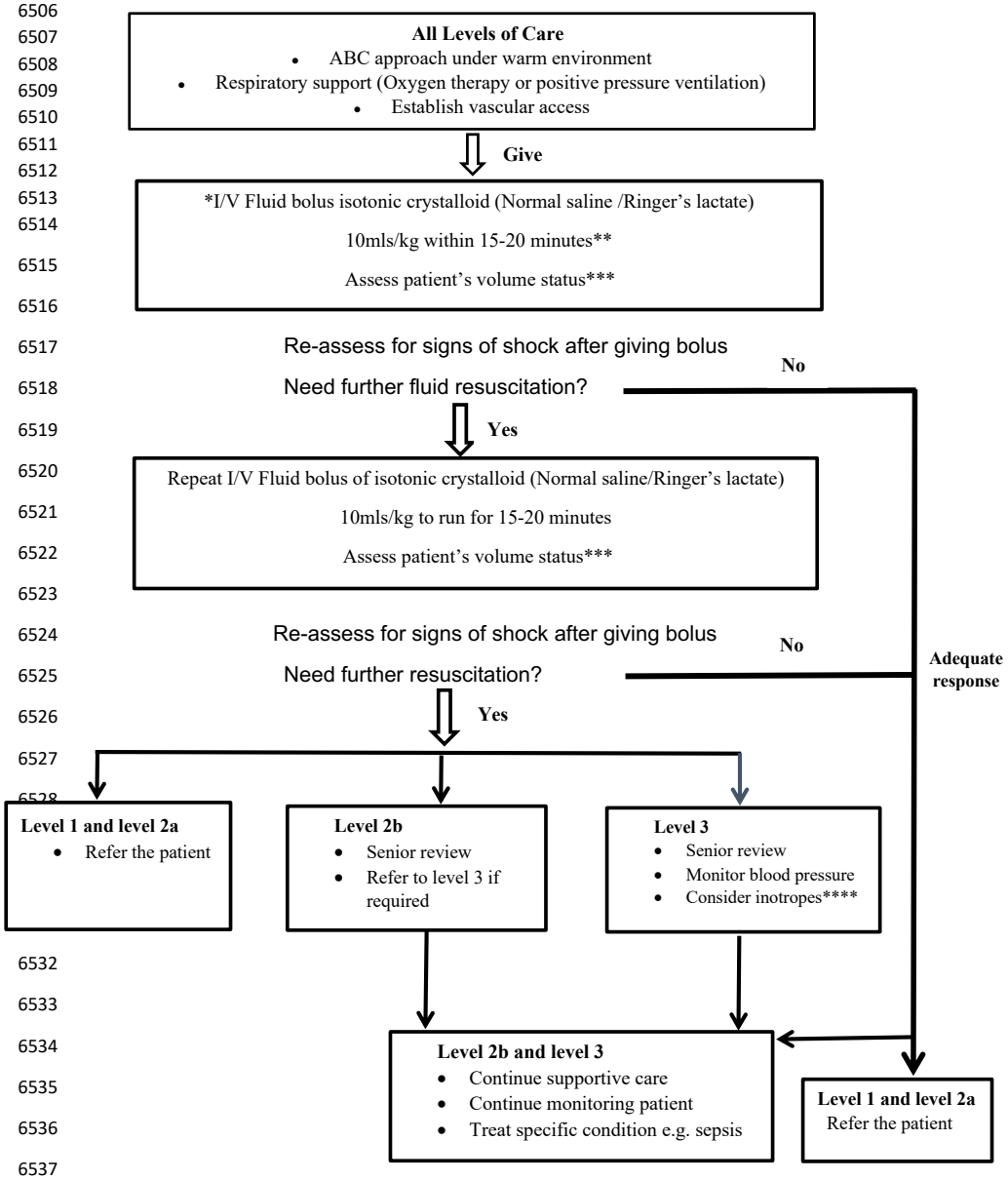
Imaging

- CXR: Assess CHD, any mechanical cause of shock (eg, pneumothorax)
- Cranial USS: If intracranial hemorrhage is suspected
- ECHO: Assess CHD and left ventricular output to evaluate mean arterial blood pressure. Can also be useful in determining volume status and following changes with intervention
- ECG: Suspect of heart issues
- Transillumination of the chest may help detect pneumothorax

Treatment

- Treatment for shock involves addressing the type of shock and the underlying etiology
- Keep NPO when in shock until gastrointestinal (GI) function has recovered
- Continuous monitoring of vitals; heart rate, blood pressure, ECG. Assess urine output and peripheral perfusion frequently
- Observe IV site closely for blanching and extravasation
- Rapidly assess the infant to rule out causes that require immediate treatment: e.g. needle decompression/ chest tube for tension pneumothorax
- Management at all levels of care should start with shock algorithm below followed by the specific management according to the type of shock if required
- At level 1 and level 2a of care, preparation for referral should be initiated early while stabilizing the patient
- Supportive treatment: Correction of hypoxia, acidosis, hypoglycemia, and other metabolic derangements will improve cardiac output
- Calcium gluconate 10% (100 mg/kg) can be infused slowly if ionized calcium levels are low as this will produce positive inotropic effect

Shock algorithm according to Levels of Care



* In hypovolemic/ dissociative shock additional to isotonic crystalloids like blood transfusion products may be necessary

** Cautious and slow fluid boluses (up to 30 minutes) in extremely preterm infants, rapid fluid administration increases risk of intraventricular hemorrhage (IVH) and death

***Reassess for fluid overload (e.g. rales, worsening respiratory distress, increasing ventilator requirements, hepatomegaly). Stop fluid if there is fluid overload. Think of cardiogenic shock

**** Inotropes will depend on the type of shock. Commonly used inotropes: Dopamine, Adrenaline, Dobutamine, Nor adrenalinene, Milrinone

Hypovolemic/ Dissociative Shock

- If the shock is due to anemia with or without blood loss, then PRBC (20mls/kg) or FFP (15mls/kg) for abnormal coagulation studies/ DIC may be better alternatives to normal saline
- Start with IV fluid bolus as per algorithm meanwhile, a blood sample should be sent to the laboratory for FBP (Hb level/Hematocrit value/Platelets), blood grouping and cross match, which is used to guide specific blood products for replacement therapy
- Hypovolemic shock in a VLBW infant: Carefully titrated dopamine can be considered in hypotensive infant after IV bolus of isotonic crystalloid. If refractory shock, consider use of hydrocortisone

Distributive shock

- Hypotension is primarily caused by systemic vasodilation (commonly septic shock)
- Start inotropes if neonate has ongoing signs of shock despite adequate IV fluid bolus for volume expansion

First line

Dopamine: Continuous IV/IO infusion 2-20 mcg/kg/min; start at 5 mcg/kg/min, titrate 5 mcg/kg/min increments until optimal response. If no effect at > 15mcg/kg/min consider adding another agent

Dopamine has dose dependent effects:

- *Low dose (dopamine receptors):* <5mcg/kg/min: Increase renal, mesenteric, and coronary vasodilation
- *Intermediate dose (beta receptors):* 5-15mcg/kg/min: Increase myocardial contractility, heart rate and cardiac output
- *High dose (alpha receptors):* > 15mcg/kg/min: Increase peripheral vasoconstriction, and increase blood pressure (BP)

OR

Nor adrenaline:

- Can be used in dopamine-resistant shock. It stimulates *beta1 and alpha-adrenergic receptors*, increasing heart rate, vasoconstriction and systemic blood pressure
- Continuous IV infusion 0.1- 0.5 mcg/kg/min. Titrate in small increments as required

Second line:

Adrenaline:

- Stimulates *alpha and beta receptors.* Vasodilator at low dose; vasoconstrictor at high dose. Bronchial smooth muscle relaxant
- Adrenaline is not a first-line drug in newborns; however, it may be effective in patients who do not respond to dopamine
- Adrenaline continuous infusion: Start at 0.05 mcg/kg/min and titrate up in increments of 0.01 mcg/kg/min to a max of 0.3 mcg/kg/min. Wean dopamine if adrenaline is effective

Cardiogenic shock

- Fluid bolus may not improve perfusion, and in some cases, may cause clinical deterioration
- Prompt ECHO to assess cardiac function and identify underlying etiology
- Start Inotropes if ongoing ventricular dysfunction despite addressing reversible causes (e.g. hypoxia, arrhythmia, hypothermia)

First line

Dobutamine

- Stimulates myocardial *alpha1 and beta1 adrenergic receptors* increasing contractility and heart rate. Useful in newborns with primary myocardial dysfunction and elevated peripheral vascular resistance (PPHN)
- Dobutamine dose 2-20 mcg/kg/min. Initiate at 5 mcg/kg/min and titrate to effect

Milrinone

- Milrinone dose 0.375 to 0.75 mcg/kg/min (start with lowest dose). Can cause hypotension and should be considered only when blood pressure is adequate. Avoid milrinone in patients with oliguria or anuria due to increased risk of toxicity
- Milrinone can improve the oxygenation index without compromising systemic blood pressure when given to term neonates with PPHN

Obstructive shock

Etiology

- Pulmonary Vascular: Severe pulmonary hypertension, pulmonary embolism
- Mechanical: Tension pneumothorax, pericardial tamponade, constrictive pericarditis
- Urgent correction of underlying cause

Refractory shock

- Corticosteroids may be useful in infants with hypotension refractory to volume expansion and vasopressors, especially among premature infants
- Shock that is refractory to fluid resuscitation and inotropes may happen in septic (distributive) or cardiogenic shock

Hydrocortisone

- <35 weeks: 1mg/kg IV single dose, then 0.5mg/kg/dose IV 12 hourly for 1 to 3 days
- ≥35 weeks: 1mg/kg IV single dose, then 0.5 – 1 mg/kg/dose 6 – 8 hourly for 1 to 3 days
- Start at lowest dose and longer dose interval, wean off as the neonate improves
- Discontinue if no response after 1st dose
- Occasionally, hypotension will recur after stopping corticosteroid therapy, requiring a longer duration of therapy with a slow dosage wean

14.2 Congenital Heart Diseases (CHD)

- CHD are a group of conditions with structural problems of the heart present at birth
- They are the most common types of congenital anomalies
- Prenatal ultrasound can detect some CHD

Signs and symptoms

- Some newborns are asymptomatic or show only mild symptoms
- Rapid breathing, grunting
- Fatigue during breastfeeding, sweating
- Tachycardia
- Poor blood circulation (e.g. greyish skin colour, prolonged capillary refill time)
- Cyanosis
- Hepatomegaly
- Low urine output
- Poor weight gain/weight loss

Note: *The most serious cardiac congenital anomalies may not be associated with a murmur*

Classification of Congenital heart disease

A common criterion to classify CHD is (based on oxygen saturation) cyanotic heart disease (present with cyanosis in the course of illness) and acyanotic heart diseases (infant has no cyanosis)

Cyanotic congenital heart diseases

- Transposition of great arteries
- Tetralogy of Fallot
- Truncus arteriosus
- Total anomalous pulmonary venous return
- Tricuspid valve abnormalities

- Hypoplastic left heart syndrome, double outlet right ventricle

Acyanotic congenital heart diseases

- Septal defects (Atrial Septal Defects, Ventricular Septal Defects)
- Patent ductus arteriosus
- Pulmonary stenosis
- Aortic stenosis
- Coarctation of aorta

Investigations

Level of care	Investigation
All levels	Pulse oximetry- pre ductal and post ductal oxygen saturation (Refer to newborn screening page ….)
Level 2b and above	Chest X ray
Level 3	Blood pressure at all four extremities
Level 3	Echocardiography
Level 3	ECG
Level 3	Blood gases analysis
Other tests based on the coexisting conditions	

Management

Stabilize the newborn as far as possible by giving supportive treatment:

- Oxygen if needed
- Close monitoring with pulse oximetry
- Nurse in propped-up position
- Feeding according to condition of the newborn, avoid fluid overload
- Provide emotional support and reassurance to the mother/care giver
- Diuretics (furosemide 1 mg/kg, spironolactone 1 mg/kg) if signs of heart failure
- Organize referral to a facility with expertise in paediatric heart disease management

14.2.1 Patent Ductus Arteriosus (PDA)

PDA is a condition where the ductus arteriosus fails to completely close post-natally

Majority of extremely preterm infants (>90%), the PDA will close spontaneously

Risk factors

- Prematurity
- RDS and surfactant treatment
- Fluid overload
- Asphyxia
- Congenital syndrome

Clinical features of PDA

Hyperactivity of precordium, bounding peripheral pulses, wide pulse pressure, and a machine-like continuous or systolic murmur; tachypnea, crackles, apneic spells, renal failure

Clinical findings that suggest a hemodynamically significant PDA in preterm infant

- Need for substantial respiratory support: Mean Airway Pressure ≥ 8 cm H20, and/or Fi02 >40%
- Pulmonary hemorrhage
- Widened pulse pressure (eg, DBP <50% of SBP or >25 mmHg difference between SBP and DBP)
- Cardiomegaly and/or pulmonary edema on chest X ray
- Hypotension requiring vasoactive infusion(s)
- Oliguria (urine output <1 mL/kg/hr) or AKI (Cr >1.2 mg/dL)
- Metabolic acidosis not otherwise explained

Investigations:

- Refer to Congenital heart disease investigations
- The diagnosis is confirmed by echocardiographic visualization of a PDA with Doppler flow imaging that demonstrates left-to-right or bidirectional shunting

Management

- Management decisions should base on neonate's clinical features and not on the presence and size of PDA
- Provide supportive care including thermal care, respiratory support, management of anemia, fluid restriction (these will facilitate spontaneous ductal closure)
- Nurse in cardiac/prop-up position when necessary

Pharmacological therapy is indicated for:

- Patient with hemodynamically significant PDA when there is a delay in clinical improvement or deterioration
- Infant with PDA who remain ventilator dependent after one week of age
- Give: IV/ Oral Paracetamol 15 mg/kg 6 hourly for 5 days, when contraindicated give IV/ Oral Ibuprofen 10mg/kg stat, followed by 5mg/kg OD for 2 days
- Diuretics are limited to pulmonary edema (may present with: respiratory distress, tachypnea, tachycardia, cyanosis, rales-diminished breath sounds, irritability, poor feeding)

  Give IV/ Oral furosemide 1mg/kg/dose (if needed maximum 4mg/kg/day)
- Repeat ECHO after completing treatment course. For small PDA will need no further treatment

Term infants:

Pharmacological therapy to close PDA is not effective thus not recommended in term infants. The infant should be monitored carefully, and surgical ligation should be considered

Surgical management is indicated for:

- Patients who fail to respond to two courses of pharmacological therapy

CHAPTER 15: NEONATAL JAUNDICE

Jaundice is the yellow discolouration of the sclera, skin and mucous membranes. It is caused by hyperbilirubinemia, an increased level of bilirubin in the blood and can be normal (physiological) and severe or prolonged (pathological). Jaundice progresses from the head downwards (cephalocaudal).

All newborns should be actively checked for the presence of jaundice to identify risk factors for developing severe hyperbilirubinemia. This should be done at birth, before discharge from postnatal ward, during postnatal follow-up and daily for admitted newborns. Mothers should be educated on early detection of jaundice.

Risk factors:

- LBW and prematurity
- Haemolytic disease of the newborn (e.g. Rhesus or ABO incompatibility)
- Jaundice observed in the first 24 hours after birth
- Severe haematoma
- Inadequate breastfeeding
- Previous baby with severe jaundice in the family
- Sepsis
- Congenital infections (e.g. malaria, congenital syphilis, viral infections)
- Hypothyroidism
- Metabolic disorders (e.g. G6PD)

Types and Grades of Jaundice

Table XX: Types of jaundice

Physiological jaundice	Pathological jaundice
• After 2 days of life (term newborns) • Mild jaundice (grade 1-4, term newborns, after day 2) • Self-limiting • Can turn into pathological jaundice	• Within first 2 days of life • All premature neonates with jaundice • High bilirubin level (grade 5) • Anaemia with jaundice • Prolonged > 14 days

Clinical presentation

- Yellowish discolouration of skin and mucous membranes

Signs and symptoms of bilirubin encephalopathy:

- Mild form: hearing loss
- Acute form:

Initial phase:

- Lethargy, poor feeding, hypotonia, increased sleepiness

Intermediate phase:

- Irritability, increased tone, backward arching of neck (retro Collis) or back (opisthotonos), high-pitched cry, fever, drowsiness.

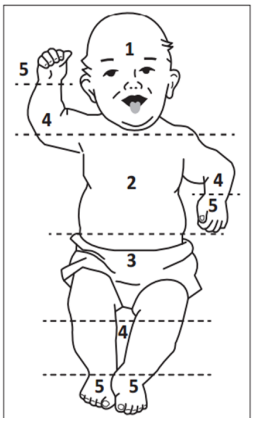
Advanced phase:

- Stupor or coma, inability to feed, cardiovascular instability, persistent convulsions, high-pitched cry, retro Collis, opisthotonos. Neurologic damage is usually irreversible at this point.

- Kernicterus: Permanent damage with dystonia and athetosis, mental retardation, hearing loss, apnoea.

Assessment:

- History (e.g. blood group of parents, maternal infections during pregnancy, difficult delivery, feeding problems, previous baby with jaundice)
- Clinical assessment for presence and grading of jaundice (use Kramer's rule, see table XXXX). Check the baby from head to toe in daylight by blanching the skin and assessing the underlying skin colour.
- Physical examination for underlying causes and complications (e.g. pallor, petechia, cephalohematoma, hepatosplenomegaly, symptoms of bilirubin encephalopathy)



Grade 1: Head and neck only
Grade 2: Upper trunk up to umbilicus
Grade 3: Lower trunk below umbilicus to knee
Grade 4: Arms and lower legs below knee
Grade 5: Palms and soles

Figure XXX: Estimating severity of jaundice by using Kramer's rule

Investigations

Note:
Any jaundice within the **first 2 days of life** and **prolonged** jaundice needs further investigations.

- Transcutaneous bilirubin or/and total serum bilirubin
- FBP (if indicated)

- Blood group, cross matching (if indicated)
- Blood group of the mother (for Rh and ABO incompatibility)

Additional investigations depending on the cause:

- Direct Coombs test
- TORCHES (e.g. in persistent jaundice)
- Septic screening (CRP, cultures)
- Thyroid panel (e.g. in persistent jaundice)
- Imaging (for obstructive jaundice)

Management



Note:
Natural sunlight should not be used at any level for prevention or treatment of neonatal jaundice

- Phototherapy (and in few cases exchange transfusion) are the mainstay for patients with unconjugated hyperbilirubinemia.
- The mother should get good breastfeeding support.
- Give antibiotics only to newborns with signs of sepsis. Avoid ceftriaxone (increased risk of bilirubin encephalopathy and kernicterus), use cefotaxime instead if indicated.
- The use of intravenous immunoglobulin (IVIG) (500-1000 mg/kg over 4 hours) is advisable in addition to continuous intensive phototherapy in cases of Rhesus (or ABO) hemolytic disease when the serum bilirubin continues to rise by more than 8.5 µmol/l per hour (to reduce the need for exchange transfusion). This requires referral for specialized care.
- Other additional treatments like phenobarbitone, albumin or sugar water are not recommended.

Phototherapy

- Start continuous phototherapy based on the total serum bilirubin (TSB) levels, gestation age and the newborn's postnatal age in hours using the bilirubin charts (see figure XXXXX).
- In case laboratory investigations (i.e. TSB) are not available, **Kramer's rule** can be applied to grade the jaundice. Always start continuous phototherapy for the following newborns:
    - Every newborn with jaundice on day 1 and 2
    - Every preterm baby with jaundice (due to increased risk of neurological injury)
    - Term baby from day 3 and above with jaundice grade 5
    - Anaemia with jaundice

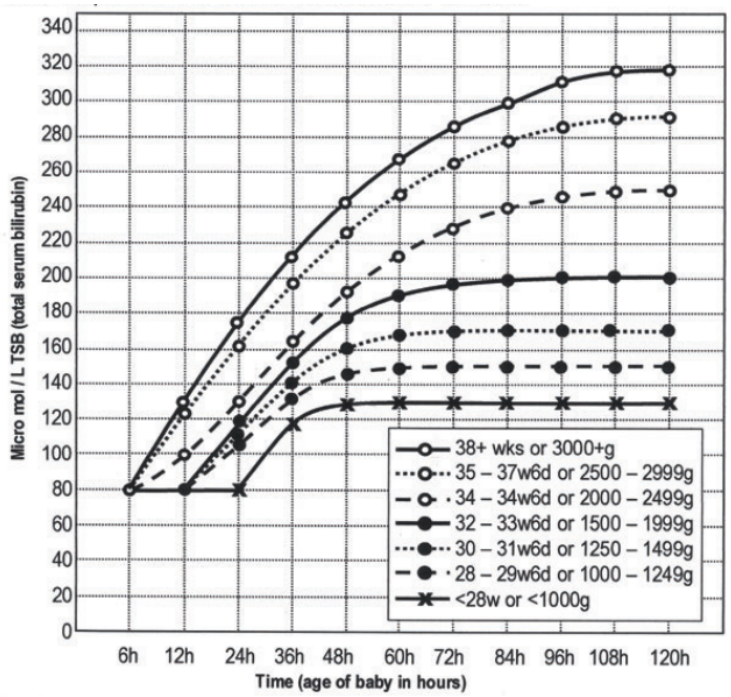


Figure XXX: Cut-off levels for phototherapy.

Explanations to Figure XXX:

1. If the newborn has any risk factors, use one line lower.
2. If gestational age is known, rather use gestational age instead of body weight.
3. Frequency of total serum bilirubin (TSB) measurements:
   a. For newborns > 12 hours old with TSB level below threshold, repeat TSB level as follows:
      - 1 – 20 µmol/l below line: repeat TSB in 6 hours or start phototherapy and repeat TSB in 12 – 24 hours.
      - 20 – 50 µmol/l below line: repeat TSB in 12 – 24 hours.
      - > 50 µmol/l below line: repeat TSB until it is falling and/or until jaundice is clinically resolving.
   b. For newborns under phototherapy:
      - Check TSB 12 – 24 hourly.
      - But if TSB is > 30 µmol/l above the line, check TSB 4 – 6 hourly.
   c. Stop phototherapy:
      - If TSB is > 50 µmol/l below the line. Recheck TSB in 12 – 24 hours.

Technical considerations for phototherapy

- During phototherapy the newborn is undressed, wearing only a small diaper (as much skin as possible must be exposed).
- Ensure good eye protection during phototherapy.
- The distance between phototherapy lamp and newborn should be as specified for each machine and according to the measurement of the lightmeter (irradiance meter). Use the lightmeter to measure the intensity of the light, for intensive phototherapy the irradiance should be ≥ 30 μW/cm^2/nm, for standard phototherapy 10-30 μW/cm^2/nm. Intensive phototherapy has been recommended as the optimal way of administering phototherapy with the advantage that it can quickly lower the TSB.
- Interrupt phototherapy only for feeding and diaper change. If total bilirubin is rapidly rising or close to exchange transfusion level, give EBM via NGT while patient is under phototherapy to minimize time without therapy.
- Monitor hydration by daily weighing and assessing urine output. Only in case of dehydration increase the total fluid amount by 10-20 ml/kg/d.
- Ensure the newborn is kept in a thermoneutral environment and monitor the temperature at least every 4 hours.
- Change the newborn's position 2-3 hourly.
- Continue phototherapy until total serum bilirubin is below phototherapy level (according to above figure xxx and its explanations).
  If bilirubin testing in laboratory is not available continue phototherapy for 3 days. (NB: clinical assessment of skin colour and Kramer's rule are no longer applicable during phototherapy).
- Re-evaluate for jaundice 12 – 24 hours after stopping phototherapy (by checking TSB; if TSB is not available by clinical evaluation and use of Kramer's rule).
- If the newborn is also anaemic give blood transfusion according to transfusion thresholds (see chapter 2, table XXX) and transfusion guideline. Transfusion in case of Rhesus incompatibility must be done with rhesus negative blood, in case of ABO incompatibility with blood group O (cross-matching is performed with mother's blood).
- If the newborn does not improve on phototherapy, consult higher facility/specialist level for further investigations and management, e.g. exchange transfusion.

Complications of phototherapy

- Dehydration
- Hyper- and hypothermia
- Eye injury – retinal damage if proper shielding not done.
- Bronze discolouration (if direct hyperbilirubinemia is mistakenly treated with phototherapy)

Exchange transfusion

Indicated when there is a failure of response to phototherapy and when the initial total serum bilirubin (TSB) level is in the exchange transfusion range according to gestation age and postnatal age using the bilirubin charts (see figure XXXXX). Exchange transfusion requires referral for specialised care.

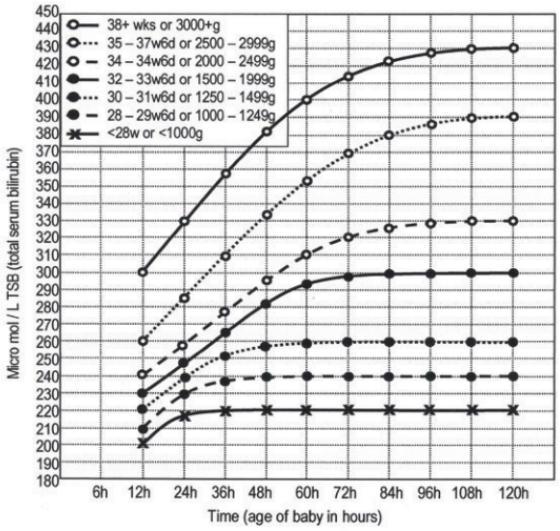


Figure XXX: Cut-off levels for exchange transfusion.

Do exchange transfusion when TSB is above the line according to gestation age and postnatal age.

Explanations to Figure XXX (=cut-off exchange transfusion):

1. If the newborn has sepsis, hemolysis, acidosis, or asphyxia, use one line lower.
2. If gestational age is known, rather use gestational age instead of body weight.
3. Exchange transfusion should be done if TSB is above the threshold and TSB is not expected to be below the threshold after 6 hours of intensive phototherapy.
4. Immediate exchange transfusion is recommended if
   a. the newborn has signs of bilirubin encephalopathy (refer to BIND score below).
   b. TSB is more than 85 µmol/l above the threshold.
   c. TSB continues to rise > 17 µmol/l/hour with intensive phototherapy.

Counselling of parents

- The parents should be informed about the reason for jaundice. If the reason is Rhesus incompatibility the mother needs to get Rhesus immunoglobulin (refer to EmONC guideline).
- Their newborns need to be followed up for neurodevelopment and hearing screening should be done.
- For subsequent pregnancies, parents should inform the obstetrician and paediatrician on the history of jaundice in their previous newborn.

Complications of neonatal jaundice

Neonates with severe hyperbilirubinemia are at risk for developing bilirubin-induced neurologic disorders (BIND). The BIND score is a score to detect and grade the presence of acute bilirubin encephalopathy (ABE) in term and late preterm neonates.

Table XXX: BIND score

	0	1	2	3
Mental status	Normal	Sleepy but able to be aroused, poor feeding	Lethargic, irritable, jittery	Unable to feed, apnoea, convulsions, semi-coma or coma
Muscle tone	Normal flexed tone (awake)	Persistent mild to moderate hypotonia	Mild to moderate hypertonia alternating with hypotonia, neck stiffness, flexor spasm, beginning of neck and back arching	Persistent retrocollis and opisthotonus, bicycling, twitching of hands and feet, fisting, severe hypotonia with limp posture
Cry pattern	Normal	High pitched cry	Shrill cry even if intermittent, difficult to console	Weak or absent cry, or inconsolable crying

Interpretation of BIND score:

Score 1-3: Subtle signs of acute bilirubin encephalopathy.

Score 4-6: Moderate acute bilirubin encephalopathy; likely reversible with prompt bilirubin reduction strategies.

Score 7-9: Advanced acute bilirubin encephalopathy; prompt and individualised interventions are recommended to prevent further brain damage, minimise severity of sequelae, and possibly reverse acute damage

Prevention of significant hyperbilirubinemia

- Education of families during ANC
- Identification of mother/fetus with risk factors during ANC
- Maternal blood grouping during ANC; for mothers with blood group O or/and Rhesus factor negative closer observation of the newborn during the first days of life.
- Identification of newborns with risk factors postnatally
- Good breastfeeding support without blaming the mother
- Examination of newborns for jaundice within 24 hours after birth and in the following days
    - By transcutaneous bilirubinometer (TcB)
    - If TcB is not available by Kramer's rule

    - For high-risk newborns by measuring TSB (interpretation see figure XXX above)
- Education of mothers on detection of jaundice

Further considerations:

- If neonatal cholestasis (e.g. direct bilirubin is more than 20 % of total bilirubin) or inborn errors of metabolism are suspected, refer the newborn for specialised care.
- If jaundice lasts longer than 14 days (in term neonates)/21 days (in preterm neonates), further investigations and specialised care may be required.
- If a transcutaneous bilirubinometer (TcB) is available:
    - Can be used for gestational age of 35 weeks or above.
    - Use serum bilirubin measurement (instead of TcB) for the following situations:
        - Within the first 24 hours of life.
        - For premature newborns below 35 weeks GA.
        - For newborns at or above the treatment threshold for phototherapy.

References:

1. NICE clinical guideline, Neonatal Jaundice, updated Oct 2023.
2. Neonatal Jaundice, Betty Ansong-Assoku, Sanket D. Shah, Mohammad Adnan, Pratibha A. Ankola, Feb 2023 (StatPearls)
3. for cut-off graphs: Phototherapy and exchange transfusion for neonatal hyperbilirubinaemia.
4. Neonatal academic hospitals' consensus guidelines for South African hospitals and primary care facilities Division of Neonatology, School of Child and Adolescent Health, University of Cape Town.
5. A R Horn, G F Kirsten, S M Kroon, P A Henning, G Möller, C Pieper, M Adhikari, P Cooper, B Hoek, S Delport, M Nazo, B Mawela.
6. South African medical journal, October 2006.
7. American Academy of Pediatrics, Subcommittee on Hyperbilirubinemia. Management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation [published correction appears in Pediatrics. 2004;114(4):1138]. *Pediatrics* 2004; 114 (1): 297–316]
8. BIND score: [Johnson et al., 2009]

CHAPTER 16: ENDOCRINE DISORDERS

16.1 Hypoglycaemia

Definition:

Level of blood glucose below 2.6 mmol/l.

- Clinical features can also be used to suspect hypoglycaemia.
- Low blood glucose levels can occur in the first hours after birth as newborns transition from maternal continuous glucose delivery to an intermittent supply of glucose from breastfeeding.
- Therefore, don't check RBG within the first two hours after birth in asymptomatic newborns.

Risk factors: (Check blood glucose for neonates with the following conditions)

- Prematurity (due to limited glycogen stores)
- Intrauterine growth retardation/SGA (due to limited glycogen stores)
- Hyperthermia, sepsis (due to increased glucose consumption)
- Hypothermia (due to increased glucose consumption)
- Newborn of a mother with diabetes mellitus, macrosomic babies
- Inadequate feeding
- Birth asphyxia
- Newborn of a mother with alcohol, substance or drug abuse (including on rehabilitation)
- Suspected inborn errors of metabolism, adrenal insufficiency or liver diseases

Clinical presentation

Neonatal hypoglycaemia is often asymptomatic and picked up incidentally on routine blood glucose testing, as a part of work up of a sick or at-risk newborn.

It can also present as:

- Floppiness
- Prolonged sleeping
- Tremors, jitteriness, irritability or sweating, lethargy
- Exaggerated reflexes
- Convulsions
- Weak cry or high-pitched cry
- Poor feeding
- Apnoea or breathing problems

Investigations

For recurrent hypoglycaemia (> 4 readings with hypoglycaemia despite corrective measures) or hypoglycaemia beyond the first 48 hours of life:

- Cortisol levels
- Insulin
- C-peptide
- Growth hormone

- ACTH
- Check mother for diabetes mellitus

Management

Asymptomatic and **symptomatic** neonates are managed differently:

- **Asymptomatic** stable newborns:
    - Advise the mother to exclusively breastfeed the newborn and if the newborn can't breastfeed give expressed breast milk according to weight and age.
    - In case of feeding intolerance give a bolus of Dextrose 10 % 2 ml/kg stat IV, continue with maintenance IV fluids appropriate for age and weight, then recheck blood glucose after 30 mins.
    - If breastmilk is not available, give donor human milk (refer to breast milk guidelines). If donor human milk is not available, give standard infant formula.
    - Recheck blood glucose 1 hour after feeding and again before next feeding.
    - If there is still hypoglycaemia, give guaranteed feeds (i.e. calculated amount of feeds given as EBM based on weight and age of the baby).
    - Recheck after 30 min, if still hypoglycaemic, admit at NCU and follow protocol of symptomatic hypoglycaemia (see below).
    - Establish venous access.
    - If hypoglycaemia is resolved, ensure more frequent feeding to prevent hypoglycaemic episodes. Continue blood glucose checks 3 hourly before feeding, stop once two readings are normal. Keep on observation for 12 – 24 hours after last normal glucose reading and make sure the baby is feeding adequately.

- S**ymptomatic** newborns:
    - For blood glucose < 2.6 mmol/l, give a bolus of Dextrose 10 % 2 ml/kg stat IV.
    - Maintenance feeds/fluids: Continue with guaranteed feeding (if baby tolerates feeding) or maintenance IV fluids appropriate for age and weight.
    - Then recheck blood glucose after 30 min.
    - If blood glucose is still < 2.6 mmol/l repeat bolus dextrose 10 % 2 ml/kg stat IV.
    - Stepwise increase glucose supply, recheck blood glucose 30 min after each increment.
    - On average a glucose infusion rate (GIR) of 4-8 mg/kg/min is needed (VLBW neonates might only tolerate 4-6 mg/kg/min in the first few days of life). GIR should be adjusted in increments/decrements of 1-2 mg/kg/min, according to actual blood glucose. This can be achieved by changing the concentration of dextrose or the total amount of fluid (a concentration of more than 12.5 % dextrose will need a central line; increasing the total fluid amount should not result in fluid overload).
    - Do not stop IV infusion abruptly.

- Once blood glucose is ≥ 2.6 mmol/l, and the newborn is stable, reduce IV infusion and increase enteral feedings. Breastfeed or give EBM appropriate for age and weight.
- Recheck blood glucose after 1 hour and again before the next feeding.
- If mother is not able to provide breastmilk, give donor human milk (refer to breast milk guidelines). If donor human milk is not available, give standard infant formula.
- If hypoglycaemia is resolved, ensure more frequent feeding to prevent hypoglycaemic episodes. Continue blood glucose checks 3 hourly before feeding, stop once two readings are normal. Keep on observation for 12 – 24 hours after last normal glucose reading and make sure the baby is feeding adequately.

$$\text{GIR (mg/kg/min)} = \frac{\text{Rate (ml/kg/day) x \% Dextrose}}{144}$$

Figure XXX: Calculation of glucose infusion rate (GIR)

Note:

- While IV access is being obtained in a symptomatic neonate with hypoglycaemia, EBM can always be given via NGT, or give 40% dextrose gel 200 mg/kg massaged into the buccal mucosa.
- Never give Dextrose 10 % rectally.

Persistent hypoglycaemia

- If there is persistent hypoglycaemia and the cause is unclear, consult/refer for further specialist care of a neonatologist (to do e.g. sepsis screening, cortisol levels, GH, ACTH, C-peptide; blood samples have to be taken immediately while the newborn is still hypoglycaemic).
- In case glucose infusions fail to maintain blood glucose at appropriate levels or an especially high glucose infusion rate (> 10 mg/kg/min) is required, consider pharmacological intervention at specialist level.

  The following drugs can be considered:
  - Glucagon: 0.1 – 0.2 mg/kg/dose IV (or IM if IV line is not readily available). Dose can be repeated after 20 minutes if needed.
  - Hydrocortisone: Slower response than Glucagon, can be given in suspected hypoadrenalism or if there was no sufficient response to Glucagon. Give 5 mg/kg/day (IV or orally) in 2 divided doses. Use cautiously due to side effects, especially in preterm newborns.
  - Diazoxide: Used in cases of persistent hypoglycaemia as long-term management at specialist level.
  - Octreotide: To be used with caution in neonates. Can be used in hyperinsulinaemic hypoglycaemia with poor response to Diazoxide. Give 1 microgram/kg/dose subcutaneously 6 hourly as starting dose, if not

effective the dose can be increased in increments of 5 microgram/kg/day up to a maximum of 35 microgram/kg/day (in 4 divided doses).

16.2 Hyperglycaemia

Hyperglycaemia is a random blood glucose level > 7 mmol/l, however, consideration for treatment should only begin when glucose levels are persistently > 11 mmol/l with two reliable measurements 3 hours apart.

Risk factors and aetiology

- Excessive glucose load from IV fluids.
- Low birth weight, extreme prematurity, intrauterine growth restriction (IUGR)/small for gestational age (SGA).
- Stress: e.g. sepsis, hypoxia, intraventricular haemorrhage (IVH), necrotizing enterocolitis (NEC), recent surgery, recent anaesthesia.
- Side effects of medications such as corticosteroids, inotropic agents.
- Transient and permanent neonatal diabetes mellitus.

Clinical presentation

- Often asymptomatic
- High urine output leading to dehydration

Investigations

- Investigate for sepsis
- For persistent hyperglycaemia: blood gas analysis, electrolytes, serum glucose, insulin, C-peptide, ketone bodies (measured from the same sample)
- Urine for glucose and ketones by dipstick
- Consider cranial ultrasound when IVH is suspected

Management

- Consider initial hyperglycaemia as iatrogenic. Check the flow rate and glucose infusion rate of running IV fluids, using an infusion pump.
- Reduce glucose concentration to 5% dextrose. Do not switch to Normal Saline, do not stop the infusion.
- If the newborn is breastfeeding, continue with breastfeeding but reduce the amount stepwise by 20 % decrements. and give dextrose 5 % IV. Look for underlying cause
- If the newborn is on IV fluids, use Dextrose 5 % under close blood glucose monitoring. If the newborn is still hyperglycaemic, continue with regular feeding. Even minimal enteral feeds (MEF) induce insulin secretion.
- Continue to monitor blood glucose hourly until glucose falls to < 11 mmol/l. Confirm the measurement by serum glucose level measured at the laboratory.
- Consider the side effects of drugs as the cause.
- Treat underlying causes, e.g. sepsis, and dehydration.
- If after 4 hours blood glucose is still > 11 mmol/l despite being on 5 % dextrose, consider giving insulin at a dose of 0.05 – 0.15 units/kg IV/subcutaneously every 4 – 6 hours (bolus) or 0.05 units/kg/hour (continuously). (Dilute 0.5 ml equivalent to 50 IU of insulin with 49.5 ml of dextrose 5% to make a solution of 1.0 IU per 1 ml (see annex on drugs)).

- Insulin and dextrose dosages must be adjusted depending on the response, with the aim to wean of insulin.
- If insulin is given continuously IV, this requires a separate IV line which is not to be flushed.
- Check blood glucose 30 minutes after giving insulin and then continue with hourly monitoring. The target blood glucose is 5.5 – 7 mmol/l.
- Monitoring can be stopped after having 3 consecutive normal readings of blood glucose before feeding.

Note:

- Blood glucose measurements have to be done before feeding (pre-prandial blood glucose).
- Extremely low birth weight newborns (< 1000 g) may have increased sensitivity to insulin. Start at the lowest dose initially.
- If hypoglycaemia occurs, stop insulin infusion and administer Dextrose 10 % (2 ml/kg) IV bolus and then continue with maintenance fluid appropriate for weight and age.
- For permanent and transient diabetes, long-term insulin use may be required, and the newborn should be referred to a specialised facility.
- Counsel the parents on the infant's condition.

16.3 Congenital hypothyroidism

One of the most preventable causes of intellectual impairment worldwide.
Most newborn babies with congenital hypothyroidism have few or no clinical manifestations of thyroid hormone deficiency at birth.
Maternal thyroid disease influences the thyroid status of the newborn

Transient congenital hypothyroidism

Refers to a temporary deficiency of thyroid hormone identified at birth, with low thyroxine (T4) and elevated thyrotropin (TSH), that resolves within first few months or years of life.

Causes: -Iodine exposure (topical iodine-containing antiseptics maternal use/ excessive iodine ingestion
-Maternal autoimmune thyroid disease with antibodies transfers to foetus
-Maternal antithyroid drugs

Risk factors/ aetiology

- Dysgenesis of the thyroid gland (agenesis, ectopy, hypoplasia)
- Inborn error of thyroid hormone production/ thyroid dyshormonogenesis (for inherited goitre)
- Maternal antithyroid drugs use e.g. propylthiouracil, methimazole
- Maternal anti thyroid antibodies crossing the placenta (graves' disease)
- Iodine excess (exposure to iodine containing anti-septics, contrast agents)

Clinical presentation

- Prolonged neonatal jaundice, usually unconjugated
- Lethargy
- Constipation
- Poor feeding

- Large tongue
- Coarse facial features
- Wide fontanelle
- Hoarse crying
- Distended abdomen
- Umbilical hernia
- Goitre (thyroid dyshormonogenesis)

Investigations

- T4, TSH (usually low T4, high TSH)

Condition	T4 levels	TSH levels
Primary hypothyroidism	Decreased	Increased
Central hypothyroidism OR primary hypothyroidism with delayed rise in TSH	Decreased	Decreased or normal

- Thyroid ultrasound (if possible)

Management

- Levothyroxine 10-15mcg/kg/dose daily per oral
- Discuss dosing and use with paediatric endocrinologist

Prevention

- Newborn screening for congenital hypothyroidism is recommended, with first screening ideally done between 24 and 72 hours after birth.
- Abnormal
- See chapter for newborn screening on congenital hypothyroidism

Suggested Readings

American Academy of Pediatrics technical report on congenital hypothyroidism: Screening and Management, 2023
Congenital hypothyroidism: initial clinical referral guidelines (NICE), 2020
Connelly KJ, Boston BA, et al. congenital hypothyroidism caused by excess prenatal maternal iodine ingestion. J Pediatr 2012; 161:760

16.4 Osteopenia (Metabolic Bone Disease) of prematurity

Metabolic bone disease (MBD) is a postnatal bone mineralization that is inadequate to fully mineralized bones and it's common among VLBW infants.
It results from inadequate calcium and phosphorus intake and absorption since 80% of mineral accretion occurs in the 3rd trimester.
Typically develop at 3 to 12 weeks of age

Risk factors

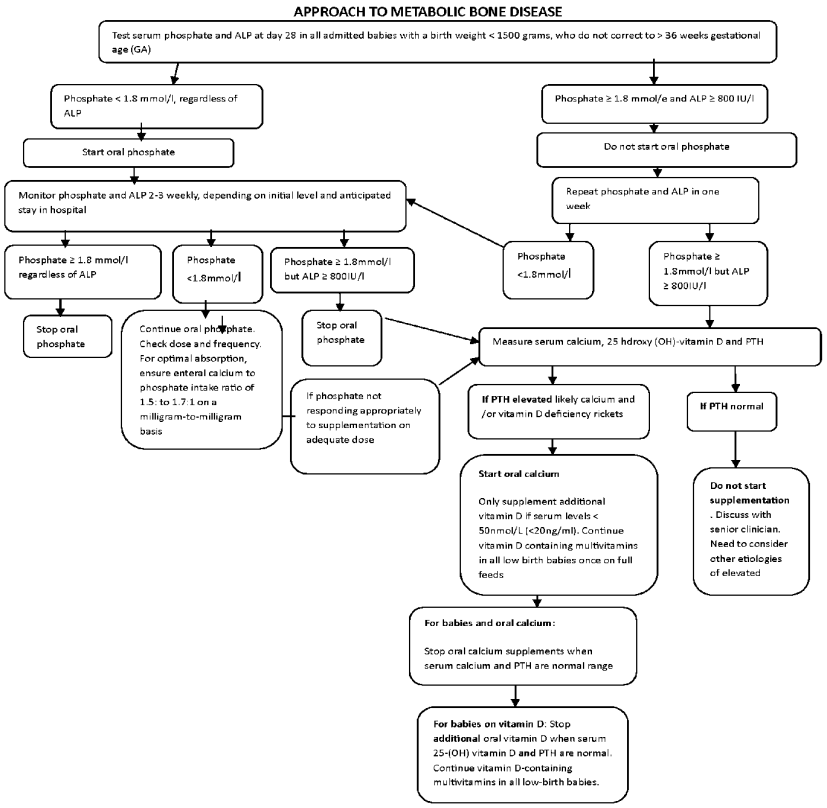
- Decreased mineral intake: very low birth weight infants <1000g, prolonged total parenteral nutrition, delayed enteral feeding, history of NEC/ surgical intervention, BPD treated with fluid restriction or diuretics)
- Increased mineral excretion: Diuretic use e.g. furosemide, long-term steroid use, cholestatic liver disease

Clinical presentation

- Respiratory insufficiency/failure to wean from a ventilator
- Hypotonia
- Pain on handling (pathological fracture)
- Decreased linear growth with sustained head growth
- Frontal bossing, enlarged anterior fontanelle, widened cranial sutures, craniotabes, rachitic rosary, Harrison grooves
- Enlarged wrists, knees and ankles

Investigations

- Serum Phosphorus levels (usually decreased, <3.5-4 mg/dl [1.1-1.3])
- Alkaline phosphatase levels (Usually increased, >800 IU/L or more)
- Serum 25(OH)D levels
- Imaging: X-ray of long bones shows epiphyseal growth plates, cupping, fraying and rarefaction of the metaphyses, subperiosteal new bone formation, osteopenia of skull, spine, scapula and ribs, and occasionally pathologic fractures



**PTH-Parathyroid hormone, ALP-Alkaline phosphatase,*

Management

Recommended intake for the day for VLBW infants:

a) Calcium 150 to 220 mg/kg/day
b) Phosphorus 75 to 140 mg/kg/day
c) Calcium:phosphorus ratio- Appr 1.5 to 1.7

For preterm and LBW give calcium 120-200mg/kg/day of calcium and 60-140mg/kg/day in enteral feeds

Give 800IU of vitamin D daily for established osteopenia

After initiating calcium and phosphorous supplementation, measure phosphorous and alkaline phosphatase activity every 2 weeks and x ray every 6 weeks.
Wean calcium and phosphorous over 2 to 4 weeks to stop when serum biochemical values have improved and radiographs show signs of healing

Prevention

- Early introduction of breastmilk
- Vitamin D
  - For infants <1500g body weight, give 400 IU once daily once on full feeds
  - Once ≥ 1500g and tolerate full feeds, vitamin D can be increased to 800IU
- Fortification of feeds for all infants who are < 1500g by;
  - Human milk fortifier
  - Using a formula designed for preterm infants
- Physical therapy (passive range of motion and joint compression) for 5 to 15 minutes
- Screen at risk newborns

Suggested Readings

1. Abrams SA, Committee on Nutrition. Calcium and vitamin D requirements of enterally fed preterm infants. Pediatrics 2013; 131: e 1676.
2. Agostini C, Buonocore GCarnielli VP, et al. Enteral nutrient supply for preterm infants: commentary from European Society of Pediatric Gastroenterology, Hepatology and Nutrition. J Pediatr Gastroenterol Nutr 2010;50:85. American Academy of pediatrics Metabolic Bone Disease of prematurity, Nov 2015
3. American Academy of pediatrics Osteopenia in Newborns and infants, May 2022

16.5 Disorders of sex differentiation (DSDs)

- DSDs (formerly called “ambiguous genitalia”) are defined as congenital conditions in which development of chromosomal, gonadal or anatomical sex is atypical.
- The newborn is usually detected with ambiguous external genitalia, but may also be diagnosed later with virilisation, delayed puberty, infertility or other problems.
- Family history of infertility/amenorrhea, family history of unexplained, sudden infant deaths or history of consanguinity serve as a clue

Diagnosis

- Careful inspection and palpation of genitalia for penile length estimation, presence/absence of gonads, location of urethral opening and clitoral size

Investigations

- Serum electrolytes: Sodium, Potassium
- Blood Gas Analysis
- Serum cortisol level
- Abdominal pelvic ultrasound (presence of gonads, a uterus and/or vagina)
- Karyotype and FISH

Management

- Provide emotional support and reassurance to the parents/care givers
- Don't assign a gender to the newborn but explain to the parents that it needs further investigation to know if the newborn is female or male
- Attend to emergencies as appropriate
- Give Fluids and Electrolytes replacement if needed (refer to the management of electrolytes)
- Treat hypoglycemia if required (refer to the management of hypoglycemia)
- Steroids replacement: According to condition and discussion with endocrinologist SEPSIS
- Parents should not register the birth until gender is assigned.
- Organize referral to a facility with further expertise (e.g. genetics, endocrinology, psychology)

16.6 Congenital Adrenal hyperplasia (CAH)

Is a group of autosomal recessive disorders affecting cortisol biosynthesis. The most common form of CAH is caused by steroid 21-hydroxylase deficiency due to mutations in *CYP21A2*.

Clinical signs and symptoms

- Atypical genitalia (especially for female)
- Hyperpigmentation of the scrotum or an enlarge phallus in male
- Poor feeding with failure to thrive
- Vomiting
- Dehydration
- Lethargy
- Hypoglycemia
- Hyponatremia with reciprocal hyperkalemia at 7 to 14 days of life

Investigation

- Random blood sugar
- Serum electrolyte (Potassium and Sodium)
- Molecular genetic diagnosis

Management

Hormonal treatment with Glucocorticoids

- Hydrocortisone 20 to 30 mg/m^2 3 times daily until the targeted hormone levels are reached.

Alternatively

- Fludrocortisone 0.05-0.2mg 1 to 2 times daily
- Supplement of Sodium chloride 1-2g (17-24meq/day) in several feeding

16.7 Undescended testes (Cryptorchism)

- Usually, the testes descend during fetal period into the scrotum, for some boys (5 % of term and up to 30 % of preterm male newborns) one or both testes are still not descended at the time of birth.
- Cryptorchidism means that testes are not within the scrotum or does not descend spontaneously into the scrotum by four months of age (or corrected age for premature infants).
- Undescended testes are a risk for infertility and testicular malignancy later in life.

Risk factors

- Prematurity
- Small for gestations age
- Pre-natal exposure to endocrine -disrupting chemicals like diethylstilbestrol, pesticides

Clinical presentation

- Empty and hypoplastic scrotum
- Inguinal fullness from the testicle or hydrocele/hernia sac maybe present

Investigations

- Ultrasound to look for gonads location

Management

- Reassurance to parents about the condition then observe for spontaneous descent until age of 6 months
- If testis/testes failed to descend by 6 months, refer/consult to urologist and endocrinologist for hormonal therapy or surgery (orchidopexy).
- By latest 12 months the testes should be in the scrotum

16.8 Neonatal breast enlargement (Mastauxe)

Benign condition occurs on both male and female during the few weeks of life.
It is related to placental transformation of androgens to oestrogens which enter foetal circulation and cause glandular proliferation.



Copyright: © 2016 Donaire A, et al. Neonatal breast hypertrophy revisited

Clinical presentation

- Enlargement of breast tissue
- Milky nipple discharge in 5 % neonates

Management

- Resolves spontaneously within 2 weeks in males and several weeks in females

> NOTE: Do not squeeze or apply anything including warm compression because it may persist if the breast tissue is stimulated. It can also develop an

16.9 Neonatal withdrawal bleeding

It occurs when maternal oestrogen crosses the placenta and stimulate growth of the female fetus's endometrial lining during intrauterine life it leads to blood mucoid discharge or light vaginal bleeding.

Clinical signs and symptoms

- Bloody mucoid discharge
- Light vaginal bleeding

Treatment

- It is a self-limiting and require no treatment.
- If bleeding is severe consult gynaecologist

CHAPTER 17: NEONATAL DERMATOLGY

Skin is the largest organ in the body, complex multi-functional structure that give clue to underlying systemic disease

Types of lesions

- **Macule** –flat lesions, not palpable
- **Papular** –raised solid lesions
- **Maculo**-papular rash- mix of the above
- **Vesicle** – blister or suck full of clear fluid
- **Pustule**- blister or suck full of cloudy fluid or puss
- **Petechiae**- small, purplish, hemorrhagic spot on the skin
- **Wheal**- usually raised pink areas with areas of blanching associated

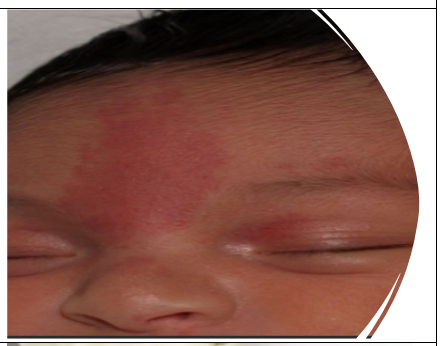
1	**Erythema Toxicum Neonatorum** • ETN is a harmless and temporary skin condition that can affect newborns shortly after birth. • An ETN rash consists of yellowish-white spots surrounded by inflamed skin. It may occur on any part of the body except the soles of the feet or the palms of the hands. • ETN resolves by itself, typically within 1st weeks of life, and does not require any treatment.	
2	**Transient neonatal pustular melanosis** Idiopathic pustular eruption with no surrounding erythema. Suggested that it is an early-onset variant of toxic erythema of newborns • Usually present at birth • Resolve within 5 days • Negative culture • No need of treatment	

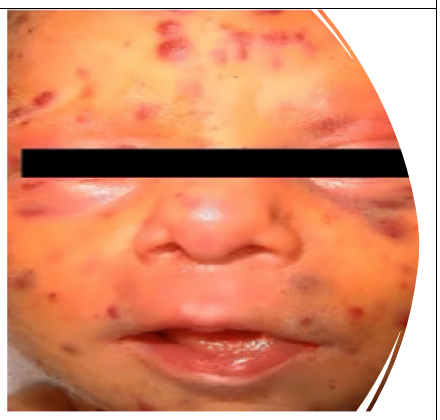
3	**Neonatal Acne Vulgaris** • Due to maternal or fetal androgens • Present at birth or shortly after birth • Papulopustular lesion and comedones on cheeks, chin and forehead • Disappear spontaneously • No need of treatment • Infants can be treated with a 2.5% benzoyl peroxide lotion if lesions are extensive and persist for several months • Oil free emollients.	
4	**Millia** • Small keratinous cyst occurring in about 50% of newborn • Small firm pearly white papules on the face of newborn • Usually disappear spontaneously during first 3-4 weeks • No need of treatment	
5	**Miliaria** Due to blockage of eccrine sweat ducts, heat, humidity, occlusive clothes and plastic sheet. • **Miliaria crystallina** (stratum corneum)-superficial vesicle 1-2 mm, without erythema followed by desquamation • **Miliaria rubra** (mid-epidermal) itchy erythematous papules. Secondary infection may lead to sweat abscess • **Miliaria profunda** (dermal-epidermal junction) • No treatment needed.	

	• Antibiotics in case of secondary infection	
6	**Epstein pearls** • Yellow white small keratinous cyst(1-2mm) • Seen in 85% of newborn • Site: along the midline at the junction of hard and soft palate • Disappear within few weeks • Need no treatment	
7	**Mongolian spot (Dermal Melanocytosis)** • Blue-gray, poorly circumscribed, single or multiple patches of various size over lumbosacral region • Common in Asian, Black and Hispanics • Usually at birth or within few weeks of life • Due to entrapment of melanocytes in dermis of developing embryo and fails to reach the dermis • Most fades during 1-2 years of life	

	Subcutaneous Fat necrosis • Inflammation of the subcutaneous adipose tissue usually occurs in the first days after birth. • The back, shoulders, buttocks, cheeks and extremities are considered predisposed sites. **Treatment** • Mainly supportive, as cutaneous lesions resolve spontaneously in the majority of cases. • Hypercalcemia should be aggressively corrected with hyperhydration, intravenous loop diuretics, and low calcium and vitamin D formulas. • In refractory cases, bisphosphonate and systemic corticosteroids are recommended	
8	**Craddle cap dermatitis(Seborrheic dermatitis** Large plaques of scales matted into large plaques of crusts Begins with non-eczematous erythematous scaly dermatitis of scalp and spread downward **Treatment:** • Olive oil/Coconut oil/vegetable oil • Topical weak steroid (1% hydrocortisone) • Ketoconazole shampoo	

9	**Capillary Haemangioma (Infantile haemangioma)** • Superficial hemangioma occurring in 10% of infants • Usually not present at birth, develop during 1st few weeks of life • Start as small red macules and grow rapidly during 1st 6 months • Site: head, neck and trunk • Over 90% disappear by age 7 **Treatment:** • **Oral Propranolol** – started as a low dosage of 0.16 mg/kg and gradually increased in the absence of complications to 2 mg/kg/day in three divided doses. • **Topical Timolol** –applied as 0.5% gel twice daily until the lesions regress • Pulse dye laser	
10	**Port wine stain** • Large irregular deep red or purple patch with well-defined borders • Usually, unilateral often on face • Represent vascular malformation involving mature capillaries • Lesion don't enlarge but persist throughout life • Maybe part of syndrome (Sturge Weber or Klippel trenuary syndrome if in lower limbs) **Treatment:** • Pulsed dye laser-camouflage-excision and grafting.	

11	**Congenital melanocytic Nevi** • Affect 1% of newborns • Abnormal growth, development or migration of malanoblasts • Present at birth or become apparent within the 1st year. • Classified according to size: small <1.5cm, medium 1.5-20cm, large >20cm • Risk of malignant transformation depends on size. **RX:** • When a large number of nevi are present, refer to dermatologist. • Excision surgery is recommended when malignancy is suspected, or when it can improve cosmetic outcome.	
12	**Samon Patch** • Most common vascular nevi of newborn (40% of newborns) • Irregular dull, pink red macules with poorly defined borders • Site: on face (angle kiss), nape of neck (stork bite) • More intense in color on crying • Represent area of superficially dilated capillaries • Disappear within a year.	
13	**Aplasia cutis congenital** • Focal absence of epidermis, dermis and subcutaneous tissue • Mostly (80-90%) in vertex of scalp • Sharp marginated, depressed hairless area • Maybe associated with limb abnormalities, epidermal nevi, trisomy, epidermolysis bullosa **Treatment:** • Regular wound dressing and antibiotics (Refer to neonatal sepsis) • Skin grafting	

14	**Herpes Simplex** • Important diagnosis of vesicles • Occasionally congenital with microcephaly and scars • Mainly acquired around delivery • Risk relates to stage and type of infection • 50% primary active HSV-2 • 5% recurrent disease • Overall HSV-1 better prognosis **Treatment:** • Topical Acyclovir • Consider oral treatment, if lesions are severe	
15	Congenital Rubella • Typical skin lesion appears at birth or during the first 48hrs, fades over a period of weeks • Lesions often purpuric and attributed to thrombocytopenia, which is another common feature of congenital rubella • Blueberry muffins lesion may appear • Classical triad of congenital Rubella • Cataract, PDA and Hearing loss **Treatment:** conservative management	

16	**Bullous impetigo** • Caused by phage II strain of S.Aureus • Perineum, periumbilical area and neck are predilection site • Rapidly enlarging bullae with a narrow, red areola containing clear fluid then become purulent **Treatment:** Topical (mupirocin) systemic antibiotics -penicillin analogue (refer to sepsis treatment)	
17	**Staphylococcal Scalded Skin Syndrome** • Caused by epidermolytic toxin A or B elaborated by phage II of S.aureus • Both toxins attack desmoglein 1 so mucosal involvement does not present at birth, appear few hours after • Extreme tenderness, pyrexia, pneumonia is a complication **Treatment:** Traat like burns, antibiotics and rehydration	
18	**Congenital syphilis** • About 15% of neonates born to mothers with untreated syphilis. • Fetal loss occur in 20% of such pregnancies. • Baby present with snuffles, jaundice, chorioretinitis, hepatosplenomegaly and skin pealing **Treatment:** Procaine penicillin Refer	

19	**Neonatal lupus** • Occurs in the babies of mothers with clinical or subclinical (60%) autoimmune connective tissue disease • Associated with the transplacental passage of anti-Ro-SSA(>90%).la-SSB • Risk of connective tissue disease later in life is increased • Systemic features are detectable in over half of all affected infants, of which congenital heart block is the commonest. **Treatment:** • No management required; lesion resolve without scarring	
20	**Harlequin Ichthyosis** • Often lethal in 44% • Neonates are born with armour like skin (truncal plates with fissuring. • Impaired movement and ability to drink and breath • Make prone to skin infections **Treatment:** skin moisturizer eg, petrolatum, glycerin) Topical salicylic acid or urea Retinoid 0.25mg/kg/day Dermatologist review	

21	**Epidermolysis Bulossa** • Group of genetically determined disease characterized blistering of the skin and mucosae following mild mechanical trauma. Types • EB simplex • Junctional EB • Dystrophic EB • Kindler syndrome **Treatment:** • wound-care, antibiotics, nutrition support	
22	**Umbilical Granulomas** • Umbilical granulomas occurs in the first weeks of life after the umbilical cord detaches. • Granulation tissue may persist at the base of the umbilicus after cord separation; **Treatment:** Silver nitrate cauterization skin moisturizer (Vaseline petroleum Jelly)	
23	**Diaper Dermatitis** • The most causative factor is wetness of the diaper area. • Due to wetness, barrier function of the skin is destroyed and penetration of irritants becomes easier. **Treatment:** • Good hygiene • Topical emollients (zinc oxide, petroleum, lanoline) • Fungal dermatitis**:** Topical antifungal agents • Bacterial dermatitis: topical antibiotics	

2 4	**Albinism** • Albinism is a group of heritable conditions associated with decreased or absent melanin in ectoderm-derived tissues (most notably the skin, hair, and eyes), yielding a characteristic decrease in skin pigmentation. • Patients with albinism are particularly susceptible to solar damage, and these patients must utilize lifelong sun protection precautions. • The most commonly presentation is oculocutaneous albinism (OCA). Treatment: • Avoidance of prolonged UV light exposure (sun, tanning beds) and medications that increase photosensitivity. • Application of sunscreen (SPF 30+) with liberal and frequent reapplication (every 2 hours) when in the sun • Refer to ophthalmologist for eye review.	

Reference

1. Taieb A, Boralevi F. - Common Transient neonatal dermatoses. In: Textbook of Pediatric Dermatology. Eds. Harper J, Oranje A, Prose N, 2th ed, Oxford. Blackwell Publ. 2006;%nbsp;:55–66.
2. erna-Tamayo C, Janniger CK, Micali G, Schwar; RA. - Neonatal and infantile acne vulgaris: an update. Cutis. 2014;94:13–16.
3. Sachdeva M, Kaur S, Nagpal M, Dewan SP. - Cutaneous lesions in new born. *Indian J Dermatol Venereol Leprol.* 2002;68:334–337. [PubMed] [Google Scholar]
4. Nguyen NV. - Pediatric Milia. *http://emedicine.medscape.com/article/910405-overview.* 2016;%nbsp; [Google Scholar]
5. Feng E, Janniger CK. - Miliaria. Cutis. 1995;55:213–216
6. Nagar H. - Umbilical granuloma: a new approach to an old problem. Pediatr Surg Int. 2001;17:513–514.

CHAPTER 18: BIRTH INJURIES

Birth injury is a harm that can happen a baby during the birth process usually in the process of passing through the birth canal a, especially in neonates who require resuscitation.

- Many newborns have swelling or minor bruising as a result of the birthing process.
- Most injuries resolve without treatment.
- Infrequently, more serious injuries occur, such as damage to nerves or a broken bone.

Risk factors

Foetal factors:

- foetal size (birth weight > 4000 g)
- Prematurity
- Abnormal foetal presentation
- Congenital anomalies
- Malpresentation

Maternal factors

- Maternal short stature
- Pelvic anomalies
- Prolonged labour
- Precipitated labour
- Oligohydramnios
- Maternal obesity
- However, birth injuries and associated disabilities are often preventable by carefully monitoring the health of mother and baby these include care throughout pregnancy, childbirth and the neonatal period,

Delivery procedure

- Assisted delivery (vacuum and forceps)

18.1 Soft tissue injuries

These are birth injuries on the soft tissue like bruising, petechiae and lacerations.

Bruising and petechiae

Bruising and petechiae (pinpoint size bleeding spots) are usually self-limiting and are often seen on the presenting part of the newborn's body.

- Bruising and oedema of the genitals are common findings in infants delivered from breech position.
- Petechiae of head and face are often seen after delivery from vertex position, especially with face presentation.
    - Most often, petechiae are present at birth, do not progress, and are not associated with other bleeding.
    - A platelet count should be obtained to rule out thrombocytopenia if petechiae continue to develop or if other bleeding is present.

- Significant bruising is a major risk factor for severe jaundice, therefore follow-up within 2 days after discharge is recommended for newborns with significant bruising.

Lacerations

- Lacerations are the most common birth injury associated with caesarean section delivery (mostly on presenting part, typically scalp and face)
- If mild repair with sterile plaster strips only.
- If moderate or severe, located on the face or ocular area, may require surgery for repair. Refer to facility with expertise.

18.2 Congenital muscular torticollis

- Haematoma of the sternocleidomastoid muscle, usually caused by a difficult delivery (e.g. breech).
- If the sternocleidomastoid muscle is stretched during delivery it may tear, causing bleeding and bruising within the muscle.
- Within the first few weeks fibrosis develops and causes the muscle to shorten and tighten, pulling the newborn's head to one side.

Clinical presentation

- Tilting of the head to one side
- Chin turning toward the opposite side
- Baby struggles to feed more on one side
- Firm, small mass in the middle of the sternocleidomastoid muscle
- Baby avoids turning head to one side

Management

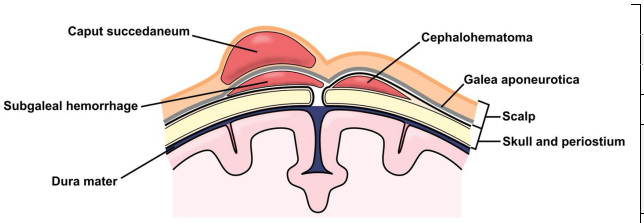
- Physiotherapy with gentle stretching exercises (to help relieve the tension and lengthen the sternocleidomastoid muscle) and massage
- Infant stimulation (to help the infant learn to move and stretch the muscle)
- Surgery (in rare cases if no improvement under physiotherapy)

Aim: to prevent development of further deformities of head, neck and back.

18.3 Extracranial injuries

Extracranial injuries can present as oedema or bleeding into various locations within the scalp and skull.

	TIMING & HISTORY	CLINICAL FINDINGS
CAPUT SUCCEDANEUM	• Apparent at birth • Disappears within 48-72 hours • Caused by prolonged engagement of head in birth canal or vacuum delivery	• **Oedematous swelling within the scalp** • Can be haemorrhagic • **Swelling <u>not limited</u> by sutures** • Firm, not fluctuant • Newborn looks otherwise well
	• **Treatment**: Not required • **Complications**: Rarely superinfection leading to sepsis	
CEPHALOHAEMATOMA	• Apparent within four hours after birth • Disappears within a few weeks to months • Caused by rupture of subperiosteal vessels during birth	• Subperiosteal haematoma • **Rounded swelling, <u>limited</u> by suture lines** • Fluctuant swelling • Newborn looks otherwise well
	Treatment: Not required **Complications**: Calcification persisting over months; jaundice, superinfection, sepsis, osteomyelitis.	
SUBAPONEUROTIC (SUBGALEAL) HAEMORRHAGE	• Apparent at birth or within two hours, expanding over up to several days • Caused by rupture of blood vessels below the aponeurosis above the periosteum, e.g. by vacuum delivery	• Swelling under entire scalp • Spongy feeling of scalp • Very painful • Pallor and tachycardia due to blood loss • Increasing head circumference ⇨ **FBP, bleeding indices**
	Treatment: May require blood transfusion	



Scalp
- Caput succedaneum
Scalp
Galea
- Subgaleal/subaponeurotic haematoma
Periostium
- Cephalohaematoma
Scull

Figure XX: Anatomical illustration of extracranial injuries

18.4 Facial injuries

Facial injuries include cuts and wounds to the face, nose bleeds, a broken nose, and injuries to the eyes and airways

Ocular injuries

- Minor ocular trauma, such as retinal and subconjunctival haemorrhages and lid oedema are common.
- Resolve spontaneously without affecting the infant.

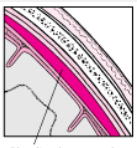
Management

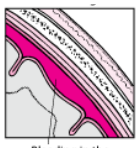
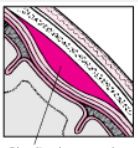
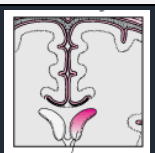
- No treatment required.
- Retinal haemorrhage resolves by 5th day and subconjunctival haemorrhage within one to two weeks.

18.5 Intracranial Haemorrhage

This includes subdural, subarachnoid, epidural and intraventricular haemorrhages, intracerebral and intracerebellar haemorrhages.

Table XX: Differential diagnoses of intracranial injuries

	CLINICAL FINDINGS	INVESTIGATIONS	LOCATION OF BLEEDING
SUBDURAL HAEMORRHAGE (Between dura mater and arachnoid membrane)	**Small SDH**: • Can be asymptomatic • Symptomatic SDH, presents within 24-48 hours, possibly lethal o Respiratory depression, apnoea o Bradycardia o Irritability, seizures, altered level of consciousness to lethargy or coma o Altered tone	• Serial FBP to assess ongoing blood loss • Bleeding indices • Cranial ultrasound (small bleeding might not be visible) • Brain MRI/CT scan	 Bleeding between the arachnoid mater and the dura mater

	○ Increased head circumference, tense/ bulging fontanelle, wide separated sutures		
	Treatment: Conservative, in more severe cases neurosurgery might be required		
SUBARACHNOID HAEMORRHAGE (Rupture of bridge veins in subarachnoid space)	• Often asymptomatic • If symptomatic: ○ Seizures, irritability, lethargy or focal neurological signs in otherwise well-appearing newborn	• Brain CT or MRI (cranial ultrasound not ideal method) • Lumbar puncture will reveal bloody CSF	 Bleeding in the subarachnoid space
	Treatment: Usually conservative		
EPIDURAL HAEMORRHAGE (Between dura and inner table of skull)	• Often accompanied by a linear skull fracture and cephalohaematoma • Seizures, altered level of consciousness. • Apnoea • Hypotonia • Bulging fontanelle	• Cranial ultrasound • Cranial CT	 Bleeding between the dura mater and the skull
	Treatment: • Surgical evacuation is necessary when there is evidence of increased intracranial pressure and/or the EDH is large. • Symptomatic treatment (e.g. anticonvulsants)		
INTRAVENTRICULAR HAEMORRHAGE	• Usually associated with prematurity. • In term newborns it can be due to traumatic delivery,	• Hb • Cranial ultrasound	 Bleeding into the normal fluid-filled spaces (ventricles) of the brain

	asphyxia or coagulation disorders ○ Small bleedings can be asymptomatic ○ For prematurity: refer chapter 2 • **Treatment**: Small IVH in term new-borns will resolve spontaneously with no long-term sequelae. • No specific treatment		
INTRACEREBRAL HAEMORRHAGE	• Usually associated with prematurity, • Less likely with traumatic delivery, asphyxia, infection or coagulation disorders ○ Small bleedings can be asymptomatic ○ Larger bleedings: apnoea, pallor • **Treatment**: Symptomatic • **Prognosis:** Good in small bleedings, poor in large bleedings	• Cranial ultrasound • Cranial CT • Hb	 Bleeding inside the brain

Commented [MOU1]:

18.6 Fractures

A general approach for suspected fractures

- Take a full history including mode of delivery, instrumentation or falls
- Examine the baby thoroughly to exclude any other injuries
- Check both proximal and distal pulses to assess perfusion as well as the colour of the limb
- Observe for the presence of swelling, pain and passive movements
- Document all the findings in the notes
- Obtain the necessary radiological investigation to make a diagnosis or assessment of the severity

Clavicle

- Clavicular fractures are the most common fractures in neonates.
- These fractures are seen in shoulder dystocia or in breech deliveries when the arms are extended
- Macrosomia is the major risk factor

- Timing of diagnosis of neonatal clavicular fractures is dependent on whether the fracture is displaced or non-displaced.

Clinical presentation

Displaced fracture:

- Crepitus and asymmetrical bone contour
- Lack of movement of the affected extremity
- Painful passive movement
- Asymmetric Moro reflex

Non-displaced fracture:

- Usually asymptomatic or painful on touch
- Visible or palpable callous after around one week

Investigation

- Radiograph of the clavicle

Management

- Usually spontaneous healing.
- Reassurance of parents
- Therapy should be directed at decreasing pain with analgesics
- Gentle handling
- Fixing the arm on the chest with the elbow at 90 degrees of flexion (e.g. by pinning the sleeve to the front of the clothes) until a callus begins to form, usually 7-10 days

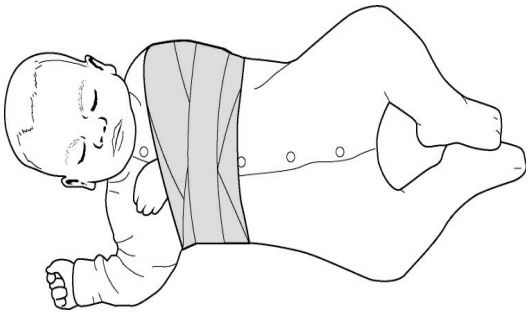


Figure 24: Immobilization of arm

Humerus

- Most fractures occur at the proximal third of the humerus and are transverse and complete.
- Usually occurs in difficult delivery of the arm in breech presentation and/or of the shoulders in vertex. Also may result from direct pressure on the humerus.

- Greenstick fractures may not be noted until a callus forms.

Clinical presentation

- Decreased movement of the affected arm and asymmetric Moro reflex
- Localized swelling and crepitation
- Increased pain response with palpation and movement of the arm

Investigations

- Plain radiograph of the affected arm

Management

- Gentle handling
- Analgesia for pain management
- Splinting of the fractured humerus for up to 2 weeks
- Displaced fractures may require closed reduction and casting.
- The prognosis is excellent with complete healing expected

Femur

- Fractures of the femur as a result of birth trauma are rare.
- The fracture is typically spiral and involves the proximal half of the femur.
- Usually occurs in breech delivery and infants with congenital hypotonia are at increased risk.

Clinical presentation

- Pain response upon manipulation of the affected extremity
- Swelling of the affected leg may be present
- Decreased movement of the affected limb

Investigation

- Plain radiograph of the leg

Management

- Analgesics for pain
- Bryant traction
- Pavlik harness
- Spica cast

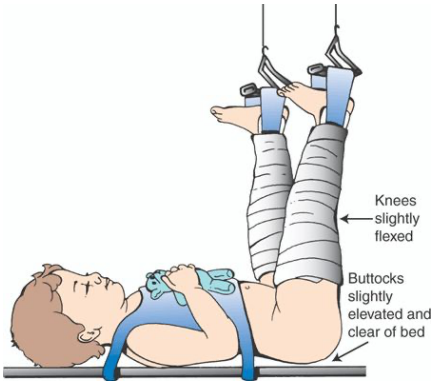


Figure XX: Bryant traction

Skull

Skull fractures as a result of birth trauma include linear and depressed skull fractures; the latter is often due to forceps delivery.

Clinical presentation

- No specific clinical features for linear fracture
- Palpable bony defect, sometimes accompanied by neurologic complications for depressed fracture
- Findings should alert to look for more serious intracranial trauma

Investigation

- Plain radiograph of the head
- Cranial CT scan

Management

- Observation if linear fracture
- Neurosurgery might be needed for some cases of depressed fracture
- If leakage of CSF from nose or ears is noted, antibiotics therapy should be started and neurosurgical consultation obtained immediately.

18.7 Dislocations

- Dislocations caused by birth trauma are rare.
- In many cases, the dislocations, especially of the hip and knee, are due to intrauterine positional deformities or congenital malformations.
- One example is the genu recurvatum.

Genu recurvatum

- Unilateral or bilateral backward bending of the knee (without dislocation, with subluxation or with complete dislocation).
- It can be an isolated deformity or part of a syndrome.



Figure XX: Genu recurvatum

Management

- Depending on severity:
  - Serial casting or surgical treatment by orthopaedic surgeon
  - Start treatment within the first week of life.
- Aim: to bring the leg back into its normal axis.
- Follow-up is needed at least until the child is walking.

18.8 Nerve injuries

Clinical presentations

- Weakness in the innervated area of the affected nerve
- Signs of the injury that led to the nerve injury (e.g. swelling, fracture, pain)

Table XX: Nerve injuries

Nerve injuries			
	History	**Clinical findings**	
BRACHIAL PLEXUS INJURY (ERB OR KLUMPKE)	• Difficult delivery (e.g. breech delivery, big baby, shoulder dystocia) • Risk factors: maternal diabetes, macrosomia, shoulder dystocia, malpresentation and instrumented deliveries.	• Arm and hand lying limply by the newborn's side • No spontaneous arm movement on one side • Asymmetric Moro reflex • Grasping reflex present in Erb palsy, not present in Klumpke palsy • Klumpke palsy can be associated with ptosis, miosis and enophthalmos (=Horner syndrome)	
	Treatment: ○ Thorough exam to exclude clavicular fracture and paralysis of the diaphragm ○ Initial treatment is mainly conservative		

<table>
<tr><td></td><td colspan="2">

Physiotherapy and passive range of motion exercise on the affected arm to prevent contractures
Wrist and digits splints may be useful

• Follow-up:

Weekly, then 2-weekly

• Prognosis:

Mostly complete healing within 3-9 months.
20-30% of affected newborns may have persistent deficits
If still not much improvement after 3 months refer to neurosurgery

</td><td></td></tr>
<tr><td rowspan="2">FACIAL PALSY</td><td>
• Difficult delivery,
• Facial trauma,
e.g. due to forceps delivery
</td><td>
• Asymmetrical crying facies
• Unable to wrinkle forehead
• Unable to close eye of the affected side
• Angle of the mouth pulled to not-affected side
• Nasolabial folds flattens
• Dribbling milk while suckling
</td><td rowspan="2">  </td></tr>
<tr><td colspan="2">
Treatment:

Artificial tears four times daily to keep eye moist until newborn can close the eye.
Protecting the open eye by patching
Support mother with feeding, alternative feeding methods if required

Follow-up: Weekly
Prognosis:

Usually resolves spontaneously within 2-3 weeks

</td></tr>
</table>

7676

7677

CHAPTER 19: NURSING CARE IN THE NEONATAL UNIT (NCU)

Nursing care in neonatal unit is a key component of neonate survival. In a neonatal care unit (NCU), nurses play a pivotal role in ensuring successful outcomes for newborns, particularly those who are premature, critically ill, or require specialized care. Nurses in a neonatal care unit are integral to providing comprehensive, compassionate, and effective care. Their expertise in monitoring, treating, educating, and supporting both neonates and their families is essential for achieving positive outcomes and fostering a nurturing environment in the NCU. This section highlights a detailed look at the essential roles and responsibilities of nurses in a neonatal care unit:

1. Clinical Care and Monitoring

- **Assessment**: Continuously monitoring and assessing the neonate's vital signs, including heart rate, respiratory rate, temperature, and blood pressure, oxygen saturation and blood sugar levels helps early detection and aids in addressing any deviations from normal patterns promptly.
- **Treatment Administration**: Administering medications, IV fluids, and other treatments as prescribed by the healthcare team while ensuring accurate dosing and monitoring for side effects or adverse reactions is very crucial in efficiency and accuracy of neonatal care and treatment.
- **Equipment Management**: Daily operation and monitoring as well as performing routine checks on complex neonatal equipment such as incubators, ventilators, CPAP machines and phototherapy units ensures that all equipment is functioning correctly.

2. Specialized Care

- **Thermal Regulation**: Maintenance of optimal body temperature for small and sick neonates, particularly those who are extreme premature or severely-ill using incubators or radiant warmers as needed.
- **Nutritional Support**: Overseeing feeding, whether through breast milk, formula, or specialized nutrition as well as assist and guiding parents with feeding techniques, including tube feeding if necessary, and monitoring for feeding tolerance.
- **Respiratory Support**: continuous managing and monitoring respiratory support, including supplemental oxygen, CPAP or mechanical ventilation by ensuring proper settings and adjustments are done timely as needed based on the neonate's condition and consultation with medical team.
- **Cardiovascular support**: continuous monitoring of cardiovascular status through vital signs monitoring, perfusion assessment, and blood gas analysis. Accurate administration of medications such as inotropic agents, vasopressors and antihypertensive in order to manage and stabilize severely sick newborns.
- **Emergency Interventions**

  -Resuscitation: all nurses working in the NCU should be equipped with knowledge and skills to respond quickly and effectively perform neonatal resuscitation if cardiac arrest occurs, following established protocols such as neonatal Advanced Life Support (NALS) and Neonatal Resuscitation Program (NRP).

  -Shock Management: All nurses working in the NCU should have knowledge and skills to correctly Identify and treat or promptly report to senior medical staff when shock is detected and identifying type of shock, whether hypovolemic, cardiogenic, or distributive, and provide appropriate interventions to restore cardiovascular stability.

3. Family Support and Education

- **Parental Guidance**: nurses in the NCU should be equipped with knowledge and skills to educate parents on neonatal care, including feeding, diapering, and recognizing signs of distress. Provide emotional support and answer questions to help parents feel involved and informed.
- **Family Interaction**: Encouraging and facilitating family bonding, including skin-to-skin contact (kangaroo care) and allowing family members to participate in care routines when possible.
- **Emotional Support**: Offer psychological support to parents, particularly when dealing with stressful or uncertain situations. Provide resources for counseling or support groups if needed.

4. Interdisciplinary Collaboration

- **Team Communication**: Collaborate with neonatologists, pediatricians, pharmacists, respiratory therapists, lactation consultants, and other healthcare professionals to develop and implement individualized care plans.
- **Care Coordination**: Coordinate with the healthcare team to ensure that all aspects of the neonate's care are addressed and that the care plan is updated as needed.

5. Documentation and Reporting

- **Accurate Record-Keeping**: Maintaining detailed and accurate records of the neonate's condition, treatments, responses, and any changes in their health status for record keeping and quality improvement.
- **Reporting**: Communicate significant findings, changes, or concerns to the healthcare team promptly to ensure timely interventions.

6. Infection Control

- **Adherence to Protocols**: Follow strict infection control measures, including hand hygiene, use of personal protective equipment, and sterilization practices to prevent the spread of infections.
- **Monitoring for Infections**: Monitor neonates for signs of infection and initiate appropriate interventions if an infection is suspected.

7. Developmental Care

- **Supportive Environment**: Implement developmental care practices to minimize stress and promote the neonate's sensory and emotional development. This includes gentle handling and creating a calming environment.
- **Family-Centered Care**: Advocate for and incorporate family-centered care practices to support the emotional and developmental needs of both the neonate and their family.

8. Emergency Preparedness

- **Crisis Management**: Be prepared to respond to emergencies, such as sudden changes in a neonate's condition or resuscitation scenarios. Provide immediate and effective interventions to stabilize the baby.
- **Training**: Continuously update skills and knowledge related to neonatal emergencies and advanced care techniques.

9. Quality Improvement

- **Participate in Protocols**: Engage in continuous quality improvement initiatives to enhance care practices and outcomes in the NCU such as developing SOPs and guidelines.
- **Feedback and Education**: Provide feedback on protocols and participate in ongoing education to stay current with best practices and emerging research in neonatal care.
- **Participate in QI initiatives**: Identifying areas for improvement, and developing and implementing strategies to improve care in the unit.

Nursing care procedures in the neonatal unit (NCU)

S.N	Procedure	Steps
1.	Triage(Admission)	**Check for emergency signs** • Check whether there is any airway or breathing problem; start immediate treatment to restore breathing. • Quickly check whether the child is in shock or has diarrhoea with severe dehydration. Give oxygen and start IV fluid resuscitation. • Quickly determine whether the child is unconscious or convulsing. Give IV glucose for hypoglycaemia and/or an anti-convulsing for convulsing. **In case of emergency signs are found:** • Call for help from an experienced health professional if available, but do not delay starting treatment. Stay calm and work with other health workers • Carry out emergency investigations (blood glucose, blood smear, haemoglobin [Hb]). **If no emergency signs are found, check for priority signs:** • Tiny infant: any sick child aged < 2 months • Temperature: child is very hot • Trauma or other urgent surgical condition • Pallor (severe) • Poisoning (history of) • Pain (severe) • Respiratory distress • Restless, continuously irritable or lethargic • Referral (urgent) • Malnutrition: visible severe wasting • Oedema of both feet **NOTE**: With all newborns, the nurse should perform a complete assessment and assess for symptoms of illness like: • Poor feeding, Poor suck, Sweats during feeding, Increased sleep • Changes in muscle tone, Decreases in activity • Change in color, Unusual cry, or moaning or groaning • Tachypnea, Repeat calls from parents • Monitor vital signs and Check RBG

		• Change baby clothes and diaper • Respond to emergency appropriately-make a triage decision using an established protocol or guideline
2.	Breast feeding /Cup feeding	• Encourage positioning and breast attachment (Refer SOPs) • If the baby is not sucking instruct on how to express the milk • Teach the mother to feed by a cup, cleaning, boiling and storage of the cup. • Recommended amount of feeding refer to the guideline • Feed preterm two hourly and term baby three hourly • Encourage exclusive breast feeding for the first 6 months • Assist on how to express the breast milk in case the baby cannot breast feed **Positioning and attachment** o Instruct the mother on how to hold her newborn comfortable o However, there is ‘‘NO’’ one ‘correct’ position for breastfeeding. o We must not be rigid about positioning. o If a newborn is gaining weight, growing well and is healthy, the mother and newborn should continue to feed in a way which is comfortable for **Assist mother with positioning for breastfeeding** o Head and body in a straight line. Face opposite the nipples o Neck not flexed. Whole body supported very close to mother’s body both of them and which maintains good attachment **Cup Feeding—how to clean the cup emphasize** • Use a small cup that matches the baby’s mouth • Measure the amount of breastmilk • Make sure the baby is awake before starting feeding • Hold the baby in semi-upright position on the lap • Touch the baby's lower lip with the cup • Gently pour the milk to the edge of the cup to stimulate sucking reflex • Avoid pouring milk into the baby's mouth; instead allow sucking • Make sure the baby swallows regularly • Allow the baby to pause while feeding • Do not remove the cup until the baby finished the calculated amount • After feeding, belch the baby
3.	Inserting a Nasogastric Tube (NGT)/oro.gt Feeding Medication by NGT	**Inform the mother** about the procedure and its purpose **Wash your hands** with soap and water **Prepare the equipment** • Appropriate of size NGT, • lubricant or hot water • 10 ml syringe • Cup with breast milk • Gloves • Plaster • Stethoscope

		Insert the NGT • Place the baby on its back and slightly extend their head • Measure the NGT length • Place the end of the feeding tube at the tip of the baby's nose and measure to their earlobe, then to the xiphoid • Mark the tube at this point with a marker pen • Lubricate the NGT with breast milk • Insert the NGT slowly into one nostril, while pointing towards the earlobe • Keep inserting the NGT until the mark appears just outside the baby's nose • **Confirm the NGT location** • Do not put anything down the tube if you are unsure of the tube position and correct placement cannot be confirmed. • Carefully secure the NGT with plaster • Withhold feeding in case of vomiting, coughing, choking, Changes in color. • Dispose of used equipment in accordance with IPC regulations • Exchange the NGT after 1 week of use or whenever dislocated/removed • Check position and securing NGT tube appropriately • Flush the NG tube by breast milk after feeding/ medication .[2]
4.	Assessment/Monitoring of vital signs	• Temperature, heart rate, respiration, oxygen saturation and blood pressure (Refer SOP) • All vital signs must be documented in the respective observation chart with the correct date and time/RBG • Analyze the newborn vital signs
5.	Positioning and nesting of a newborn baby	• Change newborn position as recommended (See neonatal guideline) The optimal position includes • • Encourage Nesting • Ensure the room is at a comfortable temperature, as neonates are sensitive to cold. • Minimize noise and distractions to create a calm atmosphere. • Place the neonate in a comfortable position(supine), • Use a soft, breathable blanket to swaddle the neonate snugly, providing a sense of security. • Use soft, dim lighting to create a peaceful environment. • Reduce the frequency of handling to allow the neonate to settle and nest comfortably. • Ensure the neonate is fed before attempting to nest, as hunger can disrupt comfort. • Check and change diapers as needed to maintain comfort. • Position baby in prone with arms flexed, elbows tucked and hands near face. Legs tucked up under trunk and feet positioned with big toes together "toe-to- toe" (avoid excessive external rotation/abduction). ensure they do not slide lower down the chest

6.	Care of the newborn with jaundice	• Encourage breast feeding 3 hourly [3][4] • Bathing and massaging of neonates [5] • Undress the baby completely. • The baby's eyes are protected by an opaque mask • The eye shield should be properly sized and correctly positioned. • The baby's eyelids are closed before the mask is applied • On each shift check eyes for discharge, excessive pressure on the lids or corneal irritation • Removed eye shields during feedings, to provide visual and sensory stimulation. • During breastfeeding switch off the photo therapy unit. • Turn the baby after each feed to expose maximum surface area of baby to light. • Keep baby at a distance of 45 cm from the light source. **Note** Observe and check the functioning of biomedical equipment's (check functioning of the equipment's in newborn unit.eg phototherapy, CPAP machine etc.
7.	Monitoring of Oxygen saturation	• Make sure the **sensor is attached well** • Wait until **reading is stable** *(Oximeters take a short time to start reading properly)* • Make sure the **waveform is equable and steady-going** • Make sure the wire probe is not crossing the neonate body. (Refer SOPs) • Change pons
8.	Drug/Fluid administration	• Consider eight drug rights, • assessing an IV site. • Insert IV line • Calculating IV rates. Formula IV drip rate =Volume(ml) x Drop factor Time (minutes) • Re-use the diluted drug for only 24 hours. • Adhere to IPC [2]
9.	Care of neonate with Intravenous fluid	• Regularly check heart rate, respiratory rate, temperature, and blood pressure. • Monitor for signs of dehydration or fluid overload. • Inspect the insertion site for redness, swelling, or signs of infection. • Ensure the correct fluid type, rate, and dosage as prescribed. • Ensure the IV line is properly secured to prevent dislodgement. • Utilize an infusion pump to regulate the flow rate accurately. • Document the amount and type of fluids administered. • Record any changes in the neonate's condition, including vital signs and signs of complications. • Provide information to parents about the purpose of IV fluids and what to expect.

		• Collaborate with the healthcare team to report any concerns or changes in the neonate's condition. • Be vigilant for signs of infiltration (fluid leaking into surrounding tissue) and phlebitis (inflammation of the vein). • Ensure the neonate is comfortably positioned to minimize stress and promote proper circulation. • Maintain an appropriate temperature to prevent hypothermia. • Be prepared to respond to signs of adverse reactions or complications such as anaphylaxis or fluid overload. • discontinuing a peripheral IV PRN • Flush the IV line before drug administration • Change the IV line after 3 days (But if it is working can remain) • Replace tapes if they look dirty or are starting to come loose • Apply normal saline/liquid oil before removing the adhesive tap • Dilute ampoules (injection gentamicin, aminophylline, phenobabitone etc.) in a labeled (date and time) 10cc
10.	Blood transfusion	• Standard precautions must be used when administering/disposing of blood products • Use aseptic non-touch technique when delivering all blood products. • Commence the transfusion as soon as possible or within 30 minutes of the blood product arriving to the unit. • Check baseline vital signs • Check the neonate's medical history for any previous transfusions or reactions. • Confirm blood type and cross-match results • Ensure informed consent is obtained from the parents or guardians. • Prepare the necessary equipment • Inspect the blood bag for any leaks, clots, or discoloration. • Use strict aseptic technique to prevent infection. • Begin the transfusion at a slow rate while closely observing the neonate. • Check vital signs every 15 minutes during the first hour • Be vigilant for any signs of transfusion reactions, such as fever, rash, or difficulty breathing. • If a reaction occurs, stop the transfusion immediately • Monitor and document vital signs after the transfusion is completed. • Check hemoglobin and hematocrit levels as ordered to assess the effectiveness of the transfusion. • Inform parents about the purpose of the transfusion and what to expect. • Provide reassurance and emotional support to the family throughout the process. • Document all relevant information, including the start and end times, volume transfused, and any reactions observed. • Ensure emergency equipment is available in case of an adverse reaction. • Fill the blood filter to the line on the drip chamber by gently squeezing and releasing the drip chamber. • Expel all air out of the extension tubing set. • Prior to connecting to the patient ensure the correct volume of blood. • Label IV set including correct patient details. • Flush cannula post transfusion

11.	Oxygen administration	• Inform, prepare environment, and equipment • Select appropriately the nasal prom • Correctly apply oxygen equipment. • Set flow rate using fixed and portable equipment. • Survey the environment for potential safety hazards. • Use pulse oximetry. • Assess patient response to oxygen therapy
12.	Mechanical ventilation	• Ensure that a manual ventilation bag (MVB), mask, and suction are immediately available in case of sudden changes in the newborn baby's condition or in the event of ventilator failure • Inspect the ventilator equipment and settings. • Assess the ventilator alarm status. ○ Assess the newborn baby's vital signs and cardiopulmonary stability, including spontaneous respiratory rate, chest expansion and response to mechanical ventilator cycling. • Auscultate the newborn baby's breath sounds, including upper and lower lung fields and differences in left and right lung fields. • Assess the newborn baby for signs of ventilatory failure, including increased $PaCO_2$, decreased arterial oxygen saturation (SaO_2), increased work of breathing, tachypnea, and increased retractions. • Assess the newborn baby for signs of hypoxemia, including decreased SaO_2, pale or cyanotic color, tachycardia or bradycardia, tachypnea, agitation, increased work of breathing, increased retractions, and acidosis. • Assess radiographic findings, blood gas analysis, and the newborn baby's clinical status for indications that weaning from the ventilator can be initiated. • Ensure that the head of the bed is slightly elevated, unless contraindicated. • Assess the need for suctioning. Signs that may indicate a need for suctioning include: ○ Visible secretions in the endotracheal tube ○ Coarse or decreased breath sounds ○ Changes in vital signs ○ Decreased oxygen saturation ○ Decreased chest wall movement • Suction as needed. • Respond immediately to ventilator alarms and watch for changes and fluctuations in prescribed settings, which may indicate water in the tubing or the need for suctioning. • Document the procedure in the newborn baby's record. • Review the ventilator settings at the beginning of each shift and with every vital sign assessment. • At the beginning of each shift, confirm that all alarms are activated. • Auscultate breath sounds and monitor chest excursion, spontaneous effort, air entry, and the newborn baby's color as the condition warrants.

		• Monitor signs of changes in oxygenation and ventilation, including lung sounds and aeration of lung segments, vital signs, oxygen saturation, $PtCCO_2$ and partial pressure of transcutaneous oxygen ($PtCO_2$) as appropriate, arterial or capillary blood gases, cyanosis, work of breathing, adequacy of chest excursion, and chest radiography findings. • Monitor and document SaO_2 values as needed or more frequently if warranted. • Monitor blood gases as indicated, typically after initiation of assisted ventilation, after significant changes in ventilation settings, and with changes in the newborn baby's condition. • Monitor gastric insufflations and remove air from the stomach as indicated. • Provide oral care as needed when performing hands-on care. • Monitor for signs of unplanned extubation, including the sudden deterioration in clinical status, decreased oxygen saturation or $PtCO_2$ readings, abdominal distention, crying, decreased chest wall movement, breath sounds in the abdomen, agitation, cyanosis, or bradycardia. • Assess, treat, and reassess pain.
13.	Nursing a neonates with CPAP	• Continuous heart rate, respiratory rate and oxygen saturation monitoring with 6hrly blood pressure checks • Hourly observations should be performed and recorded for each infant. • Staff should be vigilant for signs of pain and discomfort or distress and should seek to modify baby's environment and offer care where appropriate • There is a risk that babies' noses become squashed and pushed upwards or damaged whilst receiving CPAP, correct positioning should be used to prevent this • Ensure correct size and fit of hat • The area behind a baby's ears can become moist with dead skin collecting there under the CPAP hat, so should be checked and cleaned at least daily • Time and care should be taken to ensure that CPAP is secure, well-fitting and safe. • Rotate the use of nasal prongs and nasal mask for a baby receiving CPAP. Usual 4- 6 hourly • There should be careful monitoring of skin integrity of the nares, as there is a high risk of damage to the external skin and/or internal membranes of the nose. • Due to a risk of air building up in the baby's stomach, all babies on CPAP should have a nasogastric tube in situ. • If the baby is stable parents/carers should be encouraged to have cuddles and skin to skin care with their baby • The hat should be changed when dirty or elasticity is lost. • Prongs should be changed once a week, or sooner if necessary • Change the CPAP machine after 7days
14.	Bed making /Promote quality sleep	• Make the bed neat, change bedsheets daily and whenever necessary • Maintain quite environment

		• Place a baby on their back to sleep and make sure they can breathe Easily-Change position • Protect against mosquito bites. Use mosquito net • Avoid unnecessary noises • Refer neural developmental chapter
15.	Newborn bathing /Diaper changing	• Wipe the baby dry and clean and delay the first bath for at least 24 hours. • Keep the baby warm with one or two layers of clothes and keep the head covered with a hat. • Have the baby tested for eye and hearing problems and for jaundice. • During change of diaper observe stool note color, smell, amount, presence of mucoid blood
16.	Kangaroo Mother Care (KMC)/Thermal care for premature and low birth weight babies	• Counsel the mother and family to give support • Encourage continuous skin-to-skin contact with mother, father, or another caretaker • Exclusive breastfeeding/Expressed breast milk depending with newborn condition and body weight (Refer breast feeding chart) • Promote supportive environment for KMC • Dress the neonate (cap, socks and diaper before skin to skin contact) • Weigh the neonate daily
17.	Referral Management	• Prepare the neonate (Stabilize, Check *RBG, vital signs, and* Insert functional IV-line, Give necessary treatment) • Communicate, escort and continue monitoring newborn
18.	Discharge of a neonate from NCU	• Keeping newborn warm, • Encourage exclusive breastfeeding for first 6 months • Teach about, cord care, eye care, and encourage newborn immunization • Teach about newborn danger signs • Remind about follow up clinic • Encourage Bathing of neonate • Cleaning of cups and other feeding equipment • Milk storage guidance in case of woman who expressing mill/ alternative feeding • The quiet and comfortable home environment (avoid noises, extreme light and heating) • Teach about administration of medication safely [6] • Immunization – make sure all newborns with LBW are immunized the same way as term newborns • Follow-up on bathing of the newborn • Discuss position during discharge

References

1. United Republic of Tanzania. National guideline for neonatal care and establishment of neonatal care unit. 2019; 88, 116–117.

2. NHS. Patient Information Nasogastric (Ng) Tubes for Neonates. 2022.

3. Tyas APM, Nurvianti SA, Mardhika A, Medawati R, Lutfiandini CT, Lestari WAE. Nursing Care of Neonatal Jaundice in Hyperbilirubinemia Babies: a Case Report. J Vocat Nurs. 2021;2: 105. doi:10.20473/jovin.v2i2.30527

4. Foster J, Pathrose SP, Briguglio L, Trajkovski S, Lowe P, Muirhead R, et al. Scoping review of systematic reviews of nursing interventions in a neonatal intensive care unit or special care nursery. J Clin Nurs. 2024;33: 2123–2137. doi:10.1111/jocn.17053

5. Zühal Çamur, Çiğdem Erdoğan, Deniz Akyıldız EK. The effect of massage and bathing on bilirubin levels in newborns with hyperbilirubinemiaNo Title. J neonatal Nurs. 2024.

6. Anderson, N. and Narvey M. Discharge planning of the preterm Infant. Can Paediatr Soc. 2022.

1. Aziz, K. and others. (2020). Part 5: Neonatal resuscitation: 2020 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation, 142*(16 Suppl. 2), S524-S550. doi:10.1161/CIR.0000000000000902 Retrieved June 25, 2024, from https://www.ahajournals.org/doi/10.1161/CIR.0000000000000902

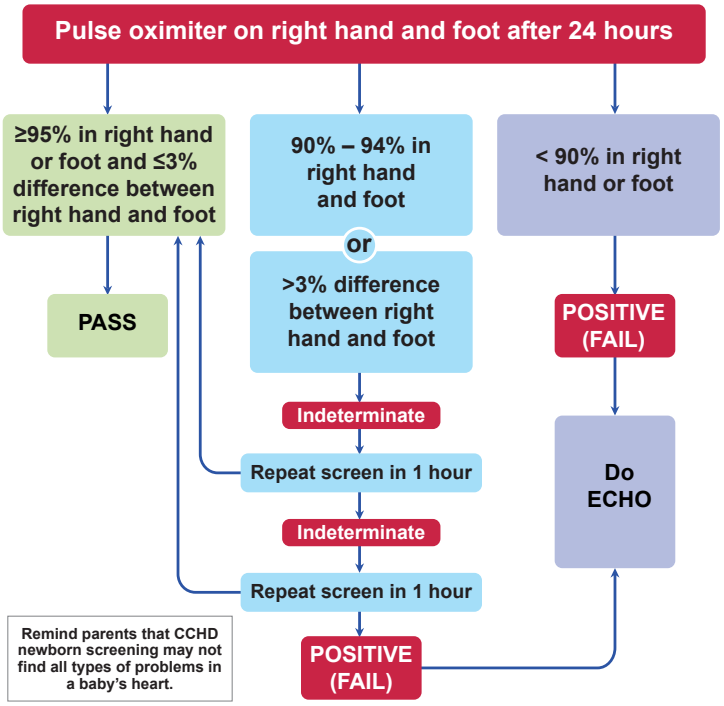
CHAPTER 20: NEWBORN SCREENING

The newborn screen involves a specific set of laboratory evaluations and point-of-care examinations performed on all newborns (universal screening). It enables early detection of disorders that may not be apparent at birth and cause significant morbidity, mortality, and intellectual disabilities.

WHO recommendations (2022) for universal screening including detection of abnormalities of eyes, hearing impairment, and hyperbilirubinemia, other screening including pulse oximetry, screening for hypothyroidism, sickle cell screening, screening for intraventricular hemorrhage, and retinopathy of prematurity and inborn errors of metabolism

Screening	Population	Time	Equipment/Test	Remark
Critical congenital heart disease	All newborns	After 24 hours OR At discharge whichever comes first	A pulse oximeter placed on the right hand and any foot	A positive test (FAIL) needs ECHO and further evaluation
Hyperbilirubinemia	All newborn	At Risk (Mother blood group O/Rh-ve or sibling with previous significant hyperbilirubinemia): 6hrs, then within 72hrs and at 7 days of life Others: At discharge, then at 72hrs and 7 days of life	-Transcutaneous bilirubinometer -Alternatively use any POC	Compare to Normogram: If high -Obtain Total serum bilirubin level (TSB) -Phototherapy and further evaluation
Red light reflex	All newborn	At discharge Or First postnatal contact	Ophthalmoscope	Refer to an ophthalmologist for abnormalities detected
Congenital Hypothyroidism	All newborn	At birth (Using cord blood) Or After 72hrs - 7 days of life	Serum TSH and T4	Refer to endocrinologist **Treatment started within 2 weeks of life**
Sickle cell	All newborn	After 72hrs - 7 days of life	- Hb electrophoresis -HPLC -Thin layer isoelectric focusing (IEF)	If positive -Close monitoring -Prophylactic folic acid & Penicillin V
Hearing loss	All newborn	At discharge Or First postnatal contact (Within 1st month of life)	-Otoacoustic Emission (OAE) -Automated Auditory Brainstem Response (AABR)	If fail test result refer to ENT for hearing test (ABR) within 3 months

7804



7805

7806

7807

NEWBORN HEARING SCREENING ASSESSMENT FORM

PART 1 – DEMOGRAPHIC INFORMATION

Newborn's Name_____**DOB:** _____Birth Weight____**Sex**_____

Parent/guardian's contact/tel: _____**Address** _____

Screening location_____**Date**: _____

PART 2 – RISK FACTORS FOR HEARING LOSS

1. Tick the appropriate risk factor

RISK FACTOR	**YES**	**NO**
Family history of hearing loss		
Intrauterine Infections		
Prematurity		
Low birth weight		
Neonatal jaundice		
Use of ototoxic medications		
Meningitis		
Craniofacial abnormalities		
More than 5 days of hospitalization at NICU		
Others, specify		

PART 3 – VISUAL INSPECTION

1. Is there obstruction or drainage from either ear?
   Yes (Consult for treatment) **NO (Proceed)**
2. Are there any facial abnormalities present? (NOTE: For ABR)
   Yes (Consult for further evaluation) No (Proceed)

PART 4 – HEARING SCREENING RESULTS (OAE/AABR)

Ear tested	Initial Screening	Re-screening
Left	PASS/REFER	PASS/REFER
Right	PASS/REFER	PASS/REFER

PASS is a hearing test result that the newborn exhibited normal hearing function in both ears at the time of the screen

REFER is a hearing test result that the newborn did not pass the hearing screen in one or both ears

Follow-up Plan …….

Recommendations to parents/Guardian…….

Name of Screener ……..... Signature ……. Date ……..

CHAPTER 21: FOLLOW UP AND CONTINUUM OF CARE

The continuum of care for all newborn infants involves a comprehensive approach to ensure they receive the necessary medical attention from birth through recovery and follow-up for them to survive, thrive and transform. The components of this continuum include:

Skilled Birth Attendance: Ensuring a skilled health professional is present during delivery. Clean safe deliver, management of Second and third stage of labour, prevention of PPH, immediate skin to skin, breast feeding within the first hour of life, administration of vitamin K and prevent, identify and treat neonatal sepsis.

Normal neonate: Parents/Guardian be counselled by health care providers before discharge of the newborn from health facilities to observe for danger signs, on how to continue the provision of essential newborn care at home, follow immunization schedule as per national Immunization Vaccine Development guideline, continue with exclusive breast feeding for the first 6 months of life then give appropriate weaning diet (Refer National Child health booklet), and attend RCH clinic for growth and early childhood development monitoring.

Discharge and Follow-up: Educate parents on newborn care, early recognition of danger signs and observing any abnormal symptoms.

- Ensuring proper feeding practices: For preterm and low birth weight neonates refer feeding management chapter XX, those with special conditions like cleft palate and swallowing difficulties like birth asphyxia should be referred to appropriate level for care.

- Scheduling follow-up visits to monitor growth, development progress and address any ongoing health issues such as screening for retinopathy of prematurity, metabolic bone disease and hearing.

- Multidisciplinary Teams: Collaboration between pediatricians, neonatologists, nutritionists, social workers, and other specialists to provide comprehensive care.

- Integrated Services: Ensuring that various health services are coordinated and accessible to the family.

- Home Visits: Health workers visit the home to provide postnatal care, monitor the newborn's health, and support breastfeeding.

21.1 High risk neonates:

- These neonates include Small and Sick neonates, like preterm, neonates with severe jaundice with exchange blood transfusion, sepsis, birth asphyxia and congenital malformations. These should be admitted in the Neonatal Care Units according to the level of care to receive appropriate management. Parents/Guardians should be educated, supported and involved in the care process during hospitalization and beyond.

Neonates born with high risks should be followed and checked for neurodevelopment attainment as per below chart.

Condition	Age at follow-up	Assessment to be performed	Intervention
Extreme VLBW	Every 2 weeks until 6 months or until attained catch-up growth.	1. Growth monitoring- weight, length, head circumference using FENTON chart 2. Feeding assessment using LATCH score and PIBB Score - EBF 3. Retina screening for Retinopathy of Prematurity 4. Hearing screening- Assessment of Brain Stem Responses 5. Anaemia of prematurity screening 6. Metabolic Bone disease screening (Alkaline Phosphatase, X-ray of the wrist)	1. Counselling for appropriate feeding and growth 2. Lactation management 3. Refer to Ophthalmologists in case of suspected ROP 4. Refer to speech and Audiology specialist 5. Iron and Folate supplementation 6. Vitamin D, Calcium and Phosphate supplementation
	Once monthly from 6 months to	1. Growth Monitoring as above 2. MUAC	1. Feeding counselling 2. ECD stimulation for sensory-

	until 2 years.	3. Early Childhood Developme nt screening	motor and speech
	After 2 years until 5 years, every 3 months.	1. Growth Monitoring as above 2. MUAC Early Childhood Development screening	1. Cognitive stimulation 2. Feeding counselling
Birth Asphyxia (moderate -severe) Day 7 HIE Thompson score	1. Every month until 2 years 2. After 2 years to 5 years every 3 months	1. Growth monitoring- weight, length, head circumferen ce 2. Vision Assessment for blindness 3. Hearing screening	1. Feeding as per condition of the child like inserting NGT/OGT, Gastric-stoma tube 2. Physiotherap y- positioning and handling to prevent contractures 3. ECD stimulation for sensory-motor and speech
Severe Jaundice at Blood exchange level	1. Every 2 weeks until the jaundic e is not detecta ble clinicall y 2. Thereaf ter monthly until 2 years 3. Thereaf ter every 3	1. Growth monitoring- weight, length, head circumferen ce 2. Vision Assessment for blindness 3. Hearing screening 4. Anaemia screening	1. Feeding counselling 2. ECD stimulation for sensory-motor and speech 3. Supplement ation as per anemia screening results

	months until 5 years		
Failure to thrive-extrauterine growth restriction	1. Once monthly until catch-up growth attained.	1. Growth monitoring-weight, length, head circumference 2. Screening for Congenital Heart Disease 3. Screening for Anaemia 4. Screening for Sepsis - late onset	1. Feeding counselling 2. Supplementation as per results of anaemia screening 3. Antibiotics as per results of screening

Note: Neonates that need referral should be stabilized and transferred to appropriate level of care as per referral guideline and protocol.

Community and Home-Based Care: Community health workers (CHWS) should be engaged to provide ongoing support and education to families, capacitated to identify danger signs and promote healthcare seeking behavior at community level.

- Community health workers should be a link between the community and health facilities.

21.2 Policy and Health System Support:

- **Health Policies:** Implementing policies that support maternal and child health, including access to healthcare services.
- **Resource Allocation:** Ensuring adequate resources, including staff, equipment, and medications, are available to support the continuum of care.
- **Social security support:** Home school for disabled children, National health Insurance benefit package for young infant and nutritional support. To provide economic upliftment for women with young infants and priority care.

References

1. National Child health booklet, Ministry of Health Tanzania.

2. Blencowe H, et al. Preterm birth-associated neurodevelopmental impairment estimates at regional and global levels for 2010. Pediatr Res. 2013. PMID: 24366461.

3. Blencowe H, et al. Estimates of neonatal morbidities and disabilities at regional and global levels for 2010: introduction, methods overview, and relevant findings from the Global Burden of Disease study. Pediatr Res. 2013. PMID: 24366460. .

4. Hurt L, Odd D, Mann M, et al. What matters to families about the healthcare of preterm or low birth weight infants: A qualitative evidence synthesis. *Patient Educ Couns* 2023; **115**: 107893.

5. National Institute for Health and Care Excellence (NICE) United Kingdom 2020. https://www.nice.org.uk/guidance. Accessed 11Dec2022.

6. World Health Organization. Survive and thrive: transforming care for every small and sick newborn. Geneva: World Health Organization; 2019. Licence: CC BY-NC-SA 3.0 IGO.

21.3 Use of Neonatal Data for Quality Improvement

Neonatal mortality and morbidity continue to pose significant public health challenges. Critical issues such as low birth weight, inadequate breastfeeding practices, and limited access to essential neonatal care persist[1].

Health Management Information Systems (HMIS) enhance routine health facility-based data management. It is composed of facility-based health records used for routine health service management, providing indicators for data on morbidity, mortality, health infrastructure, and service coverage.

The effectiveness of a health information system depends on collecting, analyzing, interpreting, and utilizing the information correctly at all levels.Quality improvement (QI) initiatives, supported by robust data collection and analysis, are crucial for identifying gaps in care, informing policy, and guiding interventions. The use of data for QI can lead to significant improvements in healthcare delivery and outcomes for newborns.

Components of data management include:

- Data collection and quality assurance
- Data analysis
- Data use

Data collection and quality assurance:

- Availability of data collection tools at health facility.
    - paper based- Neonatal register, Kangaroo Mother Care register, tally sheets and summary forms.
    - electronic medical system (should retain paper- based collection tools).
- Data accuracy that reflects care provision and free of error.
- Data completeness reflecting data elements collected at each health facility level.
- Data consistency through use and fill out reporting tools as required and maintain the required standards across reporting tools.
- Data quality checks – Refer most recent Data Quality Assessment (DQA) Guideline[2].
- Complete documentation in the neonatal inpatient and outpatient care, other physical examination and bedside testing, discharge information, and maternal history is important to track improvement in quality of care being provided in the facility.

Data analysis:

- Facility needs to analyze service coverage, facility performance, resource availability and use, disease incidence and prevalence and additional neonatal indicators.
- Data for neonatal indicators is obtained in the neonatal register and Kangaroo Mother Care register.

Data use:

- Neonatal team members need to identify aims of data collection and measures that are important to them.
- Should innovate local ways to transform data collection to use.

Table XX: Key neonatal indicators

Total number of livebirths in the facility
Total number of stillbirths
Neonatal Mortality Rate (NMR)
Low Birth Weight (LBW) Prevalence
Perinatal care index (perinatal death rate/LBW rate)
Exclusive Breastfeeding Rates
Apgar Scores below 7 at 5 Minutes
Early Initiation of Breastfeeding/ EBM (within 1 hr)
Immunization Coverage (OPV, BCG, HBV)
Vitamin K (all babies)
Pulse oximeter within 24hrs
Percentage of newborns receiving postnatal care within 48 hours after delivery
Percentage of newborns receiving postnatal care at 3-7 days after delivery
Screened for Neonatal jaundice

Table XX: IPD neonatal indicators (service provision)

Total number of admissions in the NCU
Percentage of newborns admitted with low body weight (<2500g)
Percentage of newborns immunized (BCG, OPV, HBV) among low birth weight < 2500
Percentage of newborns admitted with presumptive early onset neonatal sepsis
Percentage of newborns admitted with blood culture confirmed early onset neonatal sepsis
Percentage of newborns admitted with presumptive late onset neonatal sepsis
Percentage of newborns admitted with blood culture confirmed late onset neonatal sepsis
Percentage of newborns admitted with birth asphyxia
Percentage of newborns admitted with low birth weight(<2500g) received KMC
Percentage of newborns re-admitted with neonatal jaundice
Percentage of newborns admitted with respiratory distress syndrome

Percentage of newborns admitted with congenital malformations (NT, Cleft lip/palate, Gastroschisis, Talipes).
Percentage of newborns admitted who received antibiotics
Percentage of blood cultures on newborns admitted who received antibiotics
premature babies with RDS received CPAP survival within 72hours
of neonates admitted with hypothermia (<36oC)
of neonates survived (<1, <1.5, <2.5 and >2.5)
of survival outcome birth asphyxia, premature, sepsis, congenital
Percentage of newborns admitted who received Phototherapy
% outborn admission
% of outborn mortality
Percentage of premature newborns with RDS receive CPAP

21.4 Neonatal Referral Care

It is important to identify a newborn who needs referral to a higher-level facility without delay to avoid complications. Properly managing each component of the referral process ensures that sick newborns receive the appropriate care promptly which reduces morbidity and mortality.

Consider the following when you are referring the neonate:

1. Assessment and Identification

- **Initial Assessment:** Conduct a thorough clinical evaluation to identify the newborn's condition and severity (TRIAGE). This should include a thorough history, assessing symptoms, checking vital signs, physical examination and appropriate investigations.
- **Decision to Refer:** will depend on newborn's condition, based on clinical guidelines, the severity of the illness, and the resources available at the referring facility in consultation with facility Managers, Paediatrician/Neonatologist on the need of referral and the most appropriate referral centre. Do not refer a patient who would not benefit from a referral eg Severe multiple life-threatening congenital malformations. It is important to consider where to refer the preterm baby according to birth weight.
- CEmONC centre should ensure that the C/S should not be done to pregnant women with very low gestation age to minimize risks of transporting a very low preterm baby due to increased mortality at receiving facilities.

2. Stabilization before referral

- **Basic Interventions:** Perform necessary interventions to stabilize the newborn before transfer. This may include:
    - Ensuring the airway is clear and providing oxygen if needed.
    - Initiating IV fluids if the baby is dehydrated or in shock refer Chapter XX..
    - Gastroschisis rehydration fluid day+20 mls before referral, NGT for decompression

- Correct and prevent hypoglycaemia (check blood glucose and give 10% Dextrose if hypoglycaemic- refer Chapter XXX).
- Maintain glycaemic state -Breastfeeding, NGT, IV fluid – refer Chapter XXXY on feeding.
- Administer appropriate medications such as antibiotics for infections, anti-convulsants and specific management (eg,Gastroschisis-refer Chapter XXXZ) as necessary.
- Keep the baby warm.
- Ensure early referral timely.

3. Communication

- **Inform Parents/Guardians:** Clearly communicate with the parents or guardians about the newborn's condition, the need for referral, and the steps involved in the referral process.
- **Contact Referral Facility:** Notify the receiving facility about the incoming patient. Provide details about the newborn's condition, treatments administered, and estimated time of arrival.

4. Documentation

- **Referral Form:** Complete a referral form with essential details included in the Annex 7 in duplicate.
- **Medical Records:** Include copies of the newborn's medical records, laboratory test results, and any imaging studies.

5. Transport Arrangements

- **Transport Mode:** Choose the appropriate mode of transport (ambulance, specialized neonatal transport unit, etc.) based on the newborn's condition and the distance to the appropriate referral facility.
- **Transport Team:** Ensure a qualified transport team depending on the condition of the patient, healthcare providers trained in neonatal care should stay close to the patient and continue with provision of care of the newborn during transfer, preferably a provider who is familiar with the patient.
- **Equipment and Supplies:** Ensure the transport vehicle is equipped with necessary medical supplies and equipment (refer to newborn transport chapterXXXA).

6. Management during referral

- **Thermoregulation:** Ensure that all newborn is kept warm by skin-to-skin contact unless contraindicated, warm clothing, or in an incubator as indicated.
- Ensure airway is kept open
- Monitor vital signs; Pulse rate, Respiratory rate, Oxygen saturation
- Continue with feeding, IV fluids and medications as indicated

- Manage specific conditions as per the guideline (Portable CPAP for RDS, Plastic cover for Gastroschisis).

7. Handover at Referral Facility

- **Verbal Handover:** Provide a verbal handover to the healthcare team at the receiving facility, summarizing the newborn's condition, treatments given, and any changes during transport.
- **Transfer of Documentation:** Hand over the referral form and medical records to the receiving healthcare providers. The referral health care provider should ensure to return the signed referral form.

8. Follow-up

- **Feedback:** Obtain feedback from the referral facility about the newborn's condition, appropriateness of the referral and patient progress. A feedback form should be filled in by the receiving facility upon discharge of the patient. (Refer feedback form annex XXX)
- **Continuity of Care:** Ensure follow-up care and support for the family, including updates on the newborn's condition and any necessary post-discharge planning.
- **Down referral**: with communication between the receiving and referring facility, the patient may be returned to the referring facility for continuation of care.

References:

1. WHO: Essential Newborn Care https://www.who.int/teams/maternal-newborn-child-adolescent-health-and-ageing/newborn-health/essential-newborn-care.
2. WHO: Operationalising Management of sick young infants with possible serious bacterial infection. (PSBI) when referral is not feasible https://www.who.int/publications/l/item/9789241509268.

CHAPTER 22: MORTALITY REVIEW AND ETHICAL CONSIDERATION

22.1 Mortality review

Mortality reviews is done according to the National Maternal and Perinatal Death Surveillance and Response (MPDSR) Guideline**.**

Definitions:

Perinatal death: is a death of a fetus (≥ 1000 gms) from 28 weeks of gestation to 7 completed days of life including stillbirth.

Peri-viable deaths: death of neonates born from 20 completed weeks to before 26 weeks gestation (These deaths should be documented and discussed within the facility but are not reported as per National MPDSR guideline).

Late Neonatal deaths: death of neonates more than seven days to 28 days. The review of these deaths is covered in the Paediatric death audit guideline, that incorporates 8 days to 5 years old.

Neonatal death: is a death of a live newborn from 0 to 28 days of life[1].

MPDSR: Is the routine identification, notification, quantification and determination of causes of all maternal and perinatal deaths, as well as the use of this information to respond with actions that will prevent future deaths.

The goal of the MPDSR is to generate information that can be used by health service providers, planners and managers to improve perinatal and neonatal survival by improving the quality of care. If the death occurs it is important to conduct a discussion review on the reasons for death with the following objectives.

- To generate information, provide recommendations and actions to take in order to eliminate preventable perinatal and neonatal deaths.
- To document perinatal and neonatal death in order to understand and assess the true magnitude of the problem, and trends overtime to assess the impact of various perinatal and neonatal mortality reduction strategies.

NB: All perinatal deaths shall be identified, notified and documented within 24 hours; the MPDSR committee should conduct the death review within 7 days according to the national MPDSR guideline (refer to the Maternal and Perinatal Death Surveillance and Response Guideline).

Cause of death and certification

Classification of correct cause of perinatal and neonatal deaths can be challenging and inconsistent.

Improper classification usually leads to challenges in interpreting information for planning strategies and resources to prevent future deaths.

It also leads to inconsistencies in comparing data across geographical locations, misclassification, underestimation or overestimation of perinatal and neonatal deaths. To avoid these challenges all cause of death and certification should be done according to International Classification of Diseases Perinatal Mortality (ICD PM)[2]. Refer to National MPDSR Guideline.

22.2 Ethical Considerations

There are several complex ethical dilemmas faced by Health Care Providers and families during the provision of perinatal and neonatal care. Although Parents/guardians are viewed as primary decision makers for the neonates, health care providers play an important role in determining what actions are in the child's best interest. Ethical dilemmas may arise when Health Care Providers and parents disagree on the best course of action[3,4].

The four main ethical principles should be considered:

1	Beneficence
2	Non-Maleficence
3	Autonomy
4	Justice

Some Ethical Questions that may arise during neonatal care include:

- Does the clinical condition of the neonate warrant specialized care?
- When to initiate and stop invasive intensive care?
- When to stop resuscitation?
- Discharge against medical advice?
- Allocation of scarce neonatal care resources, especially when triage decisions must be made

Health Care Providers should adhere to medical ethics in provision of neonatal care. Each facility must have a clinical care ethical committee with multi-disciplinary team of experts, to deliberate on complex ethical dilemmas.

Team members of Ethical committee according to level of health care:

1. National hospitals, Zonal hospitals, Regional Referral hospitals

   Legal Officer, Social welfare Officer, Head of Paediatrics, Head of Neonatal unit, Nurse In-charge of Neonatal Unit, Therapist, Neonatologist, Paediatrician, Religious leader and Community leader.

2. District hospital and Council hospital
   Social welfare Officer, Head of Paediatrics, Head of Neonatal unit, Nurse In-charge of Neonatal Unit, Therapist, Paediatrician, One member from hospital management team, Clinicians, Nurses, Religious leader and Community leader.
3. Health Center
   Social welfare Officer, Facility in-charge, Head of Neonatal Care unit, Nurse In-charge of Neonatal Care Unit, One member of health management team, Clinicians, Nurses, Religious leader and Community leader.

Key ethical considerations in perinatal and neonatal care include:

- Health care providers should ensure that parents/caregivers are fully informed about the management options for their newborns, to allow them to make autonomous decisions.
- The care provided should be to the best interest of the neonate, especially for premature and critically sick neonates.
- Respecting the autonomy of parents to make decisions, while considering the health care provider duty to provide beneficial care and prevent harm to the neonate.
- Protecting sensitive medical information of the neonate and their families
- Ethical issues around prenatal testing, selective abortions and other reproductive choices that impact perinatal care.
- The need to ensure comfort and dignity for neonates with life-limiting conditions and supporting families through difficult end of life decisions
- The need to ensure that all neonates, regardless of their socio- economic status or other factors (cultural, Gender, religious beliefs), have access to appropriate and high -quality neonatal care.

References

1. WHO 2019: Definition of Perinatal death.
2. National MPDSR Guideline; 2019
3. Gerri R Baer and Robert M Nelson: A Review of ethical issues involved in premature birth: https://www.ncbi.nlm.nih.gov/books/NBK11389/#a20012272ddd00401.
4. Ethical Issues in Neonatal Care: https://emedicine.medscape.com/article/978997-overview?form=fpf#a2.

8149 **ANNEX**

1. Aminophylline	
Indication	Treatment of apnea of prematurity or prevention of apnea of prematurity in infants <32weeks gestational age Used as alternative when caffeine citrate not available
Dosage	**IV** 1. Loading dose- 5-6mg/kg stat 2. Maintenance Dose- 2-3mg/kg BD, start 12 hours after loading dose
Preparation	0.4ml of 250mg/10ml Aminophylline solution added to 4.6ml of water for injection/normal saline gives 2mg/ml.
Administration	Slow bolus injection for over 10 mins.
Storage	Unopened ampoule Store at room temperature, 20-25°C Diluted solutions Store at room temperature (25°C) for 24 hours or refrigeration (4°C) for 7 days
Side effects	
2. Adrenaline	
Indication	Cardiopulmonary resuscitation with asystole or bradycardia < 60 bpm
Dosage	Intravenous/intraosseous - 0.01-0.03mg/kg or 0.1-0.3ml/kg(1:10 000 dilution) 3 to 5 minutes as necessary Intratracheal- 0.03 to 0.1mg/kg (0.3 to 1ml/kg of 0.1mg/ml solution) every 3 to 5minutes until IV access established or return of spontaneously circulation.
Route	Intravenous (preferred route) Intraosseous Intratracheal bolus
Preparation	1ml of 1mg/ml of adrenaline added to 9mls of water for injection/normal saline
Administration	Intravenous - IV bolus followed with 3ml normal saline flush Via Endotracheal tube-
Storage	Unused ampoule • Store at room temperature, 20-25°C Diluted solutions • Store at room temperature (25°C) or refrigeration (4°C) is 24hours
3. Ampicillin	
Indication	Treatment of Group B streptococcus, listeria monocytogenes and some E.coli species
Dosage	If age ≤ 7 days: 50 mg/kg 12 hourly If age > 7 days: 50 mg/kg 8 hourly
Route	IV
Preparation	Dissolve vial contents in 5ml of water for injection or normal saline to a final concentration of 100mg/ml.
Administration	Administer slowly over 3-5minutes Rapid administration has been associated with seizures.
Storage	Diluted solution should be used within 1 hour. Store unopened vial in room temperature below 25°C.
4. Ampiclox	
Indication	

<table>
<tr><td>Dosage</td><td>If age ≤ 7 days: 100 mg/kg 12 hourly
If age > 7 days: 100 mg/kg 8 hourly</td></tr>
<tr><td>Route</td><td>Intravenous (IV)</td></tr>
<tr><td>Preparation</td><td>Dissolve vial contents in 5 ml Water for Injections BP/Normal Saline</td></tr>
<tr><td>Administration</td><td>Slow bolus injection over 3 minutes</td></tr>
<tr><td>Storage</td><td>Unused vials
• Store at room temperature, 20-25°C
Diluted solutions
• Store at room temperature (25°C) for 24 hours or refrigeration (4°C) for 7 days</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">5. Azithromycin</td></tr>
<tr><td>Indication</td><td>Treatment or post-exposure prophylaxis of Bordetella pertussis infections, Chlamydial conjunctivitis</td></tr>
<tr><td>Dosage</td><td>10 mg/kg every 24 hours for 5 days</td></tr>
<tr><td>Route</td><td>Slow IV or orally</td></tr>
<tr><td>Preparation</td><td>For Intravenous administration;
Add 4.8 mL of sterile water for injection/Normal saline 0.9% to 500-mg vial; final concentration is (100 mg/mL); shake vial until the entire drug is dissolved.
Dilute reconstituted drug in either a 250-mL (final concentration 2 mg/mL) or 500-mL IV bag (final concentration 1 mg/mL)</td></tr>
<tr><td>Administration</td><td>IV Administration
1 mg/mL diluted solution: Infuse over 3 hr
2mg/mL diluted solution: Infuse over 1 hr</td></tr>
<tr><td>Storage</td><td>Reconstituted vial: Store at <30°C for 24 hr
Diluted solutions: Store <30°C for 24 hr OR refrigerate at 5°C for 7 days
Reconstituted oral suspension: Store at 5-30°C and use within 10 days; discard after full dosing is completed.</td></tr>
<tr><td colspan="2">6. Amikacin</td></tr>
<tr><td>Indication</td><td>Treatment of serious infections due to susceptible strains of;
• Gram negative bacilli resistant to other aminoglycosides.
• Mycobacteria susceptible to amikacin.</td></tr>
<tr><td>Dosage</td><td>
<table>
<tr><th>Corrected Gestational Age</th><th>Postnatal Age</th><th>Dose</th><th>Frequency</th></tr>
<tr><td rowspan="2">< 30 weeks</td><td>≤ 14 days</td><td>15mg/ kg/ dose</td><td>48 hourly</td></tr>
<tr><td>≥ 15 days</td><td>15mg/ kg/ dose</td><td>24 hourly</td></tr>
<tr><td>30-34 weeks</td><td>All</td><td>15mg/ kg/ dose</td><td>24 hourly</td></tr>
<tr><td rowspan="2">≥ 35 weeks</td><td>≤ 7 days</td><td>15mg/ kg/ dose</td><td>24 hourly</td></tr>
<tr><td>≥ 8 days</td><td>17.5mg/ kg/ dose</td><td>24 hourly</td></tr>
</table>
</td></tr>
<tr><td>Route</td><td>IV (preferred route)
IM</td></tr>
<tr><td>Preparation</td><td>Dilute 1mL (250mg) of amikacin solution with 49mL of compatible fluid. Final Volume is 50mL. Concentration is 250mg/50Ml.
Final Concentration is 5 mg/mL</td></tr>
</table>

<table>
<tr><td>Administration</td><td>Infuse over 1 to 2 hours</td></tr>
<tr><td>Storage</td><td>Vial: Store at room temperature, below 25°C
diluted solution is stable at room temperature for at least 3 weeks or in the refrigerator for at least 60 days.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">7. Caffeine citrate</td></tr>
<tr><td>Indication</td><td>Used to treat apnea of prematurity or as prophylaxis for apnea of prematurity in infant < 32 weeks of GA</td></tr>
<tr><td>Dosage</td><td>To ensure clear orders ALWAYS prescribe dose as milligrams of caffeine citrate. The intravenous injection contains 20mg/mL caffeine citrate</td></tr>
<tr><td>Route</td><td>IV or PO</td></tr>
<tr><td>Presentation</td><td>For IV:20mg/ml or 40mg/2ml ampoule
For PO, 20mg tablet reconstituted to 5-10mg/ml syrup (communicate with pharmacist for compounding of the medication)</td></tr>
<tr><td>Preparation</td><td>Draw up 1 mL (20 mg) of caffeine citrate and add 4 mL sodium chloride 0.9% or glucose 5% to make a final volume of 5 mL with a concentration of 4 mg/mL</td></tr>
<tr><td>Administration</td><td>FOR IV:
Administer intravenous loading doses as an infusion over at least 30 minutes.
Administer intravenous maintenance doses as a bolus injection over at least 3 minutes.
For PO:</td></tr>
<tr><td>Storage</td><td>For IV:
Store below 30°C
For PO (compounded syrup):</td></tr>
<tr><td colspan="2">8. Cefotaxime</td></tr>
<tr><td>Indication</td><td>Suspected meningitis, Neonatal sepsis, Gonococcal infection, Susceptible gram negative infections excluding Pseudomonas sp.</td></tr>
<tr><td>Dosage</td><td>50mg /kg /dose
<table><tr><td colspan="2">Dosing interval</td></tr><tr><td>Postnatal age</td><td>Dose interval</td></tr><tr><td>≤7days of age</td><td>12 hourly</td></tr><tr><td>≤8-21 days of age</td><td>8 hourly</td></tr><tr><td>≤21days of age</td><td>6 hourly</td></tr></table></td></tr>
<tr><td>Route</td><td>slowly IV/IM</td></tr>
<tr><td>Preparation</td><td>Add 9.6mL of water for injections or normal saline to a 1g vial, Concentration is 1000mg/10mL = 100mg/mL,</td></tr>
<tr><td>Administration</td><td>For intravenous, Inject over at least 3 to 5 minutes</td></tr>
<tr><td>Storage</td><td>Store reconstituted vial at <30ºC room temperature for 24 hours
OR refrigerate at 4ºC for 7 days</td></tr>
</table>

8150

9. **Ceftriaxone**

<table>
<tr><td>Indication</td><td>Broad-spectrum cephalosporin with good CSF penetration. It is active against most community-associated enteric Gram-negative organisms, beta-haemolytic Streptococci and Streptococcus pneumoniae. It is not active against Enterococci.</td></tr>
<tr><td>Dosage</td><td>50mg/kg/day
Meningitis or severe sepsis: 50 mg/kg/dose given 12 hourly OR 100 mg/kg/dose given 24 hourly</td></tr>
<tr><td>Route</td><td>IV/IM (preferred route is IV)</td></tr>
<tr><td>Presentation</td><td>Vial of 250mg, 500mg or 1000mg</td></tr>
<tr><td>Preparation</td><td>Step 1: Reconstitute 1g vial with 9.6mL of Water for Injections Concentration is 1g/10mL = 1000mg/10mL or 100mg/ml
Step 2 : Take 2mL of the above solution (200mg) and add 3ml NS to make up a final volume of 5mL.
Concentration is 200mg/5mL, Final Concentration = 40mg/Ml</td></tr>
<tr><td>Administration</td><td>IV push: Give slowly over 3 to 5 minutes
IV Infusion: Infuse over 30 minutes via syringe pump</td></tr>
<tr><td>Storage</td><td>Store diluted solution at 25ºC room temperature for 24 hours or
OR refrigerate at 4ºC for 7 days</td></tr>
<tr><td colspan="2">10. ciprofloxacin</td></tr>
<tr><td>Indication</td><td></td></tr>
<tr><td>Dosage</td><td>FOR IV
For <34 weeks GA: 10mg/kg/dose 12 hourly IV
For >34 weeks GA: 20mg/kg/dose 12 hourly IV
FOR Oral
For preterm infants:10mg /kg/dose 12 hourly PO.
For term infants: 15mg /kg/dose 12 hourly PO.</td></tr>
<tr><td>Route</td><td>IV/PO</td></tr>
<tr><td>Preparation</td><td>Use undiluted</td></tr>
<tr><td>Administration</td><td>Use undiluted at a concentration of 2mg/mL and give for 60minutes if IV
If given orally, Ciprofloxacin should be given 2 hours before or 2 hours after feeds, iron or calcium intake. Iron, Calcium and Milk bind to ciprofloxacin in the GIT and can reduce its absorption. Separate administration times where possible.</td></tr>
<tr><td>Storage</td><td>Stored at room temperature</td></tr>
<tr><td colspan="2">11. Clindamycin</td></tr>
<tr><td>Indication</td><td>MRSA</td></tr>
<tr><td>Dosage</td><td>5mg/kg/dose
<table>
<tr><td>Dosing interval</td><td></td><td></td></tr>
<tr><td>Weight</td><td>Postnatal age</td><td>Diose interval</td></tr>
<tr><td><1kg</td><td>≤ 14 days</td><td>12hourly</td></tr>
<tr><td></td><td>≤ 14 days</td><td>8 hourly</td></tr>
<tr><td>1-2 kg</td><td>≤ 7 days</td><td>12 hourly</td></tr>
<tr><td></td><td>8-28 days</td><td>8hourly</td></tr>
<tr><td>>2kg</td><td>≤ 7 days</td><td>8hourly</td></tr>
<tr><td></td><td>8-28 days</td><td>8hourly</td></tr>
</table></td></tr>
</table>

Route	IV/PO
Presentation	150mg/ml ampoule
Preparation	Intravenous Dilute 1mL of clindamycin 150mg/mL with 14mL compatible fluid (total volume 15mL). The resulting solution contains clindamycin 10mg/mL solution. May be further diluted in compatible fluid Oral Disperse one capsule (150mg) in 15mL of water for injection. The resulting oral solution contains clindamycin 10mg/mL.
Administration	Administer as an intravenous infusion over at least 30 minutes
Storage	
12. Potassium chloride (KCL)	
Indication	Treatment severe hypokalemia
Dosage	2-4mmol/kg/day
Route	Slow Intravenous Infusion only (Never Use IV push, IM or SC)
Preparation	Potassium must be diluted prior to parenteral administration • Solution must be diluted to a maximum concentration of 1 mmol/25 ml (40 mmol/L) for a peripheral line • Solution must be diluted to a maximum concentration of 1 mmol/12.5 ml (80 mmol/L) for a central line • When adding potassium chloride to an IV fluid bag, mix well by inverting the bag at least 10 times. Do not add potassium chloride to a bag that is already hanging • Clearly label all bags, syringes, pumps and lines that contain potassium to avoid inadvertent flushing
Administration	Infuse at a rate not exceeding 0.2 mmol/kg/hr
Adverse Reactions	Common: hyperkalaemia, hypotension, oral administration – gastrointestinal disturbances, vomiting Serious: concentrated solutions through peripheral IV can cause thrombophlebitis and pain at injection site. Rapid IV infusions may cause cardiac arrest and cardiac dysrhythmias
Storage	Potassium ampoules and oral solution should be stored at room temperature below 25 °C11 Diluted potassium chloride solutions should be prepared immediately before use, but is stable if refrigerated between 2 to 8 °C for up to 24 hours11 Discard any unused solution
13. Calcium gluconate	
Indication	Symptomatic Hypocalcemia;including seizures, hyperkalemia
Dosage	Note: Prescribe calcium salt in full (i.e. calcium gluconate) and strength (i.e. 10%). Dose should be expressed as 'mmol' IV: Urgent correction: 0.22-0.44mmol/kg (1-2mL/kg) over 10 minutes. Maintenance Infusion 0.44 to 0.88mmol/ kg / day(2-4mL/kg) over 24 hours Maximum 0.88mmol/ kg/ day
Route	For intravenous use only – Avoid intra-arterial, intramuscular or subcutaneous administration as calcium gluconate 10% is extremely irritant and may cause severe necrosis.
Preparation	Urgent Correction: Prepare a 1:1 dilution of Calcium Gluconate for administration.

<table>
<tr><td></td><td>e.g. for a 0.22mmol dose (1mL) dilute with 1mL of a compatible fluid to a final volume of 2mL
Maintenance infusion: Dilute calculated dose to a final volume of 25mL with normal saline. E.g. calculated dose + normal saline=25mls solution</td></tr>
<tr><td>Administration</td><td>For rapid administration, push dose at a rate of 0.23mmol/minute to reduce the risk of phlebitis/extravasation.
Maintenance Infusion: Infuse at 1mL/hour Use central line if available If administering through UVC ensure tip of UVC is not in the heart or liver</td></tr>
<tr><td>Adverse Reactions</td><td>Common: abdominal distension, constipation
Serious: Extravasation causing tissue necrosis; rapid infusion may cause bradycardia, hypotension and peripheral vasodilation</td></tr>
<tr><td>Storage</td><td>Store at room temperature, below 25°C The solution may precipitate at low temperatures and must be discarded if it is cloudy or contains particles</td></tr>
<tr><td colspan="2">14. Erythromycin</td></tr>
<tr><td>Indication</td><td>For the treatment of susceptible organisms
• Chlamydia trachomatis
• Mycoplasma
• Ureaplasma</td></tr>
<tr><td>Dosage</td><td><table><tr><td>Postnatal Age</td><td>Dose</td><td>Frequency</td></tr><tr><td>≤7 days</td><td>10mg/kg</td><td>Every 12 hours</td></tr><tr><td>8-28 days</td><td>10mg/kg</td><td>Every 8 hours</td></tr><tr><td>≥29 days</td><td>10mg/kg</td><td>Every 6 hours</td></tr></table></td></tr>
<tr><td>Route</td><td>orally</td></tr>
<tr><td>Preparation</td><td>Dilute according to manufacturer instructions</td></tr>
<tr><td>Administration</td><td>Oral: Shake well before use
May be given at any time with regard to feeds.</td></tr>
<tr><td>Storage</td><td>Oral Mixture:
Dry granules: Store at room temperature - below 25 °C
Prepared suspension: Refrigerate at 2 to 8 °C, Do not freeze Discard 10 days after reconstitution</td></tr>
<tr><td colspan="2">15. Furosemide</td></tr>
<tr><td>Dosage</td><td>Oral: 1 to 2mg/kg/dose
Intravenous injection: 1mg/kg/dose</td></tr>
<tr><td>Route</td><td></td></tr>
<tr><td>Preparation</td><td>Continuous intravenous infusion: Dilute 10mL of furosemide(frusemide) 10mg/mL injection with 40mL of sodium chloride 0.9% (final volume 50mL). This results in a 2mg/mL furosemide(frusemide) solution.</td></tr>
<tr><td>Administration</td><td>IV bolus:
Administer undiluted over 15 to 30 minutes. Rate should not exceed 0.5mg/kg/minute.
Continuous intravenous infusion
Initial rate 0.1 mg/kg/hour Double the dose every 2 hours (to a maximum of 0.4mg/kg/hour) if the urine output is less than 1mL/kg/hour. Strict monitoring of fluid input and urine output is mandatory.</td></tr>
<tr><td>Adverse Reactions</td><td>Common: Electrolyte disturbances (hyponatraemia, hypokalaemia, hypomagnesaemia, hypocalcaemia, hypochloraemia), dehydration, hyperuricaemia, increased serum creatinine concentration Nephrocalcinosis in preterm neonates</td></tr>
<tr><td>Storage</td><td>Use infusion solution within 24 hr</td></tr>
</table>

16. Gentamicin	
Dosage	5 mg/kg every 24 hours for newborn >2.5 kg 3 mg/kg every 24 hours for newborn < 2.5 kg
Route	IV only
Preparation	A dilution will be required only if using gentamicin 80mg/2mL injection. Dilute 2mL of the 80mg/2mL gentamicin solution with 6mL of compatible fluid (to a total volume of 8mL). The resulting solution contains 10mg/mL of gentamicin. The intravenous solution contains 10mg/mL gentamicin
Administration	Administer over at least 5 minutes
Storage	Store unopened ampoule at room temperature Diluted solution: stable for 24 hours at 25°C.
17. Glucagon	
Indication	• For prolonged hypoglycaemia unresponsive to routine therapy • For management of hyperinsulinemic hypoglycemia e.g. congenital hyperinsulinism. • Adjunctive treatment of beta blocker overdose
Dosage	200mcg/kg/dose For IV bolus/IM/SC (maximum dosage is 1mg/dose, do not exceed!!) 5-20mcg/kg/hr for IV infusion (Contact senior staff prior to further adjustments)
Route	IV/IM/SC
Preparation	FOR IV bolus/IM/SC Add 1 mL of the diluent provided (water for injection) to the 1 mg (1000 microgram) vial; this will give a resulting solution of 1000 microgram/ml. FOR IV INFUSION (DOUBLE STRENGTH AND SINGLE STRENGTH) **SINGLE STRENGTH (40mcg/ml)** STEP 1: Add 1 mL of the diluent provided (water for injection) to the 1 mg (1000 microgram) vial; this will give a resulting solution of 1000 microgram/ml. STEP 2: Add 1 mL of the 1000 microgram/mL glucagon solution to 24 mL 5% glucose (to a total of 25 mL). This makes a 40 microgram/mL solution. **DOUBLE STRENGTH (80mcg/ml)** STEP 1: Add 1 mL of the diluent provided (water for injection) to the 1 mg (1000 microgram) vial; this will give a resulting solution of 1000 microgram/mL. Prepare 2 vials. STEP 2: Add 2 mL of the 1000 microgram/mL glucagon solution to 23 mL 5% glucose (to a total of 25 mL). This makes an 80 microgram/mL solution.
Administration	• Evaluate glucose levels prior to each dose • For IV Bolus: administer recommended dose of the reconstituted solution for over 3 to 5 minutes. • For IM: Inject into anterolateral thigh(preferred) or the ventrogluteal area. • For SC: inject into the area over the deltoid muscle or over the anterolateral thigh. • FOR IV INFUSION Step 1: calculate infusion rate and dose per hour **To calculate infusion rate (mL/hr):** Rate (mL/hr) = dose (micrograms/kg/hour) x weight(kg)

	Strength (microgram/mL) **To calculate the dose (micrograms/kg/hour):** Dose (micrograms/kg/hour) = Rate (mL/hr) x Strength (microgram/mL) Weight (kg) Step 2: administer via syringe pump on a separate peripheral IV line.
Storage	Store at room temperature, below 25°C in original packaging to protect from light
PRECAUTIONS	• Glucagon is not usual first line treatment of hypoglycaemia; consider in cases of hypoglycaemia refractory to intravenous glucose infusion, or when glucose infusion is unavailable, or in cases of documented glucagon deficiency • When considering original vial strength and possible patient condition, it is recommended that only 25 mL volume infusions are prepared • Watch for rebound hypoglycaemia. Rise in blood glucose will last approximately 2 hours • Persistent hypoglycaemia should not be treated with repeated doses of glucagon alone. Glycogen stores in preterm and growth retarded infants are limited and easily depleted • Evaluate glucose levels prior to each dose
18. Hepatitis B immunoglobulins	
Indication	Prophylaxis in infant born to Hepatitis B surface antigen(HBsAg) positive mothers.
Dosage	100 units single dose immediately after birth Ideally given within 12 hours of birth and certainly within 48 hours.
Route	IM only
Administration	• The product should be brought to room temp before use and injected immediately. • Administer intramuscularly into the anterolateral thigh. • Administer at the same time as the Hepatitis B vaccine but into the opposite anterolateral thigh. • DO NOT administer intravenously.
Storage	Store unopened vial between 2°C and 8°C. Do not freeze, protect from light.
19. Hydrocortisone	
Indication	• Treatment of cortisol deficiency (hypoadrenalism) • Treatment of hypotension not responding to inotropes • Short term adjunctive therapy for persistent hypoglycemia • Prevention of bronchopulmonary dysplasia (not routinelry recommended) • Adjunct therapy in PPHTN secondary to meconium aspiration syndrome
Dosage	**Treatment of pressor and volume resistant hypotension** **Intravenous**: 1mg/kg/dose Doses up 2.5mg/kg/dose have been used for inotrope resistant hypotension. < 34 weeks GA Every 6 to 12 hours ≥ 34 weeks GA Every 6 to 8 hours

	Use for the least possible duration, until stable off inotropes (usually 2 – 5 days). **Hypoglycaemia** Intravenous/Oral: 1 - 2.5mg/kg/dose every 6 hours as required For oral administration, dose should be rounded to the nearest whole milligram. Body surface area (BSA) calculation: BSA(m^2)= $\sqrt{\frac{height(cm) \times weight(kg)}{3600}}$ **Low dose for prevention of bronchopulmonary dysplasia(not routinely recommended)** 0.5mg/kg/dose every 12hrs for seven days then; 0.5 mg/kg/dose every 24hrs for 3 days
Route	IV and PO
Preparation	FOR IV STEP 1: Add 2mL of Water for Injection to the vial (100mg) and shake gently to dissolve (to a total volume of 2mL). The resulting solution contains 50mg/mL hydrocortisone. STEP 2: Further dilute 1mL of the 50mg/mL hydrocortisone solution with 9mL of compatible fluid (to a total volume of 10mL). The resulting solution contains 5mg/mL hydrocortisone
Administration	IV: Administer over 3 to 5 minutes Oral: Doses should be administered during or after a feed to reduce stomach discomfort.
Storage	Vials and tablets: store below 25°C. Protect from light. Do not freeze.
20. Ibuprofen	
Indication	Treatment of significant Patent Ductus Arteriosus (PDA)
Dosage	First dose: 10 mg/kg Second dose 24 hours after the first dose: 5 mg/kg Third dose 48 hours after first dose: 5 mg/kg
Route	IV or PO
Preparation	The intravenous injection contains 5mg/mL ibuprofen and Can be given undiluted.
Administration	IV: Administer intravenous over at least 15 minutes. Orally: give with feeds or after feeds to minimize risk of gastrointestinal irritation. If baby is not on enteral feeds or breast milk is not available, give dose via nasogastric tube and flush with 0.5 mL water for injection.
Storage	Store unopened vial and oral liquids at room temperature below 25°C
21. Insulin	
Indication	Treatment of infants with persistent hyperglycemia To reduce blood potassium levels (in combination with glucose) in Hyperkalemia
Dosage	For Hyperglycemia: 0.01-0.1unit/kg/hr Titrate in small increments to blood glucose, target blood glucose level is 8-10mmol/l For Hyperkalemia: IV injection: 0.1 unit/kg IV infusion: 0.1-0.2 unit/kg/hr

Route	IV and Subcutaneous Injection (Seek endocrinologist advice)
Preparation	FOR IV INFUSION Step ONE: Dilute 0.5mL of 50unit/mL soluble insulin with 9.5mL of normal saline (total of 10mL). The resulting solution contains 5 unit/mL insulin. Step TWO: Dilute 1mL insulin (5units/mL) with 49mL of compatible fluid (total of 50mL)
Administration	**Calculate infusion rate and dose before administering** Formulae To calculate Infusion rate (mL/hr): Rate (mL/hour) = dose (units/kg/hour) x weight(kg) / Infusion Strength (units/mL) dose (units/kg/hour): Dose (units/kg/hour) = Rate(mL/hr) x Strength (units/mL) / Weight (kg)
Storage	Unopened vials to be stored in the fridge. Opened vials may be kept at room temperature
22. **Isoniazid**	
Indication	Prophylactic treatment for newborns exposed to TB
Dosage	10mg/kg/day for 6 months NB: do not Give BCG vaccine until 2 weeks after completion of isoniazid dose.
Route	orally
Administration	Best given on empty stomach
Storage	Suspension must be kept in room temp <25^{o}C
23. Phenytoin	
Indication	Control of seizures unresponsive to first line therapy
Dosage	Loading dose: 20 mg/kg Maintenance dose (start 12 hours after loading dose) dose): 2-4mg/kg/day in 2 divided doses
Route	IV or Oral
Preparation	Dilute 1mL (50mg) of phenytoin sodium to a final volume of 10mL normal saline Final Concentration is 50mg/10mL = 5mg/mL
Administration	Slow IV over 30 minutes. Flush the line well with normal saline before and after drug administration. (central line or large vein preferred if available) Oral: may be given with or without feeds, but administration with respect to feeds should be consistent. If possible, give separate from other medications.
Storage	Diluted solution should be used immediately and discard unused solution. Unopened ampoule: store below 25^{o}C. Protect from light.
24. Phenorbabitone	
Indication	First line therapy of neonatal seizure Initial treatment of Non Opioid neonatal abstinence syndrome (NAS)
Dosage	**FOR IV** Loading dose: 20 mg/kg If still convulsing 10 mg/kg can be added after 30 min (max. twice) Maintenance dose (start 24hours after loading dose) dose): 5 mg/kg OD or in 2 divided doses; end by tapering over 2 days **FOR ORAL** 5mg/kg/day
Route	IV or PO

Preparation	FOR IV: Add 1mL (200mg) of phenobarbital injection to 9mL of normal saline (to a total volume of 10mL). Shake gently to mix. The resulting solution contains 20mg/mL FOR ORAL: Contact Pharmacy for an oral preparation which is suitable for neonates
Administration	• Administer loading dose slowly over 20 minutes. Maximum intravenous rate is 1mg/kg/minute. • Administer maintenance dose slowly over 5 minutes • Give immediately before or with feeds to minimize gastric irritation.
Storage	Refrigerate diluted solution at 4°C Store unopened ampoule below 25°C. Protect from light.
25. Paracetamol	
Indication	Analgesia, Antipyretic, Adjunct to post-operative analgesia, treatment of Patent Ductus arteriosus
Dosage	15mg/kg/dose, do not exceed 60mg/kg/day.
Route	IV or Oral
Preparation	Intravenous undiluted
Administration	Administer over 15 minutes via syringe Oral given with or without feeds
Storage	IV do not store above 30°C Do not refrigerate or freeze Oral store below 25°C. protect from sunlight
26. Piperacillin-tazobactam	
Indication	Infection due to susceptible organisms (only use after culture and sensitivity results)
Dosage	100mg/kg/dose 8 hourly
Route	IV only
Preparation	STEP 1: Add 17 mL of Water for Injection to the vial (4000 mg piperacillin content) and shake gently to dissolve (to a total volume of 20 mL). The resulting solution contains 200 mg/mL piperacillin. STEP 1: Further dilute 2 mL of the 200 mg/mL piperacillin solution with 8 mL of compatible fluid (to a total volume of 10 mL). The resulting solution contains 40 mg/mL piperacillin.
Administration	Infuse over at least 30 minutes
Storage	Store unused vial below 25°C Refrigerate diluted solution at 2-8°C for 7 days
27. Pyridoxine	
Indication	Treatment of suspected of confirmed pyridoxine dependent seizures
Dosage	Initial dose: 100mg/dose (NOT PER KILOGRAM) (IV route recommended only with EEG monitoring) Maintenance dose: 30mg/kg/day orally (do not exceed 200mg/day)
Route	IV or PO
Preparation	For IV Use undiluted For Oral: Crush a 25mg tablet and disperse in a 5ml of water to get 5mg/ml. OR Crush a 100mg tablet and disperse in 10ml of water to get 10mg/ml.
Administration	Administer as an Intravenous push over 5 minutes. Administer orally with feeds to minimize GI irritation.
Storage	Store at or below 25°C
28. Total Parenteral nutrition solution (TPN) (neonatal)	
Indication	usually commenced if the neonate is not likely to be fed for longer than 3 days

Dosage	**GLUCOSE**: for preterm and term babies, give glucose as follows • If starting TPN in the first 4 days after birth: -give a starting range of 6-9g/kg/day, gradually to increase to a maintenance range of 9 to 16g/kg/day from day 5 • If starting TPN more than 4 days after birth: -give a range of 9-16 g/kg/day **AMINO ACID**: For preterm babies, give amino acids as follows: • If staring parenteral nutrition in the first 4 days after birth • Give a starting range of 1.5 to 2g/kg/day, gradually increase to a maintenance range of 3 to 4h/kg/day from day 5. • If starting parenteral nutrition more than 4 days after birth • Give a range of 3 to 4g/kg/day For term babies give amino acids as follows: • If staring parenteral nutrition in the 4 days after birth - Give be starting range of 1 to2 g/kg/day, gradually increase to a maintenance range of 2.5 to 3g/kg/day from day 5. • If starting parenteral nutrition more than 4 days after birth - Give a range of 2.5 to 3g/kg/day. **LIPIDS AND LIPIDS EMULSIONS** For preterm and term babies, give lipids as follows: • If starting TPN in the 4 days after birth: -give a starting range of 1-2g/kg/day the gradually increase to a maintenance range of 3-4g/kg/day from day 5. • If starting TPN more than 4 days after birth: -give 3-4g/kg/day. • For preterm and term babies with TPN associated liver disease, consider giving a composite lipid emulsion rather than a pure soy lipid emulsion.
Route	Intravenous infusion
Preparation	Contact pharmacist for direction or see manufacturers directions for use.
Administration	Administer through a Central Venous Catheter (UVC/PCVC). Administration via peripheral IV catheters only to be used after discussion with Neonatal Consultant using selected solutions only. Use with caution and monitor IV site
Storage	Store in fridge. Stable at room temperature below 25^0C for 7 days.
29. Sodium bicarbonate	
Indication	For correction and treatment of metabolic acidosis
Dosage	Determined by base deficit Full Correction Dose (mmol) = 0.3 x base deficit (mmol/L) x wt(kg) Administer half of the calculated dose, and then assess the need for remainder.
Route	IV or PO
Preparation	Draw up 10 mL (10 mmol) and add 10 mL of normal saline to make a final volume of 20 mL. Concentration is 10mmol/20mL = 0.5mmol/mL
Administration	Administered as an infusion over 30 to 60 minutes. Maximum rate in medical emergency is 10mmol/minute. Flush with normal saline after infusion. The intravenous preparation contains 1mmol/mL and may be given orally. To minimise gastric irritation, give with feeds or dilute with equal volume water for injection.

Storage	Store ampoule below 30°C. discard unused diluted solution
30. sildenafil	
Indication	Treatment of persistent pulmonary hypertension Chronic pulmonary hypertension secondary to respiratory, cardiac or chest wall disease.
Dosage	For IV: Loading dose of 0.4mg/kg over 3 hours followed by a continuous infusion of 0.07mg/kg/hour. For oral: 0.5mg/kg every 8 to 12 hours, increasing according to response to a maximum of 3mg/kg every 6 hours
Route	IV or PO
Preparation	FOR IV INFUSION STEP ONE: Dilute 12.5mL (10mg) of sildenafil injection with 7.5mL of 5% glucose (to a final volume of 20mL). This results in a 0.5mg/mL solution. STEP TWO: Dilute 20mL sildenafil (0.5mg/mL) with 5mL of 5% glucose (total of 25mL). The resulting solution contains 0.4mg/mL sildenafil. FOR ORAL communicate with pharmacist for dilution/preparation of the oral medication
Administration	FOR IV INFUSION Calculate infusion rate and dose per hour prior to starting infusion Infusion rate(mL/hr) = $\frac{\text{dose (milligram/kg/hour) x weight (kg)}}{\text{Strength (milligram/mL)}}$ Infusion dose (mg/kg/hour)= $\frac{\text{Rate (mL/hr) x Strength (milligram/mL)}}{\text{Weight (kg)}}$ Loading dose infused for over 3 hours followed by a continuous infusion of 0.07mg/kg/hour. FOR ORAL Shake well before drawing up the dose. Give with feeds to minimize GI irritation, if baby is not on enteral feeds or breast milk is not available, give via nasogastric tube and flush with 0.5 ml water for injection or normal saline.
Storage	Store unopened vial at room temperature belo 25ºC Refrigerate oral suspension at 4ºC. Do not freeze.
31. spironolactone	
Indication	Diuresis in combination with other diuretics in the treatment of congestive heart failure and BPD (conditions of increased aldosterone secretion).
Dosage	1-3 mg/kg/dose PO, given q 12-24 hrs
Route	Oral
Preparation	Communicate with pharmacist for dilution/preparation of the oral medication
Administration	Administer undiluted with feeds
Storage	Refrigerate oral suspension at 4ºC. Do not freeze.
32. Ursodeoxycholic acid	
Indication	Treatment of neonatal cholestatic liver disease Adjuvant therapy for unconjugated hyperbilirubinemia
Dosage	10mg/kg every twelve hours Dose may be increased up to 15mg/kg every twelve hours.
Route	Oral
Preparation	Communicate with pharmacist for dilution/preparation of the oral medication
Administration	Administer with feeds.
Storage	Refrigerate oral suspension at 4ºC. Do not freeze

8151

33. Vancomycin	
Indication	Infection due to susceptible organisms (confirmed with culture and sensitivity)
Dosage	15mg/kg/dose
Route	IV
Preparation	500mg VIAL STEP 1 ; add 10mls of water for injection to the 500mg powder for reconstitution to make a 50mg/ml solution STEP 2 : Draw up 2mls of the above solution { 100mg of Vancomycine and add 18ml of normal saline to make 20mls with final concentration of 10mg/ml 1000MG VIAL STEP 1 ; add 20mls of water for injection to the 1000mg powder for reconstitution to make a 50mg/ml solution STEP 2 : Draw up 2mls of the above solution { 100mg of Vancomycine and add 18ml of normal saline to make 20mls with final concentration of 10mg/ml
Administration	IV infusion over 1 hour, flush before and after infusion.
Storage	Store unopened vial below 25ºC. Protect from light
34. Vitamin K_1	
Indication	Prophylaxis against Vitamin K Deficiency Bleeding Prevents and treats hemorrhagic disease of the newborn
Dosage	For neonates less than 1500grams give 0.5mg as single dose at birth For neonates equal to or greater than 1500grams give 1mg as single dose at birth
Route	IV or IM
Preparation	Administer undiluted for ampoule of 1mg/ml (recommended) For 10mg/ml ampoule, draw up 1ml of vitamin (10mg), add 9mls of water for injection or normal saline, to make a 1mg/ml solution.
Administration	IM: administer undiluted IV: slow bolus over, maximum rate of 1mg/minute.
Storage	Store unopened ampoule and diluted solution at room temperature, below 25°C Protect from light- solution should be clear
35. Metronidazole	
Indication	Infection due to susceptible anaerobic organisms Necrotizing Enterocolitis
Dosage	7.5 mg/kg 8 hourly for 7 days
Route	IV and PO
Preparation	Intravenous doses may be given undiluted
Administration	Administer as an intravenous infusion over at least 30 minutes. Give oral suspension at least an hour before or two hours after feeds to maximise absorption.
Storage	• The intravenous infusion should be protected from light. Short term exposure to normal room light does not adversely affect stability, however direct sunlight should be avoided • The intravenous infusion must not be stored in the fridge as it may crystallise out of solution. Store at room temperature below 25ºC • The oral suspension should be stored at room temperature below 25ºC. Protect from light

8152

36. Tranexamic acid

Indication	Inhibition of fibrinolysis
Dosage	Loading dose: 10-15mg/kg/dose Maintenance dose: 45mg/kg/day
Route	IV
Preparation	Loading dose: Draw 1 ml of tranexamic acid (100mg), add 9ml of water for injection or normal saline, to make a final volume of 10mls with final concentration of 10mg/ml. Maintenance dose: Draw 5ml of tranexamic acid (500mg), add 45mls of water for injection or normal saline to make a final volume volume of 50mls with final concentration of 10mg/ml
Administration	Loading dose: IV slowly over 15minutes Maintenance dose: IV Infusion, flow rate adjusted according to baby's response.
Storage	Store below 25°C. Do not freeze. Protect from light. Discard any unused product.
37. Pantoprazole	
Indication	Treatment of gastroesophageal reflux disease (GORD) Post-operative prophylaxis in congenital tracheoesophageal fistula and oesophageal atresia
Dosage	IV 0.5 mg/kg/dose 12 hourly Oral: 0.6–1.2 mg/kg/dose daily
Route	IV or PO
Preparation	IV infusion: Add 10 mL of sodium chloride 0.9% to 40 mg powder to make a volume of 10 mL with a concentration of 4 mg/mL. Draw up 1 mL (4 mg) of pantoprazole and add 9 mL of sodium chloride 0.9% to make a final volume of 10 mL with a concentration of 0.4 mg/mL. IV bolus: Add 10 mL of sodium chloride 0.9% to 40 mg powder for reconstitution to make a volume of 10 mL with a concentration of 4 mg/mL
Administration	IV: IV infusion — over 15 min IV bolus — over at least 2 minutes. Oral: Give ½ hour before feed. Shake well before use
Storage	IV: Store below 25°C. Protect from light. Oral: as per pharmacist recommendation.
38. Fentanyl	
Indication	Analgesia and sedation in ventilated newborns
Dosage	Intravenous bolus 0.5 to 4 microgram/kg as a single dose. Repeated as required (usually every 2 to 4 hours) Intravenous Infusion 1 to 5 microgram/kg/hour (titrate to response)
Route	IV
Preparation	IV push: IV Push Use prefilled syringes if available Dilution: Use fentanyl 100microg/2mL ampoules to prepare. Dilute 50 microgram (1mL) of fentanyl and make up to a final volume of 5mL with a compatible fluid. Concentration = 10 microg/mL IV Infusion:
Administration	IV push: Administered as a push over at least 3 minutes. Rapid administration of fentanyl is associated with hypotension, bradycardia, apnoea, respiratory depression and muscle rigidity. Infusion calculation:

	Use fentanyl 100microg/2mL ampoules to prepare. Dilute 50 microgram (1mL) per kg of baby's weight and make up to a final volume of 50mL with a normal saline or dextrose 5%. **1 mL/hour = 1 microgram/kg/hour** Example: To prepare an infusion for a 900g infant Weight = 0.9kg Dose in infusion = 50 microgram x 0.9 kg = 45 microgram Dilute 45 microgram (0.9 mL) to 50 mL with a compatible fluid(D5 or NS)
Storage	Store ampoule at room temperature, below 25°C The dilution solution is stable at room temperature for 24 hours. (prepare a new solution if continuing after 24 hours)
39. levetiracetam	
Indication	Control of seizures unresponsive to second line therapy
Dosage	Loading dose: 15-20 mg/kg Maintenance dose (start 24 hours after loading dose): 10 mg/kg/day in 2 divided doses Weekly increase by 5-10mg/kg/day Typical maintenance dose: 30-40 mg/kg/day max. 60 mg/kg/day
Route	IV
Preparation	Take 1mL (100mg) of 100mg/mL levetiracetam concentrated injection and add to 9mL of glucose 5% (preferred) or normal saline, mix well. This creates a solution containing 100mg in 10mL (10mg/mL).
Administration	Administer slowly over 15 minutes.
Storage	Store ampoule below 25°C. Diluted solution: Stable for 24 hours at 2−8°C or 6 hours at 25°C
40. vitamin D	
Indication	Prophylaxis for all LBW/prematures
Dosage	400-500 IU for term babies 800-1000 IU for preterm babies
Route	orally
41. Tetracycline eye ointment	
Indication	Prophylaxis for all newborn infants to prevent eye infections and treatment of eye infections
Dosage	Prophylaxis: 1 % tetracycline eye ointment stat Treatment: 1 % tetracycline eye ointment 6 hourly for 7 days
Route	Topical
Administration	Apply Inside the lower lid beginning with the side of the nose and extending to the opposite side of the lid.
42. Elemental Iron	
Indication	Prophylaxis for all LBW/prematures
Dosage	2-4 mg/kg/day in 2-3 divided doses; starting at 3 weeks until 3-9 months of age(Check Hb at follow up visits to decide on duration)
Route	orally
Administration	Prophylactic iron supplementation should be started once the infant is on full enteral feeds
43. Multivitamins	
Indication	Prophylaxis for all LBW/prematures
Dosage	Dose depends on the manufacturer Duration: 6 months
Route	orally

A

Clear airway if needed:

- Slightly extend the neck to keep the airway open.
  Note: If the neck is flexed or overextended, air may not enter freely.
- If there are secretions remove secretions
  - By using a cloth for wiping if there are minimal secretions
  - By using a penguin sucker if secretions are thick and larger amounts, and for suctioning the nose
- If there are no secretions avoid unnecessary suctioning
- How to suction the airway:
  - Do brief suctioning only (do not suction with the aim of clearing all secretions but to open the airway)
  - Suck the mouth first, then the nose (to avoid aspiration of large amount of secretions in the mouth)

  NB: Suctioning too long, too vigorously, too deeply, or too often can cause injury, slow down heart rate and prevent breathing



Remove secretions from the airway ONLY IF:

- They are blocking the mouth or nose,
  OR,
- There is meconium in the amniotic fluid AND the newborn is not breathing

B

If still not breathing or gasping:

- Shout for help
  - "Msaada, resuscitation!"
  - Urgency of the situation should be known by the way of shouting (e.g. tone of voice)
  - If possible, the name of the required person should be mentioned
- Clamp and cut the cord and move the newborn to the resuscitation area
  - Change gloves before cutting the cord

- Follow procedure of cord cutting as explained above
- Inform the mother on the newborn's situation

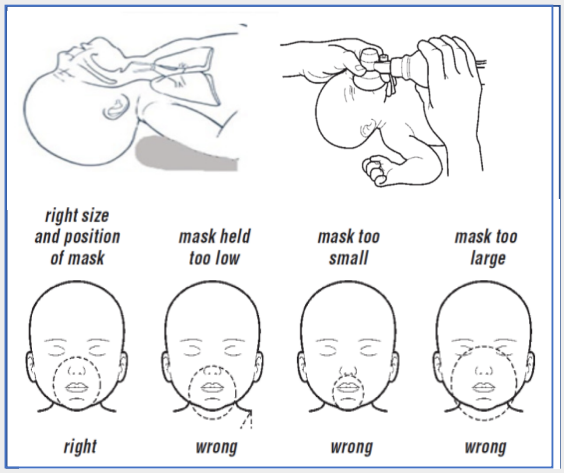
- Start positive pressure ventilation within the Golden Minute (= within 60 seconds afterbirth)

Improve ventilation

Perform ventilation

B

- Stand by the newborn's head
- Choose the correct mask size
- Position the mask over mouth and nose of the newborn
- Use the C-E-grip to hold the mask and to create a good seal
- Using the same grip, perform a slight head tilt by extending the neck and do a jaw thrust
- Give 40-60 ventilation breaths per minute, give just enough volume to see the chest rising
- Continuously evaluate newborn during ventilation: Chest movement? Breathing?



NB: Cutting the cord has to be done quickly and should not delay ventilation.

➔ If still not breathing and no/inadequate chest movement during positive pressure ventilation:

C	If still not breathing: • Check heart rate (NB: remember all the events so that you can assign Apgar score later) • Heart rate is checked by using stethoscope or by feeling for cord pulsations. • This is done by the 2nd person. • Report the heart rate to the team. • If heart rate is ≥ 100 /min and newborn is breathing: Stop ventilation and monitor the newborn with the mother. • If heart rate is ≥ 100 /min and newborn is not breathing: Continue ventilation and monitor heart rate every minute. • If heart rate is < 100 /min: Refer to section on advanced life support. • If heart rate is 60 – 100 /min: Check for adequate chest movements, improve ventilation while observing the heart rate. The most sensitive indicator of a successful response to resuscitation is an increase in heart rate

Advanced life support

This is applicable in a setting where there is staff with enough knowledge, skills and experience to provide advanced life support to newborns. At least three people are required once drugs are needed.

This entails chest compressions, giving oxygen, giving medications to stimulate the heart and managing any other cause of poor response to resuscitation.

4. **Chest compressions (Compression of the sternum to exert pressure on the heart to forcefully circulate the blood)**
    a. Indication: Heart rate < 60 /min despite effective ventilation
    b. Procedure