



MINISTRY OF HEALTH

NEONATAL CARE CLINICAL GUIDELINES



THE KINGDOM OF ESWATINI 2018

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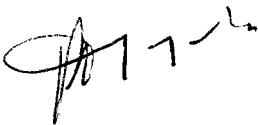
FOREWORD

The first 28 days of life (the neonatal period) is the most vulnerable time for a child's survival. Globally about 2.6 million children die in the first month of life, with approximately 7,000 newborns dying every day, most of which occur within the first week of life. Neonatal mortality contributes significantly to under-five deaths (WHO, 2016). Each of these deaths is a tragedy particularly because many of these deaths are preventable.

The Kingdom of Eswatini experiences high neonatal mortality rates, with a rate of 20 per 1,000 live births (MICS 2014). As a country, we commit to working tirelessly to reduce the neonatal mortality rates by putting in place all necessary health interventions, ensuring that we meet the global SDG target of less than 10 deaths per 1,000 live births by 2030 and putting an end to preventable neonatal deaths.

This first edition of our national neonatal care clinical guidelines is an initiative that aims to ensure that all the neonates in the Kingdom of Eswatini are offered standard, best quality of care and the best possible start in life. The guidelines have been formulated from various global sources and tailored to the needs and health practises of the country. They are designed to serve as a guide to all healthcare providers in the country to provide standardized quality neonatal care.

I would like to congratulate the team that worked with zeal and commitment to ensure that this initiative was a success. I hope that the guidelines will offer great learning and will be a useful resource to all healthcare workers caring for neonates. In siSwati we have a slogan 'Bantfwana bangumliba loya embili' that means that children are the future. We will continue to strive to let our neonates thrive.



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ABBREVIATIONS

ACTH	Adrenocorticotrophic hormone
AGA	Appropriate for gestational age
ARV	Antiretroviral
ASD	Atrial septal defect
AXR	Abdominal X-ray
BP	Blood pressure
BPD	Bronchopulmonary dysplasia
BPM	Beats per minute
CAH	Congenital adrenal hyperplasia
CHF	Congestive heart failure
CNS	Central nervous system
CMP	Calcium, magnesium, phosphorus
CMV	Cytomegalovirus
CXR	Chest X-ray
CO₂	Carbon dioxide
CPAP	Continuous positive airway pressure
CRP	C-reactive protein
DA	Ductus arteriosus
DAT	Direct antiglobulin test
DNA	Deoxyribonucleic acid
DW	Dextrose water
ELBW	Extremely low birth weight
ETT	Endotracheal tube
ECG	Electrocardiogram
EEG	Electroencephalogram
FiO₂	Fractional inspired oxygen
FFP	Fresh frozen plasma
GA	Gestational age
GBS	Group B streptococcus
Hb	Haemoglobin

HDN	Haemolytic disease of the newborn
HFOV	High frequency oscillatory ventilation
HIE	Hypoxic ischaemic encephalopathy
HIV	Human immunodeficiency virus
Hr	Hour
IAP	Intrapartum antibiotic prophylaxis
IM	Intramuscular
IMV	Intermittent mechanical ventilation
INR	International normalized ratio
IV	Intravenous
IVH	Intraventricular haemorrhage
K	Potassium
KMC	Kangaroo mother care
LBW	Low birth weight
LGA	Large for gestational age
LFT	Liver function test
MAP	Mean airway pressure
MAS	Meconium aspiration syndrome
Max	Maximum
mg	Milligram
Mg	Magnesium
MgSo4	Magnesium Sulphate
Mmol	Millimol
MRI	Magnetic resonance imaging
Na	Sodium
NE	Neonatal encephalopathy
NICU	Neonatal intensive care unit
NO	Nitric Oxide
NPO	Nil per os
PDA	Patent ductus arteriosus
PEEP	Positive end-expiratory pressure

PIP	Peak inspiratory pressure
PMTCT	Prevention of mother to child transmission
PO	Per os
PPHN	Persistent pulmonary hypertension of the newborn
PUV	Posterior urethral valves
RBC	Red blood cells
RDS	Respiratory distress syndrome
Rh	Rhesus
ROP	Retinopathy of prematurity
SGA	Small for gestational age
SIADH	Syndrome of inappropriate antidiuretic hormone secretion
SIMV	Synchronized intermittent mandatory ventilation
TB	Tuberculosis
TPN	Total parenteral nutrition
TSB	Total serum bilirubin
TSH	Thyroid-stimulating hormone
TTN	Transient tachypnoea of the newborn
U&E	Urinalysis and electrolytes
UTI	Urinary tract infection
VLBW	Very low birth weight
VSD	Ventricular septal defect
Vt	Tidal volume
WBC	White blood cells

INTRODUCTION

The Kingdom of Eswatini is a lower middle-income country with an estimated population of approximately 1.1 million people (Population Census 2017). The fertility rate is 3.14 children per woman of childbearing age. The proportion of births attended by skilled personnel is approximately 88% (MICS 2014), with a neonatal mortality rate of 20 deaths per 1,000 live births (compared to the infant mortality rate of 85 deaths per 1,000 live births). In 2016, neonatal deaths ranked 12th in the list of childhood mortality in Swaziland and ranked 6th of all causes of years of life lost in 2016. Preterm births composed about 1 out of 9 births and ranked 7th of all causes of death and disability combined in Eswatini.

Given the large number of newborn babies born to mothers in Eswatini, combined with the limitation of resources, the Kingdom of Eswatini mobilized partners through the Ministry of Health, in cooperation with UNICEF and WHO, to systematically provide evidence-based, high-quality standards of care to ensure the health of newborns born in the country in an attempt to meet the Sustainable Development Goals. It is from this desire for better care for the babies of Eswatini that the first-ever Kingdom of Eswatini Neonatal Care Clinical Guidelines were developed. The guidelines are the collection of global best practices that are modified for the practical use by all healthcare workers and healthcare facilities in Eswatini.

The guidelines also include a quick reference section for readily-available retrieval of important neonatal care instruction for healthcare workers in the field, in addition to guidance for a wide range of medical problems encountered by health professionals in the neonatal care facilities. The guidelines also assist in establishing criteria for admission, discharge, as well as referral and transport to higher, more intensive levels of care throughout the healthcare continuum in the country.

CHAPTER 01

ROUTINE CARE OF THE NEWBORN AT BIRTH AND BEYOND

1.1 IMMEDIATE NEWBORN CARE AT BIRTH

Although most newborn babies require only simple supportive care at and immediately after delivery, immediate care of the newborn is essential for the survival of the babies.

The following steps should be followed to provide essential immediate care for newborns:

STEP 1

DRY AND STIMULATE THE BABY

- Immediately after birth, dry the baby, especially the head, with a warm dry towel and discard the wet towel. Cover the baby with a dry towel.
- Newly born babies who do not breathe spontaneously after thorough drying should be stimulated by rubbing the back 2–3 times before clamping the cord and initiating positive pressure ventilation.

NOTE:


Do not handle the baby upside down, slap the feet and pinch the chest.

STEP 2**ASSESS THE BABY'S BREATHING AND COLOUR**

As you dry the baby, check to see if:

- The baby is breathing (normal rate is 30 to 60 breaths per minute).
- The baby's skin colour is pink. If the baby is having trouble breathing/gasping/or not breathing: quickly clamp and cut the cord, leaving a stump at least 10 cm long, call for help and start resuscitation immediately.
- A blue colour of the tongue, lips and trunk is a sign of a lack of oxygen in the blood.
- A bluish colour of only the hands and feet may be present after birth and usually does not indicate a lack of oxygen.
- Continuously assess the APGAR score at 1, 5 and 10 minutes (refer to Figure 1).

Figure 1: Apgar score

	0 POINTS	1 POINT	2 POINTS	POINTS TOTALED	
Activity (muscle tone)	Absent	Arms and legs flexed	Active movement		
Pulse	Absent	Below 100bpm	Over 100bpm		
Grimace (reflex irritability)	Flaccid	Some flexion of extremities	Active motion (sneeze, cough, pull away)		
Appearance (skin colour)	Blue, pale	Body pink, extremities blue	Completely pink		
Respiration	Absent	Slow, irregular	Vigorous cry		
				Severely depressed	0-3
				Moderately depressed	4-6
				Excellent condition	7-10

NOTE

Routine nasal, oral and tracheal suctioning is not recommended in neonates born through liquor with or without meconium who start breathing on their own and are vigorous (active).

- In neonates born through clear amniotic fluid who do not start breathing after thorough drying and rubbing the back 2–3 times, suctioning of the mouth and nose should not be done routinely before initiating positive pressure ventilation. Suctioning should be done only if the mouth or nose is full of secretions.
- In neonates born through meconium-stained amniotic fluid who do not start breathing on their own, suctioning of the mouth and nose should be done before initiating positive pressure ventilation.



Deep and aggressive pharyngeal stimulation with a suction catheter may cause arrhythmia and should be avoided.

STEP 3

CLAMP AND CUT THE CORD

- Cut the cord within 1 to 3 minutes after birth for all births while initiating simultaneous essential newborn care.
- Early cord clamping (<1 minute after birth) is not recommended unless the neonate is asphyxiated and needs to be moved immediately for resuscitation.
- DO NOT apply anything on the cord stump and leave it uncovered.
- Clean, dry cord care is recommended for newborns born in health facilities and at home.

STEP 4

KEEP THE BABY WARM

- Newborns without complications should be kept in skin-to-skin contact with their mothers during the first hour after birth to prevent hypothermia and promote breastfeeding.
- Cover the mother and the baby with a clean blanket/cloth.

STEP 5**HELP THE MOTHER INITIATE BREASTFEEDING**

- Help the mother initiate breastfeeding within the first hour of birth (most newborn babies are ready to feed as early as 15 minutes after birth).
- Help the mother with correct positioning, attachment and suckling.
 - » Babies should be placed in skin-to-skin contact immediately after birth for at least an hour.
 - » Mothers should be supported to initiate breastfeeding within 1 hour after delivery and to recognize when their babies are ready to breastfeed.
 - » All newborn babies should be kept close to their mothers (rooming in) to ensure frequent feeding. This also helps in early secretion of breast milk and better milk flow.
 - » Counsel mothers and support them on correct positioning and attachment to promote milk flow and prevent breast conditions.
 - » Promote exclusive breastfeeding for the first six months.
 - » Provide counselling on appropriate and adequate complementary feeding from six months of age while continuing breastfeeding.
 - » Promote continued breastfeeding up to the age of 24 months or beyond.
 - » Counsel on adherence of HIV treatment for HIV-positive mothers to reduce transmission of HIV through breast milk.
 - » If mother opts not to breastfeed, assess the home conditions before decision is made (refer to the national guidelines on infant and young child feeding).

STEP 6**GIVE EYE CARE AND ANTIRETROVIRAL (ARV) PROPHYLAXIS**

- Within 1 hour after birth, give the newborn eye antimicrobial medication to protect the baby from serious eye infection.
- Give ARV prophylaxis to all HIV-exposed neonates according to the national guidelines on prevention of mother to child transmission (PMTCT).

STEP 7**PREVENT BLEEDING**

- Give 1 mg of vitamin K intramuscularly (IM) to all neonates (including preterm) after birth.
- Give 0.5mg vitamin K IM to neonates less than 1kg.
- Check if cord stump is bleeding; if it is, put on an additional clamp between the abdomen and the existing clamp.

STEP 8**IDENTIFY INFANT**

- Place the infant's identification band on the wrist or ankle with mother's name and sex of the baby on it.

STEP 9**WEIGH THE NEWBORN**

- It is not necessary to weigh the baby immediately after birth; all infants should be weighed after stabilization and warmth.
- The completion of the first breastfeed should be given priority over weighing.
- A single-use paper towel or a sterile cloth towel should be placed on the weighing scale beneath the infant.
- The weighing scale must be periodically (at least weekly) calibrated.
- Inform the mother of the newborn's weight and sex.
- Record weight on mother's chart, delivery book and other records as necessary.

STEP 10**RECORD ALL OBSERVATIONS AND TREATMENT PROVIDED IN THE APPROPRIATE CHART**

1.2 NEONATAL RESUSCITATION

1. High-risk deliveries that may require resuscitation include:

- ≤ 36 weeks gestation.
- Meconium staining.
- Foetal distress.
- Known congenital malformations.
- Multiple births.
- Malpresentation.
- Maternal complications such as diabetes, haemorrhage, hypertension.

See Figure 2 on neonatal resuscitation algorithm.

NOTE:

Neonatal resuscitation is **NOT** recommended for extremely low birth weight (ELBW) less than 600g or 26 weeks gestational age (GA).

Recommended ventilation support at above 850g.

2. Personnel

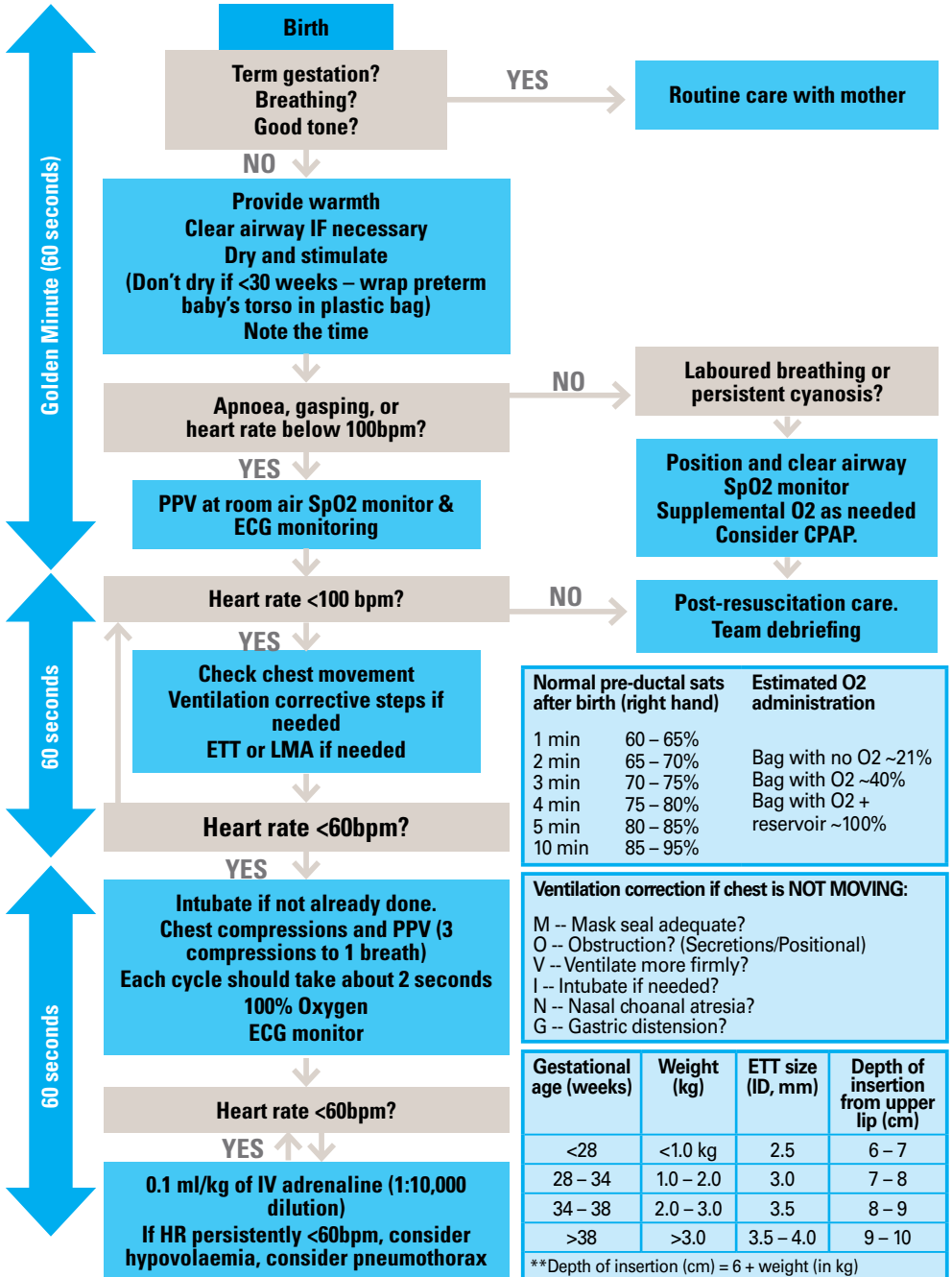
Every delivery should be attended by at least two trained personnel.

- One is responsible for the mother, another for the infant, and should be capable of initiating resuscitation.
- Either person or someone else who is immediately available should have the skills required to perform a complete resuscitation.



When resuscitation is anticipated, additional personnel should be present in the delivery room before the delivery occurs.

Figure 2: Neonatal resuscitation algorithm



Normal pre-ductal sats after birth (right hand)		Estimated O2 administration
1 min	60 – 65%	Bag with no O2 ~21%
2 min	65 – 70%	Bag with O2 ~40%
3 min	70 – 75%	Bag with O2 + reservoir ~100%
4 min	75 – 80%	
5 min	80 – 85%	
10 min	85 – 95%	

Ventilation correction if chest is NOT MOVING:

- M -- Mask seal adequate?
- O -- Obstruction? (Secretions/Positional)
- V -- Ventilate more firmly?
- I -- Intubate if needed?
- N -- Nasal choanal atresia?
- G -- Gastric distension?

Gestational age (weeks)	Weight (kg)	ETT size (ID, mm)	Depth of insertion from upper lip (cm)
<28	<1.0 kg	2.5	6 – 7
28 – 34	1.0 – 2.0	3.0	7 – 8
34 – 38	2.0 – 3.0	3.5	8 – 9
>38	>3.0	3.5 – 4.0	9 – 10

**Depth of insertion (cm) = 6 + weight (in kg)

3. Delivery room

- For the very low birth weight (VLBW) infant in the stabilization room, remember thermal control is a major issue!
 - » Raise the air temperature of the stabilization room to a maximum and raise the temperature of the scrub room to 25°C.
 - » As soon as possible after drying the infant, cover with recommended food-grade polyethylene plastic (Cling/Ziploc) or pre-warmed blanket.
- Prior to the birth, have all equipment at the bedside and verify that it is functioning properly. It is VITAL to check your equipment and have the appropriate sizes handy!
 - » Prepare infant resuscitator with appropriate settings preset and O2 on.
 - » Laryngoscope with functioning bulb and correct size blade.
 - » Endotracheal tube (ETT).
 - » Suction machine.
 - » CO2 detector.

APGAR SCORE DURING RESUSCITATION

- The Apgar score at 1, 5 (10, 20) minutes after delivery gives you a retrospective idea on the effectiveness of the resuscitation.
- The Apgar scores should be recorded in the neonate's birth record. Complete documentation of the events taking place during resuscitation must also include a description of interventions performed and their time.

It is not a tool to determine the initiation or the decisions about the course of resuscitation.

4. Post-resuscitation care

- An infant who has required resuscitation must have close monitoring and management of oxygenation, infection, blood pressure (BP), fluids, apnoea, blood sugar, feeding and temperature. Be careful not to overheat the infant during or following resuscitation.

5. Withdrawal of resuscitation

Discontinuation of resuscitation efforts may be appropriate if there are no signs of life in an infant after 15-20 minutes of complete and adequate resuscitation efforts.

1.3 NEWBORN CARE DURING THE FIRST DAY

Assess the baby

Assess the baby every 30 minutes to 1 hour for at least 6 hours or until the newborn is stable and stays warm and pink. On the first day, check the baby for the following:

1. Breathing: the normal baby breathes 30-60 times a minute with no gasping, grunting or in-drawing of the chest.
2. Warmth: check if the baby is warm - use a thermometer to take an axillary temperature (must be between 36.5°C to 37.4°C).
3. Colour: check that the tongue, lips and mucous membranes (inside the mouth) are pink.
4. Bleeding: check the cord for bleeding; if present, add another cord clamp.
5. Breastfeeding: check if the baby is breastfeeding.
6. Take a complete history (maternal history, antenatal history and labour/delivery) and do a physical examination.

1.3.1 ASSESSMENT OF NEWBORN

Assessment of a newborn infant is generally performed within 24 hours of life to identify any abnormality that would alter the normal newborn's course or identify a medical condition that should be addressed. It includes the review of the maternal, family and prenatal history and a complete physical examination.

History

- The maternal background:
 - » The mother's age, gravidity and parity.
 - » The number of infants that are alive and the number that are dead. The cause of death and age at death.
 - » The birth weight of the previous infants.

- » Any problems with previous infants, e.g. neonatal jaundice, preterm delivery, congenital abnormalities.
- » The home and socioeconomic status.
- » Family history of congenital abnormalities.
- » Still births.
- » Review of the parents' medical and genetic history.
- The present pregnancy:
 - » GA based on menstrual dates and ultrasound examination.
 - » Problems during the pregnancy, e.g. vaginal bleeding.
 - » Illnesses during the pregnancy, e.g. rubella, tuberculosis (TB), hepatitis B, vaginal infection, thyroid, urinary tract infection (UTI).
 - » Smoking, alcohol or medicines taken.
 - » Venereal disease research laboratory or rapid plasma reagin test results. Treatment if syphilis diagnosed.
 - » HIV status: antiretroviral treatment, CD4 count and viral load if HIV positive.
 - » Blood groups, haemoglobin (Hb) and an assessment of foetal growth and condition.
- Events surrounding labour and delivery:
 - » Spontaneous or induced onset of labour.
 - » Duration of labour.
 - » Duration of rupture of membranes and the characteristics of the liquor (amount and the smell).
 - » Method of delivery.
 - » Signs of foetal distress.
 - » Problems during labour and delivery.
 - » The newborn's condition at delivery and any resuscitation needed.
 - » Medicines given to the mother, e.g. steroids, pethidine, antiretroviral treatment.

- Infant at delivery:
 - » Apgar score and any resuscitation needed.
 - » Any abnormalities detected.
 - » Birth weight and head circumference.
 - » Estimated gestational age.
 - » Vitamin K given.
 - » Placental weight.

- Infant since delivery:
 - » Time since delivery.
 - » Feeds given.
 - » Urine and meconium passed.
 - » Any clinical problems, e.g. hypothermia, respiratory distress, hypoglycaemia.

- Contact between infant and mother. Risk factors for sepsis: particularly for Group B streptococcal (GBS) infection.
 - » Intrapartum temperature $\geq 38^{\circ}\text{C}$ (100.4°F).
 - » Membrane rupture ≥ 18 hours.
 - » Delivery at <37 weeks gestation.
 - » Chorioamnionitis.

Physical examination

The examination can be performed in the nursery or the mother's room. The area should be warm and quiet and should have good lighting.

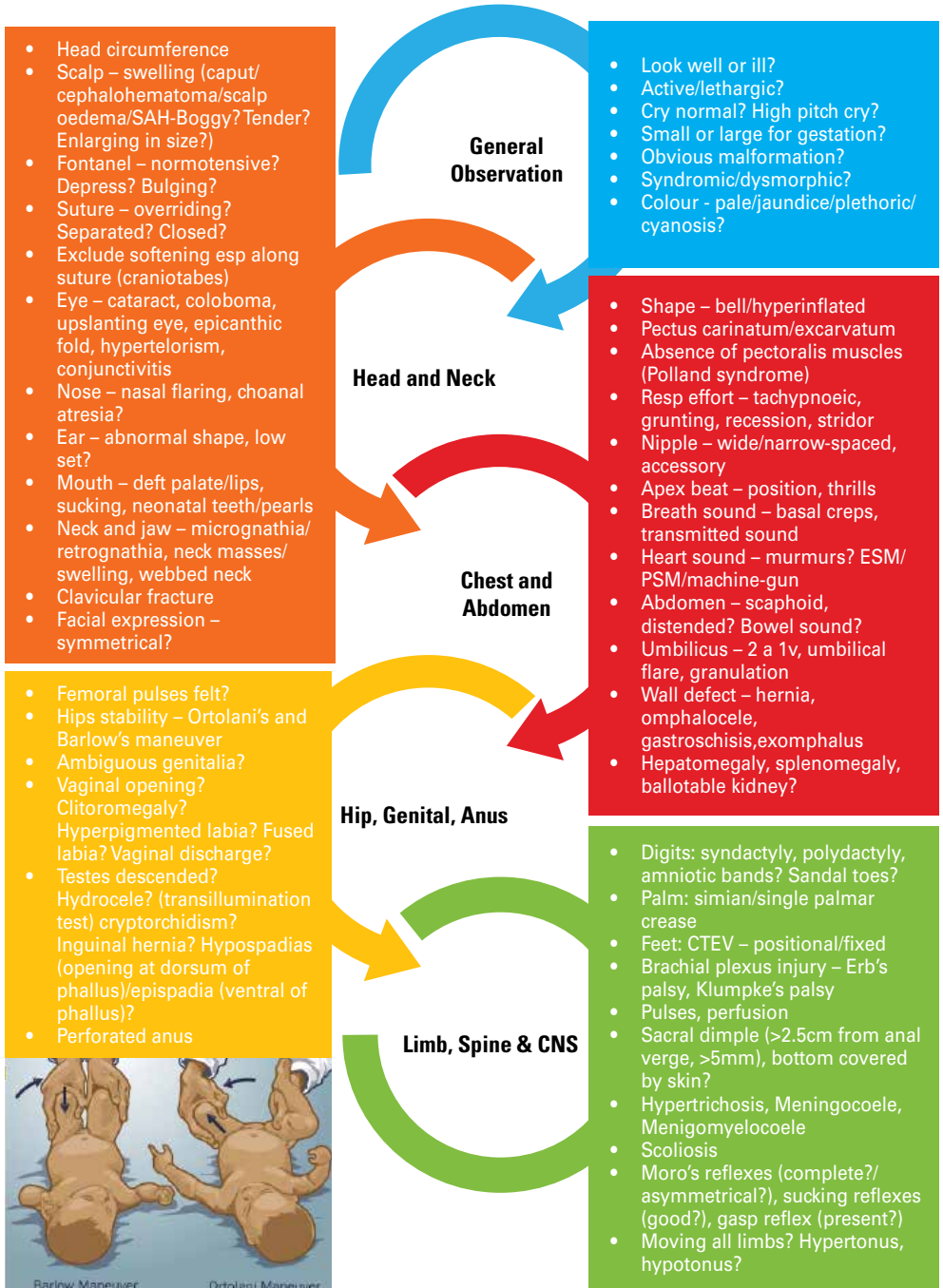
The examination includes:

- Vital signs (See Table 1 for details).
- Observation of the infant's general appearance including their body position at rest, body movement, colour and respiratory effort.
- Body measurements (i.e. weight, length and head circumference).
- Examination of individual body parts and organs.
- Glucose measurement where indicated and baby at risk.

Table 1: Vital signs

Pulse	100-160
Temperature	35.6-37.4
Respiratory rate	30-60
Blood pressure	MBP = current gestation age
Blood sugar	2.6-11mmol/l
Oxygen saturation	88-94

See Figure 3 and Annex I for details on the physical examination of the baby.

Figure 3: Physical examination of the baby

Gestational age assessment

All infants admitted to neonatal care units should have a complete GA assessment using the Ballard Score (see Annex II).

Classification of newborns

Based on GA:

- Preterm: less than 37 completed weeks (259 days).
- Term: 37-41 weeks and 6/7 days (260-294 days).
- Post-term: 42 weeks (295 days) or more.

Based on birth weight:

- Normal birth weight: from 2,500-3,999g.
- Macrosomia weight: ≥ 4000 g.
- Low birth weight (LBW): less than 2,500g.
- Can be further classified to:
- Very low birth weight (VLBW): less than 1,500g.
- Extremely low birth weight (ELBW): less than 1,000g.

Based on maturity and intrauterine growth:

- Small for gestational age (SGA): defined as 2 standard deviations below the mean weight for GA or below the 10th percentile.
- Appropriate for gestational age: 10th to 90th percentile.
- Large for gestational age (LGA): defined as 2 standard deviations above the mean weight for GA or above the 90th percentile.

NOTE:

LGA can be seen in infants of diabetic mothers, infants with Beckwith's syndrome, constitutionally large infants with large parents or infants with hydrops foetalis.

1.4 NEWBORN SCREENING

Newborn screening varies by state and is subject to change, especially given advancements in technology. However, the disorders listed here are those usually included in newborn screening programmes:

- Phenylketonuria.
- Congenital hypothyroidism.
- Galactosemia.
- Sickle cell disease.
- Biotinidase deficiency.
- Congenital adrenal hyperplasia (CAH).
- Maple syrup urine disease.
- Tyrosinemia.
- Cystic fibrosis.
- Medium-chain acyl-CoA dehydrogenase deficiency.
- Severe combined immunodeficiency.
- Toxoplasmosis.

1.4.1 HEARING EVALUATION IN CHILDREN

In the first few years of life, hearing is a critical part of children's social, emotional and cognitive development. Even a mild or partial hearing loss can affect a child's ability to develop speech and language properly. The good news is that hearing problems can be overcome if caught early — ideally by the time a baby is 3 months old. Therefore, early and regular hearing screens are recommended.

Causes of hearing loss

Hearing loss is a common birth defect, affecting about 1 to 3 out of every 1,000 babies. Although many things can lead to hearing loss, approximately half of the time, no cause is found.

Hearing loss can occur if a child:

- Was born prematurely.
- Stayed in the neonatal intensive care unit (NICU).
- Had newborn jaundice with bilirubin levels high enough to require a blood transfusion.
- Was given medications that can lead to hearing loss (e.g. gentamicin).
- Has family members with childhood hearing loss.
- Had certain complications at birth.
- Had many ear infections.
- Had infections such as meningitis or cytomegalovirus.
- Was exposed to very loud sounds or noises, even briefly.

When should hearing be evaluated?

Newborn hearing screening identifies most children born with a hearing loss. But in some cases, the hearing loss is caused by things like infections, trauma and damaging noise levels, and the problem doesn't emerge until later in childhood.

All newborns should have a hearing screening before being discharged from the hospital or within the first 3 weeks of life. The failure to pass the test does not necessarily mean there is hearing loss. Because debris or fluid in the ear can interfere with the test, it is often redone to confirm within 3 months so treatment can begin right away. This treatment can be the most effective if started before a child is 6 months old.

Hearing tests are usually done at ages 4, 5, 6, 8 and 10 years, and any other time if there is a concern.

Symptoms of hearing loss

Even if the newborn passes the hearing screening, continue to watch for signs that hearing is normal.

Some normal hearing milestones in the first year of life include the following:

- Most newborn infants startle or “jump” to sudden loud noises.
- By 3 months, a baby usually recognizes a parent’s voice.
- By 6 months, a baby can usually turn his or her eyes or head toward a sound.
- By 12 months, a baby can usually imitate some sounds and produce a few words, such as “mama” or “bye-bye.”

As the baby grows into a toddler, signs of hearing loss may include:

- Limited, poor or no speech.
- Frequently inattentive.
- Difficulty learning.
- Seems to need higher TV volume.
- Fails to respond to conversation-level speech or answers inappropriately to speech.
- Fails to respond to his or her name or easily frustrated when there’s a lot of background noise.

Types of hearing loss

- Conductive hearing loss is caused by a blockage in the transmission of sound to the inner ear (infections).
- Sensorineural hearing loss can happen when the sensitive inner ear (cochlea) has damage or a structural problem, though in rare cases it can be caused by problems with the auditory cortex, the part of the brain responsible for hearing.
- Mixed hearing loss happens when a person has both conductive and sensorineural hearing loss.
- Central hearing loss occurs when the cochlea is working properly, but other parts of the brain are not.

Hearing tests

- Several methods can be used to test hearing, depending on a child’s age, development and health status.

- For neonates, the recommended tests are auditory brainstem response and otoacoustic emissions. Behavioural audiometry is not useful for neonatal hearing screening.

1.4.2 RETINOPATHY OF PREMATURITY SCREENING

Retinopathy of prematurity (ROP) is a proliferative disorder of the developing retinal blood vessels in preterm infants that can lead to blindness.

Who to screen:

- Infants with birth weights <1500g or less than 30 weeks GA.
- *Selected* infants with birth weights between 1500g and 2000g or over 30 weeks GA with unstable clinical course or high risk of ROP (e.g. requiring mechanical ventilation).

Babies who meet criteria should be referred to an ophthalmologist.

Table 2: When to screen

TIMING OF THE FIRST RETINOPATHY OF PREMATURITY SCREENING EXAMINATION		
Gestational age at birth, weeks	Age at initial examination, weeks	
	Postmenstrual age	Chronological age
22	31	9
23	31	8
24	31	7
25	31	6
26	31	5
27	31	4
28	32	4
29	33	4
≥30	≥34	4

1.5 SUBSEQUENT CARE OF THE NEWBORN

1. Keep the baby warm.
2. Support breastfeeding.
3. Keep the mother and baby together after delivery and they should be covered or kept warm.
4. Give other care for any problems or needs.
5. Teach mother how to care for the baby (warmth, sleep, feeding, bathing, cord care and protecting baby from infection) and common newborn problems.
6. Give vaccinations as per national immunization schedule.
7. Screen the newborn for:
 - Congenital infections as indicated by antenatal history or examination.
 - Metabolic and genetic disorders such as (if available and consult guidelines):
 - » Hypothyroidism.
 - » Sickle cell disease.
 - » Congenital adrenal hyperplasia.
8. Offer HIV testing to mothers with unknown status and those tested negative more than 8 weeks prior to delivery to ascertain neonate exposure status.

1.6 EARLY CHILDHOOD DEVELOPMENT (STIMULATION, NURTURING AND CARE)

- Early child development encompasses physical, socio-emotional, cognitive and motor development between 0-8 years of age (*See Annex III for details on developmental milestones*).
- The early years are critical, because this is the period in life when the brain develops most rapidly and has a high capacity for change and the foundation is laid for health and wellbeing throughout life.

Nurturing care: defined as care that is provided in a stable environment, that is sensitive to children's health and nutritional needs, with protection from threats and opportunities for early learning.

Early childhood stimulation: interactions that are responsive, emotionally supportive and developmentally stimulating to support the potential development of a child.

Why stimulation is important

- Stimulation sparks connections between brain cells and helps a baby's brain to mature.
- Children can see and hear at birth. Starting when they are very young, children need opportunities to use their eyes and ears, in addition to good nutrition.
- For their brains to develop, children also need to move, to have things to touch and explore, and to play with others. Children also need love and affection. All these experiences help the brain to develop.

Recommended actions for stimulation and nurturing

- Skin-to-skin contact in the first hour of life.
- Health workers and mothers should talk to and play with the neonate.
- The wards, nurseries and neonatal care units should be well lit, have bright colours and pictures to stimulate babies' brains through sight.

Preterm and low birth weight

- For preterm neonates, sound and light should be minimized. Kangaroo mother care (KMC) should be encouraged. Nesting is also recommended. The child's face should not be covered.
- Avoid wrapping or swaddling the newborn tightly.
- Encourage the mother and father to hold their child closely.
- Encourage gentle stroking of the child's skin.

1.6.1 NEONATAL CARE ENVIRONMENT

Sound environment

- Avoid loud noise.

Light environment

- **Use dimmed night light.** This will help in starting a day/night sleep schedule and support diurnal variations in hormone and temperature levels.

Positioning

- Nesting is one of the key factors in maintaining the beneficial position of a neonate and should be practiced routinely. It enhances muscle strength and body control.

Handling

- Minimize handling of the neonate to avoid physiological and behavioural stress.

Touch

- KMC facilitates intimate touching of the baby by the mother and should be encouraged. **Beyond KMC, for preterm neonates <30 weeks GA, touch may be stressful rather than soothing. For older preterm neonates, gentle touching can be helpful.**

CHAPTER 02

CARE OF SMALL AND SICK NEWBORN

2.1 ADMISSION

2.1.1 INDICATIONS FOR ADMISSION

- **Prematurity <34 weeks' gestation**
- **LBW < 1800g**
- **Cardiopulmonary problems:**
 - » Central cyanosis
 - » Respiratory distress
 - » Apnoea/bradycardia
 - » Tachycardia >200 beats per minute (bpm)
- **Neonates that required resuscitation**
- **Neurological problems:**
 - » Seizures
 - » Impaired consciousness
 - » Abnormal neonatal reflexes
 - » Severe hypotonia
- **Low 5-minute Apgar score <7**
- **Gastrointestinal and genitourinary problems:**
 - » Delayed passage of meconium beyond 48 hrs
 - » Bile stained vomiting or other signs suggesting bowel obstruction

- » Feeding problems severe enough to cause clinical concern
- » Abdominal masses
- » Delayed passage of urine beyond 24 hrs
- **Haematological problems:**
 - » Pallor
 - » Polycythaemia with venous haematocrit > 65%, or 60-64% with clinical symptoms
 - » Petechiae and purpura
 - » Bleeding
- **Neonatal jaundice requiring treatment**
- **Neonatal infection**
- **Metabolic problems:**
 - » Infant of diabetes mother (IDM)
 - » Hypothermia or hyperthermia
 - » Hypoglycaemia or hyperglycaemia
- **Dehydration**
- **Electrolyte disturbances**
- **Congenital malformations**
- **Birth injuries**
- **Surgical conditions**

2.1.2 COMPLICATIONS IN PRETERM AND LOW BIRTH WEIGHT NEONATES

Preterm neonates

The basic underlying feature of the preterm LBW infant is immaturity of its organ systems. These babies are prone to develop:

- Hypothermia.
- Asphyxia necessitating resuscitation.
- Respiratory distress syndrome (RDS).

- Feeding problems.
- Apnoeic spells.
- Intraventricular haemorrhage (IVH).
- Hypoglycaemia.
- Hyperbilirubinaemia.
- Infection.
- ROP.

2.2 PRETERM RESUSCITATION

NOTE:

No resuscitation for ELBW less than 600g or 26 weeks GA.

Ventilation support recommended at above 850g.

Preterm babies are at additional risk for requiring resuscitation because of their:

- Excessive heat loss.
- Vulnerability to hyperoxic injury.
- Immature lungs and diminished respiratory drive.
- Vulnerability to infection.
- Low blood volume, increasing the implications of blood loss.

Additional resources needed to prepare for an anticipated preterm birth include:

- Additional trained personnel, including intubation expertise.
- Careful attention for maintaining temperature.
- Compressed air.
- Oxygen blender.
- Pulse oximetry.

Premature babies are more vulnerable to hyperoxia; use an oximeter and blender to gradually achieve oxygen saturations in the 85-95% range during and immediately following resuscitation.

Decrease the risk of brain injury by:

- Handling the infant gently.
- Avoiding the Trendelenburg position.
- Avoiding high airway pressures, when possible.
- Adjusting ventilation gradually, based on physical examination, oximetry and blood gases (See Annex IV on interpretation of blood gases).
- Avoiding rapid intravenous fluid boluses and hypertonic solutions because of the risk of IVH.

After resuscitation:

- Monitor and control blood glucose level.
- Monitor for apnoea, bradycardia or desaturations, and intervene promptly.
- Monitor and control oxygenation and ventilation.
- Consider delaying feeding if perinatal compromise was significant.
- Increase your suspicion for infection.

2.3 MANAGEMENT OF LOW BIRTH WEIGHT BABIES WEIGHING $\geq 1800\text{G}$

- These babies can be kept with the mother in the postnatal ward as long as they are well. However, they require extra assistance and monitoring including temperature, blood sugar and assessment for respiratory distress.
- KMC should be provided as part of routine care of newborns weighing 2000g or less at birth and should be initiated in healthcare facilities as soon as the newborns are clinically stable.
- Intermittent KMC should be done for newborns weighing 2000g or less at birth, if continuous KMC is not possible.

- The mothers of these babies need to be educated and supported on a regular basis by the healthcare providers on the postnatal ward. The training of the mother during her stay should include:
 1. KMC (to be done for stable babies).
 2. Assessment of temperature by touch technique or training on how to use a digital thermometer.
 3. Breastfeeding and expression of milk.
 4. Recognition/reporting of danger signs.
- LBW babies in the postnatal ward should be discharged from hospital only when breastfeeding is well established.
- Once the mother and the family are confident that they can care for the LBW baby and the baby is clinically well, the LBW baby can be discharged and managed at home.
- A baby who is unable to feed from the breast and cup or is sick should be immediately admitted to the neonatal unit.

2.4 LOW BIRTH WEIGHT BABIES LESS THAN 1800G

- These babies should be monitored and cared for in the neonatal unit. During stabilization and transfer of preterm newborns to specialized neonatal care wards, wrapping in plastic bags/wraps may be considered as an alternative to prevent hypothermia.
- LBW neonates weighing >1200g who do not have complications and are clinically stable should be put in skin-to-skin contact with the mother soon after birth and after drying them thoroughly to prevent neonatal hypothermia.
- Unstable newborns weighing 2000g or less at birth, or stable newborns weighing less than 2000g who cannot be given KMC, should be cared for in a thermal neutral environment either under radiant warmers or in incubators.

2.5 KEEPING LOW BIRTH WEIGHT BABIES WARM

At home

- Encourage KMC at home.
- Baby should be nursed next to the mother and the room should be kept warm. The baby should be well clothed (2-3 layers of clothes).
- The mother should be trained to monitor the baby's temperature by a digital thermometer or hand touch. The baby in cold stress should be given additional warmth immediately.

In the hospital

- Apart from the above methods, an overhead radiant warmer or an incubator may be used to keep the baby warm.
- Regular monitoring of axillary temperature at least once every 6-8 hours should be carried out in all hospitalized babies.

Kangaroo mother care

- It is recommended that all babies less than 2500g should be initiated on KMC as the mother is transferred from the labour ward to the postnatal ward if the baby is clinically stable.

NOTE:

If the mother is a smoker, advise her on the importance of stopping smoking or refraining from it in the room where the baby is. Explain to her the danger of passive smoking for her and other family members and the small infants.

Community health services

- Community health workers/rural health motivators should provide home-based follow up care for LBW babies on KMC discharged from health facilities.
- The rural health motivators should also refer all preterm/LBW babies delivered at home to a health facility for assessment.

2.6 NUTRITION AND FLUIDS

Breast milk feeds should be initiated as soon as the baby is stabilized. The following aspects regarding the feeds should be addressed:

- Quantity of feeds.
- Frequency of feeding.
- Mode of feeding that is appropriate for the baby.

QUANTITY OF FEEDING

- Total daily requirements can be estimated from the table on fluid requirements (see Table 4).
- In a stable, growing LBW baby, daily intake of feeds should be increased to 150ml/kg as made available by the mother and increased thereafter if needed (generally up to 180ml-200ml/kg in babies <1500g).
- The quantity delivered should be monitored and charted.

FREQUENCY OF FEEDING

- LBW babies should initially be fed every 2 hours starting as soon as possible after birth. When the mother's breast milk volume increases, feeds should be given 3-hourly and later on demand.

MODE OF FEEDING

- The neonate at 30 weeks attains the ability to coordinate swallowing with respiration, but still has no suck-swallow coordination. Neonates less than 30 weeks (or 1200g) need to be tube fed (orogastric or nasogastric).
- At 34-35 weeks, the suck-swallow coordination is gained. Babies >34 weeks can be breastfed and those less than 34 weeks, but more than 30 weeks and who weigh between 1200 to 1500g, can be fed by syringe.
- A baby should be put to suckle the empty breast when it is showing sucking movements and hunger cues during skin to skin contact by KMC.

- When the baby is assessed to have suck-swallow coordination, it can be given to feed on a partially filled breast and gradually progress onto a full breast.

LOW BIRTH WEIGHT/SMALL FOR GESTATION AGE BABY

- These babies have all the reflexes and therefore the skill necessary to obtain an adequate amount of milk but get tired easily.
- Breastfeeding should be limited to 10-15mins and the baby given a rest by giving the remainder of the feed by cup (breastfeeding expends more energy than a cup feed). However, when the baby grows and is bigger and stronger, it will be able to extract more from the breast. Demand feeds have to be done once the baby is predominantly breastfed and timed 3-hourly feeds should be stopped.

NOTE:

The gestational age and weight cut-offs are general guidelines only with a safety margin. The baby's condition should guide the decision on mode of feeding.

2.7 NUTRITIONAL SUPPLEMENTS

VITAMIN K

- ELBW <1000g should receive 0.5mg IM at birth and all other babies should receive 0.1mg.

VITAMIN D

- All LBW infants should receive 400 IU daily of vitamin D once they accept full feeds. This supplementation should continue until 6 months of age.
- Larger doses (800-1000) may benefit the smaller babies (<1500g).

VITAMIN A

- A dose of 400- 1000 μ g/kg/day is recommended for preterm infants. Multivitamin drops 0.3ml/day from the time the baby receives full enteral feeds.

CALCIUM AND PHOSPHOROUS

- All VLBW (1500g) should receive calcium 100-220mg/kg/day and phosphorus at 60-140mg/kg/day³ (ostocalcium syrup 5ml = 81mg Ca and 42mg PO₄) in 2 divided doses. This may be continued till 40 weeks post conceptual age or 3.5 to 4 kg.

IRON SUPPLEMENTATION

- <37 weeks and/or <2.5kg – give iron supplementation (can start at 2 weeks of age in babies on full feeds)
 - » 3mg elemental iron/kg/day single dose drops up to 2 years.
 - » If discharged prior to 2 weeks, start at the 2-week follow up clinic.

GROWTH MONITORING

- The weight of all preterm babies should be checked two to three times a week and occipitofrontal circumference weekly during neonatal care stay.

2.8 IMMUNIZATION

- Immunization schedule is the same for LBW babies as other children. However, BCG may be delayed if they are sick. If the baby is completing 2 months at the time of discharge, give BCG and Pentavalent and OPV on the same day.

2.9 DISCHARGE PLANNING

The discharge of these babies must be planned and the following points should be considered prior to discharge:

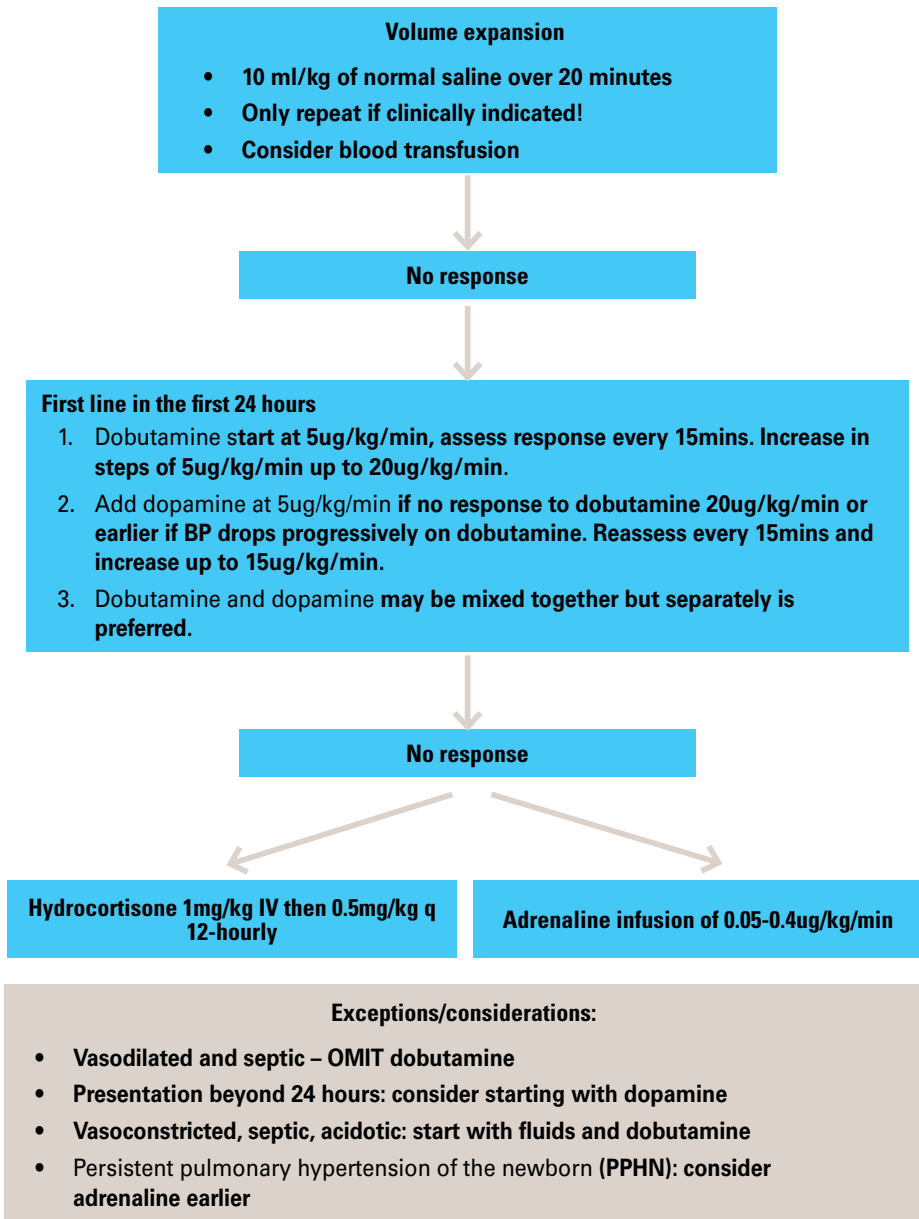
- The weight gain should be consistently demonstrated for 2-3 consecutive measurements if the baby is more than 1 week old (or weight loss should be less than 10%). The weight, head circumference and the length should always be recorded at the time of discharge.
- Mother should be confident in feeding the neonate with any alternate feeding method like a cup.
- Babies who are discharged before a weight gain is evident should be reviewed in 2 to 3 days with regard to feeding and then monitored closely until they demonstrate a steady weight gain.
- The required nutritional supplements should have been started prior to discharge.
- The baby should have received BCG prior to discharge.
- The methods of temperature regulation like KMC and any other necessary skills should have been explained and mastered by the mother with adequate practice in the hospital under supervision.
- All danger signs should be explained in detail to the parents with information regarding whom and where to contact being mentioned on the discharge slip.

2.10 HYPOTENSION IN PRETERM NEONATES

Goals:

- Aim for mean blood pressure (MBP) = current gestational age.
- Monitor indices of perfusion (urine output, lactate, capillary refill) to determine acceptable MBP.
- In the presence of pulmonary hypertension, aim for higher MBP.

Figure 4: Management of hypotension



2.11 NEONATAL HYPOTHERMIA

A baby is hypothermic when axillary temperature is below 35.5°C or core temperature is below 36°C

- **Who is at risk?**
 - » Wet infants (after delivery or bathing).
 - » LBW infants.
 - » Infants requiring resuscitation.
 - » Sick infants, particularly if there is infection.
 - » Infants who are in a cold room.
 - » Infants who are not fed.
 - » Hypoglycaemic infants.
 - » Infants undergoing medical procedures.
 - » Infants born before arrival at a health facility, home delivery.

- **Prevention is the cornerstone of management**
 - » Dry the infant well after birth and wrap in a second warm and dry towel.
 - » Keep the baby with the mother in the kangaroo position.
 - » Nurse babies less than 1.8kg in KMC or in an incubator (at appropriate temperature).
 - » Feed all babies within 30 minutes after birth (unless contraindicated e.g. severe respiratory distress).
 - » Ensure that there is a good overhead heater in the infant resuscitation area.
 - » Keep the room warm, i.e. at 25-26°C, but not higher.
 - » Dress babies in incubators in a nappy and a woollen cap. Do not wrap in a blanket.
 - » Keep the baby away from windows and draughts.
 - » Keep incubators and resuscitaires warm, even when not in use (see *Table 3 for details on incubator temperature settings*).

Table 3: Incubator temperature setting

BIRTH WEIGHT (G)	DAYS OF LIFE						
	0	5	10	15	20	25	30
<1000 - 1500	35.5	35.0	35.0	34.5	34.0	33.5	33.0
1500 – 2000	35.0	34.0	33.5	33.5	33.0	32.5	32.5
2000 – 2500	34.0	33.0	32.5	32.0	32.0	32.0	32.0
2500 – 3000	33.5	32.5	32.0	31.0	31.0	31.0	31.0
>3000	33.0	32.0	31.0	30.0	30.0	30.0	30.0

*Taken from Neonatal Guidelines, Department of Paediatrics, Pietermaritzburg Metropolitan Hospitals Complex

- Check the temperature every ½ to 1 hour and keep the temperature according to the guidelines in the table above. The temperatures are based on the weight and the age of the baby.
- Record the incubator temperature & the baby's temperature at each check.
- Incubator temperature should only be 1°C more than the temperature of the baby.

- **Clinical signs of hypothermia**

- » Cold, lethargy, apnoea, peripheral oedema, sclerema.
- » In severe cases, bleeding and pulmonary haemorrhage may occur.

- **Treatment of hypothermia**

- » Give oxygen until the baby's temperature is normal (longer if indicated by respiratory problem).
- » Ensure an adequate glucose level:
 - Monitor and record the blood glucose levels.
- » Feed the baby with breastmilk, milk or IVF.
- » If temperature is less than 35°C, start IVF (neonatolyte).
- » Warm the baby up as quickly as possible.
- » Place the baby in the KMC position OR in an incubator, set the temperature to 1°C higher than the baby's temperature, and increase as the baby warms up. Cover the baby with a plastic sheet to protect radiant heat loss. Do not cover with blankets or tin foil.
- » Check the temperature ½ hourly until it is normal.
- » Decrease the incubator temperature as the baby's temperature returns to normal (use Table 3 as a guide).
- » Identify and treat the underlying cause.

CHAPTER 03

INFANT FEEDING AND FLUID ADMINISTRATION

3.1 BREASTFEEDING SICK/SMALL NEWBORNS

- Initiate breastfeeding soon after (within one hour) birth in all babies who are born in good condition (who do not require resuscitation at birth) and have a sucking reflex along with coordinated swallowing (more than 32-34 weeks gestation).
- Preterm babies more than 32-34 weeks should be breastfed as soon as they are stabilized.
- Babies who are resuscitated can be breastfed as soon as the baby is stabilized.
- Breastfeed day and night on demand by responding to early hunger cues from the baby.
- A baby will feed about 8 to 12 times a day once the milk production increases after 48 to 72 hours.
- If a sick baby or small baby sleeps for more than 4 hours at a stretch more than once a day, baby may need to be woken up for feeds. Undressing the baby can be used for waking up.

- Babies may tend to sleep at the breast when sick. They may also pull off the breast frequently when they have a blocked nose, etc. Mothers should be advised to give shorter feeds more frequently to overcome these problems. Nasal saline drops or mist can be used for a blocked nose. The normal pattern of breastfeeding should be re-established as soon as the baby is better.
- The baby may refuse to suckle at the breast or suckle less efficiently when sick or preterm. In this instance, mothers should be advised to express the milk and feed preferably via a cup, failing which a gastric tube may need to be used.
- If the baby cannot take oral feeds due to medical reasons, advise mothers to empty their breasts by expressing 3-hourly to maintain the milk supply until the baby is able to resume oral feeds.
- Proper positioning and attachment are important in the establishment of breastfeeding.
- **Indications for nil per os (NPO)**
 - » Neonate is clinically unstable.
 - » Necrotizing enterocolitis.
 - » Progressive abdominal distension or signs of bowel obstruction.

3.2 FLUID ADMINISTRATION AND FEEDING

3.2.1 HOW TO INITIATE FEEDS

Start feeds at 10-20ml/kg/day. Recommended first feed is 2ml/kg and advance as tolerated. Increase by 20ml/kg daily if tolerated until full feeds are achieved. For babies that are not gaining weight adequately, use a human milk fortifier (e.g. FM85).

Table 4: Recommended total daily fluid administration (intravenous and oral) for newborns

	TOTAL DAILY FLUIDS (ML/KG)			SUGGESTED ORAL (ML/KG)
	<1000 g	1000-1500 g	>1500 g	
Day 1	90	75	60	Nil
Day 2	115	100	90	25
Day 3	140	125	120	50
Day 4	140	150	150	75
Day 5	165	165	150	100
Day 6	165	165	150 - 180	125
Day 7	150 - 180	150 - 180	150 - 180	150

- Suggested IV (ml/kg) is calculated by taking the total daily fluids and subtracting the suggested oral
- These values are guides and must be determined by the baby's clinical condition and ability to tolerate
- Drip rate = weight x volume/kg/24 = ml/hour
- If using a 60 drop/ml IV infusion administration set, then ml/hour = drops/min
- ALWAYS USE an infusion controller, buretrol or dial-a-flow when administering fluids to neonates

IV fluids should be prescribed with great care and attention (refer to Table 4).

INDICATIONS FOR CIRCULATORY SUPPORT IN RESUSCITATION

- Fluid replacement and electrolyte deficits.
- Maintenance.
- Replacement of ongoing losses.



The initial fluid for neonates is 5% dextrose water (DW). Fluid rates are adjusted based on amount of oral (enteral) feeds (see above section on infant feeding).

- Always assess the neonate's hydration, peripheral circulation and nutritional status and adjust accordingly.
- In babies, especially LBW with an unsatisfactory weight gain (<15g/kg/day) due to inadequate caloric intake, the total enteral intake can be gradually increased to 180ml/kg/day from day 8.
- Fluid restriction should be considered in the following conditions: patent ductus arteriosus (PDA), bronchopulmonary dysplasia (BPD), oedema, etc.
- Maintain glucose 2.5 - 7mmol/l.
- Monitor the infant's weight daily.
- Urine output: >6 wet nappies indicate good urine output. Sick neonates need urine output monitoring; aim to achieve a minimum urine output of 0.5 - 1ml/kg/hr.
- Serum sodium is a good indicator of hydration status in the first few days of life. Rising sodium indicates dehydration and a falling level indicates over-hydration.
- Fluids could be changed to 5% DW or 10% neolyte depending on the glucose level.

Additional volumes:

- Phototherapy: give extra 20%.
- Radiant warmer: give extra 10%.
- Abnormal gastrointestinal tract losses: e.g. nasogastric aspirates (replace ml for ml).
- Patients on mechanical ventilation.

INTRAVENOUS FLUIDS

1. Neolyte or neonatolyte
 - » Used as the standard maintenance fluid.
 - » In cases of renal failure, consider potassium free neolyte.
2. Half strength Darrows solution
 - » Not to be used routinely in neonates.
3. 5% DW with or without 0.2% NaCl
 - » Used in the event of renal failure, or hyperkalaemia or hyperglycaemia.
4. Normal saline
 - » Used in resuscitation at 10ml/kg.

BICARBONATE

- 4.2% should be used to correct severe or non-resolving metabolic acidosis.
- Dose = base excess \times 0.6 \times weight (kg) = ml NaHCO₃.
- Half of the volume is given in Ca free solution, i.e. (5-10% DW plus 0.2%) over 4-6 hours as a main or side infusion.

3.3 ELECTROLYTE ABNORMALITIES

Hypernatremia

- Serum Na >145 mmol/l.
- Dehydration is a common cause.
- Correct dehydration over 24hrs with 5% DW.
- Avoid intravenous solutions with excessive sodium.

Hyponatremia

- Serum Na <130mmol/l.
- Dilutional hyponatremia.
- Consider if hyponatraemic + weight gain or absence of weight loss.
- May be secondary to: renal dysfunction (reduced urine output), cardiac failure, excessive water intake or syndrome of inappropriate antidiuretic hormone secretion (SIADH).
- Management: establish the cause and restrict fluid intake.
- If serum (Na) <120mmol/l or symptomatic, calculate the sodium deficit and replace deficit with saline over 24 hours. Be careful not to overload the patient with fluid.
- Sodium deficiency:
 - » Hyponatremia + weight loss = sodium and or water depletion.
 - » Common causes: diuretics, GI or renal losses, osmotic diuresis.
- Management: reduce sodium losses, replace sodium and water deficit.
 - » Sodium deficit (in mmol): $(140 - (\text{serum Na})) \times 0.6 \times \text{weight (kg)}$.
 - » 0.9% saline contains 0.15mmol/ml.
 - » 3% saline: Na = 0.5mmol/ml.

Hypokalaemia

- Serum K <3.0mmol/l.
- Can occur in alkalosis, nasogastric or ileostomy losses, renal tubular disorders. Patients may present with lethargy, ileus or arrhythmia.
- Acute cases:
 - » Monitor electrocardiogram (ECG) and replace intravenously (1-3 mmol/l/kg/24 hours). Infuse very slowly over 12-24 hours.

- » Use 15% KCL solution (1ml 15% KCL = 2mmol K+).
- » Recheck serum K+ after 6 -12 hours.
- Chronic cases:
 - » Supplement orally.
 - » 3mmol K+/kg/24 hours in 4 divided doses.
 - » Use Potchlor (5ml = 13mmol K+)
 - » Repeat serum K+ after 24 hours.

Hyperkalaemia

- Serum K >7.0mmol/l.
- Often seen in very preterm infants, renal failure, haemolysis, and sepsis.
- Dangers: ECG changes, arrhythmia, cardiac arrest.
- Haemolysed specimen may falsely elevate K. Repeat test if this is suspected. If ECG changes are present or expected result is delayed, institute measures immediately.
- Management:
 - » Stop all potassium-containing fluid.
 - » Correct acidosis if present (NaHCO₃ 2ml/kg/IV over 15 minutes).
 - » 10% calcium gluconate (0.5-1ml/kg/IV over 3-5min).
 - » Insulin with 10% glucose infusion (0.1u/kg insulin).
 - » Consider kayexalate (1g/kg per rectum or per os, 6-hourly/ per need (prn)).

Hypocalcaemia

- Serum Ca <1.8mmol/l.
- Correct with 10% calcium gluconate solution 1-2ml/kg IV over 10-30 minutes.
- Always dilute with sterile water. Monitor heart rate and stop infusion if the heart rate is <100bpm.
- Refer infants with persistent or recurrent hypocalcaemia to a specialist.

Hypomagnesaemia

- Serum Mg <0.8mmol/l.
- Administer MgSO₄ (50% solution) 0.1-0.2 ml/kg IM or IV.

3.4 TOTAL PARENTERAL NUTRITION

Goal to provide nutritional requirements for the proper growth of an infant that is not able to feed enterally. This is only a temporary measure until the baby is able to tolerate enteral feeds.

GENERAL GUIDELINES

- Minimal caloric requirements to prevent catabolism are at least 40kcal/kg/day.
- For growth, minimal requirements are 80kcal/kg/day and protein intake of >2g/kg/day.
 - » Term infants: 100kcal/kg/day and protein intake of 3g/kg/day.
 - » Preterm infants: aim for 100kcal/kg/day and protein intake of 3.5g/kg/day.

INDICATIONS

- Prolonged feeding intolerance >3 days.
- Necrotizing enterocolitis.
- Gastrointestinal tract abnormalities.

PARENTERAL ACCESS VIA

- Central or peripherally inserted central catheter lines if total parenteral nutrition (TPN) will be needed >5 days.
- Umbilical venous catheter can be used for <14 days.
- Peripheral IV cannula can be used if osmolality is <1000mOsm/l. Should only be used for <5 days. Sites must be monitored regularly for signs of tissue infiltration or infection.

PRESCRIPTION OF TOTAL PARENTERAL NUTRITION

- Order using the codes for specific formulations.
- Order TPN daily.
- Prescribe the total TPN volume, the concentration and the rate of infusion.
- The maximum volume of TPN is 150mL/kg/24 hours.

COMPONENTS OF PARENTERAL NUTRITION

- Protein.
- Carbohydrate.
- Fat/lipids.
- Electrolytes.
- Minerals.
- Calcium and phosphorus.

Table 5: Metabolic and laboratory monitoring of newborns on TPN

METABOLIC AND LABORATORY MONITORING OF NEWBORNS ON TPN		
Test	Initial	When stable
Electrolytes, blood urea nitrogen, creatinine	Daily	2-3 times per week
Blood glucose	Q 6-24 hourly	Daily, more frequently when changing carbohydrate/ glucose in TPN
Calcium, ionized	Daily	2-3 times per week
Total calcium, phosphorous, magnesium, bilirubin (total, direct), alanine aminotransferase, ALT, alkaline phosphatase, gamma-glutamyl transferase), albumin	Baseline	Weekly
Triglycerides	When lipid infusion reaches 1.5g fat/kg/day and 3g fat/kg/day	Weekly
Full blood count (FBC)		Weekly

ADMINISTRATION AND STORAGE

- TPN must be kept refrigerated according to manufacturer instructions.
- Administer within 1 hour of removal from refrigerator.
- TPN bag should be gently agitated and rubbed between the hands prior to administration to redistribute contents evenly.
- Shield TPN bag from any lights.
- New administration set should be used with each new bag of TPN to minimize contamination.
- Should be administered through a terminal 1.2 micron “in-line” filter.
- Should use aseptic technique to prepare and to administer.
- NO additions should be made to the TPN bag.
- Should be infused over 24 hours.

WEANING TPN

- May begin to wean TPN when patient is receiving and tolerating >50% of the total fluid requirements as enteral feeds unless on chronic TPN.
- May be stopped when the infant is tolerating >100 - 120 ml/kg of enteral feeds or receiving <25ml/kg/day of parenteral nutrition.
- Dextrose should be progressively weaned to avoid rebound hypoglycaemia.

CHAPTER 04

MANAGEMENT OF SPECIFIC CONDITIONS

4.1 RESPIRATORY CONDITIONS

4.1.1 RESPIRATORY DISTRESS OF THE NEWBORN

**DEFINITION OF RESPIRATORY DISTRESS:**

Newborn experiencing abnormal respiratory rate or respiratory effort.

Diagnostic criteria

Pulmonary and/or extra pulmonary disorders presenting with two or more of the following signs in a newborn baby:

- > Tachypnoea (≥ 60 breaths/minute).
- > Expiratory grunting.
- > Intercostal and sternal retractions (recession).
- > Central cyanosis while breathing room air.

Clinical presentation may include any of the following:

- Apnoea (no spontaneous breathing for over 15 seconds).
- Inspiratory stridor.
- Nasal flaring.
- Poor feeding.
- Tachypnoea (> 60 breaths per minute) or bradypnoea (< 30 breaths per minute).
- Dyspnoea.



DEFINITION OF RESPIRATORY FAILURE:

Clinical state of inadequate oxygenation, ventilation or both. This is the end stage of respiratory distress and requires resuscitation.

Signs include:

- Tachypnoea.
- Apnoea or bradypnoea.
- Increased, decreased or no respiratory effort.
- Poor to absent distal air movement in the lungs.
- Tachycardia (in early stage respiratory failure) or bradycardia (late stage respiratory failure).
- Cyanosis.
- Altered mental status (late sign of respiratory failure).

Causes of respiratory distress

See Table 6 for details.

Table 6: Causes and differential diagnosis of respiratory distress in the newborn

PULMONARY CAUSES	EXTRAPULMONARY CAUSES
RDS or hyaline membrane disease (HMD)	Sepsis
Meconium aspiration syndrome (MAS)	Cardiac failure
Pulmonary haemorrhage	Pulmonary hypertension
Hypoplastic lungs	Hypothermia/hyperthermia
Diaphragmatic hernia	Hypoglycaemia
Transient tachypnoea of the newborn (TTN)	Anaemia
Pneumonia	Polycythaemia
Pneumothorax	Hypovolaemic shock
	Perinatal hypoxia

Investigations

- Blood sugar.
- Blood gas (if available).
- FBC, C-reactive protein (CRP).
- Chest X-ray (CXR).
- Blood culture if infection is suspected.
- Urine culture.
- Cerebrospinal fluid (CSF) culture.
- Echocardiogram, if available (to exclude cardiac causes).

Management

General measures

- Determine if resuscitation is needed:
 - » Is the baby unresponsive?
 - » Is there apnoea or gasping/ineffective breathing?
 - » Are there less than 20 breaths per minute?
- If the answer is yes, initiate neonatal resuscitation and stabilize the baby first.
- Place on cardiorespiratory monitor for respiratory rate, oxygen saturation, heart rate and blood pressure.
- Establish intravenous access (peripheral, central or intraosseous).
- If there is hypoxia, provide enough oxygen support to keep oxygen saturation between 90 to 94% (85% to 90% if there is congenital cyanotic heart lesion).
- Treat any identifiable causes or problems (e.g. hypoglycaemia, infection, anaemia, etc.).
- Insert gastric tube to empty stomach of air and secretions.
- Commence IV fluids.
- Evaluate to see if criteria are met for continuous positive airway pressure (CPAP):
 - » Signs of respiratory distress.
 - » Respiratory acidosis on blood gas (if available).

- » The following diagnoses:
 - RDS.
 - Pulmonary oedema.
 - Atelectasis.
 - Recent extubation.
 - TTN.
 - Tracheomalacia.
 - Apnoea of prematurity.
- Monitor vital signs and condition until 24 hours after baby is stable.
- NPO until stable.
- If breathing condition worsens or has central cyanosis, then increase oxygen administered.
- If still cyanotic despite 100% oxygen, transfer to hospital or ICU capable of assisted ventilation immediately.

Figure 5: Reading a chest X-ray

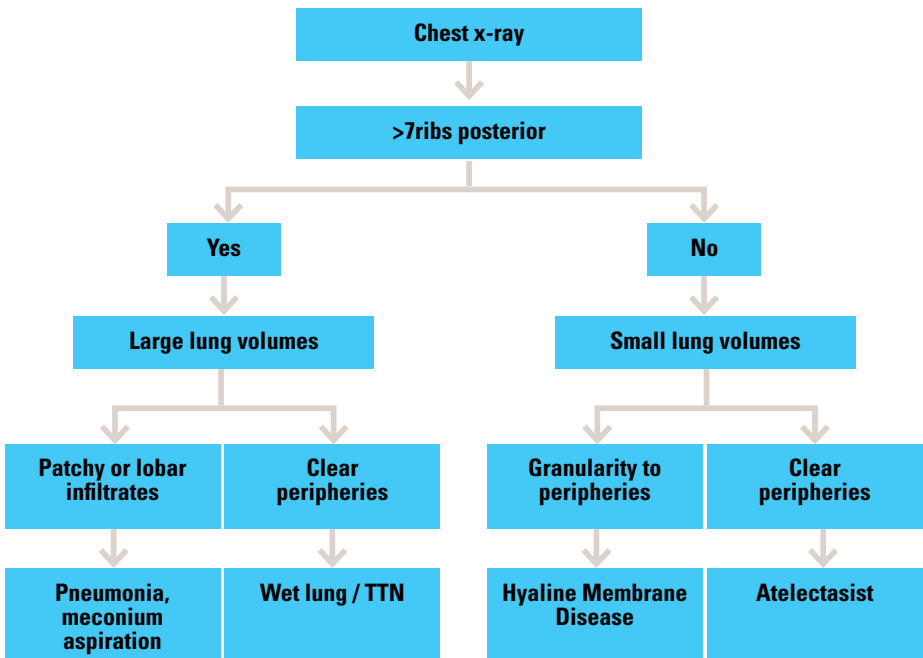


Table 7: Distinguishing features of TTN, RDS, MAS and PPHN

CAUSE	AETIOLOGY	TIMING OF DELIVERY	RISK FACTORS	CLINICAL FEATURES	CXR FINDINGS	TREATMENT	PREVENTION
TTN	<ul style="list-style-type: none"> ▪ Persistent lung fluid 	<ul style="list-style-type: none"> ▪ Any 	<ul style="list-style-type: none"> ▪ Caesarean delivery ▪ Macrosomia ▪ Male sex ▪ Maternal asthma ▪ Maternal diabetes 	<ul style="list-style-type: none"> ▪ Tachypnoea ▪ Often no hypoxia or cyanosis 	<ul style="list-style-type: none"> ▪ Parenchymal infiltrates ▪ "Wet silhouette" around the heart ▪ Intralobar fluid accumulation 	<ul style="list-style-type: none"> ▪ Supportive, oxygen if hypoxic 	<ul style="list-style-type: none"> ▪ Consider prenatal steroids before caesarean delivery if 37 to 39 weeks GA
RDS	<ul style="list-style-type: none"> ▪ Surfactant deficiency ▪ Lung under-development 	<ul style="list-style-type: none"> ▪ Preterm 	<ul style="list-style-type: none"> ▪ Male Sex ▪ Maternal Diabetes ▪ Preterm 	<ul style="list-style-type: none"> ▪ Tachypnoea ▪ Hypoxia ▪ Cyanosis 	<ul style="list-style-type: none"> ▪ Homogeneous infiltrates ▪ Air bronchograms ▪ Decreased lung volumes 	<ul style="list-style-type: none"> ▪ Resuscitation ▪ Oxygen ▪ Ventilation ▪ Surfactant 	<ul style="list-style-type: none"> ▪ Prenatal corticosteroids if risk of preterm delivery 24 to 34 weeks GA
MAS	<ul style="list-style-type: none"> ▪ Lung irritation and obstruction 	<ul style="list-style-type: none"> ▪ Term or post term 	<ul style="list-style-type: none"> ▪ Meconium-stained amniotic fluid ▪ Post term delivery 	<ul style="list-style-type: none"> ▪ Tachypnoea ▪ Hypoxia 	<ul style="list-style-type: none"> ▪ Patchy atelectasis ▪ Consolidation 	<ul style="list-style-type: none"> ▪ Resuscitation ▪ Oxygen ▪ Ventilation ▪ Surfactant 	<ul style="list-style-type: none"> ▪ DO NOT impede delivery for suctioning

CAUSE	AETIOLOGY	TIMING OF DELIVERY	RISK FACTORS	CLINICAL FEATURES	CXR FINDINGS	TREATMENT	PREVENTION
PPHN	<ul style="list-style-type: none"> ▪ Failure of pulmonary vascular resistance to fall soon after birth 	<ul style="list-style-type: none"> ▪ Preterm ▪ Term 	<ul style="list-style-type: none"> ▪ Lung infection ▪ Maternal Medications during pregnancy ▪ Idiopathic ▪ Congenital Diaphragmatic Hernia 	<ul style="list-style-type: none"> ▪ Tachypnoea ▪ Hypoxia ▪ Cyanosis 	<ul style="list-style-type: none"> ▪ Any of the above 	<ul style="list-style-type: none"> ▪ ICU monitoring ▪ Respiratory support ▪ Lower the pulmonary vascular resistance ▪ Give 100% oxygen ▪ Keep blood gas pH normal (7.3-7.4) while keeping PaCO₂ >35-45 mm Hg ▪ Keep systemic BP high (mean BP >45-50 mm Hg) with volume, transfusions, or ▪ Dobutamine 10mcg/kg/min ▪ Manage treatable causes (acidosis, etc.) ▪ Consider inhaled nitric oxide (NO) ▪ Medical treatment ▪ Sildenafil start at 0.5 (max 2) mg/kg/dose PO 6 hourly ▪ Reduce oxygen demand ▪ Consider sedatives and/or paralytics if indicated ▪ Minimize stimulation 	<ul style="list-style-type: none"> ▪ Treatment of existing lung diseases

4.1.3 BRONCHOPULMONARY DYSPLASIA

BPD is a form of chronic lung disease affecting mainly premature newborns. The neonatal airways and lungs are damaged from inflammation and scarring. The condition results from damage caused by mechanical ventilation and long-term use of supplemental oxygen.

Complications of BPD:

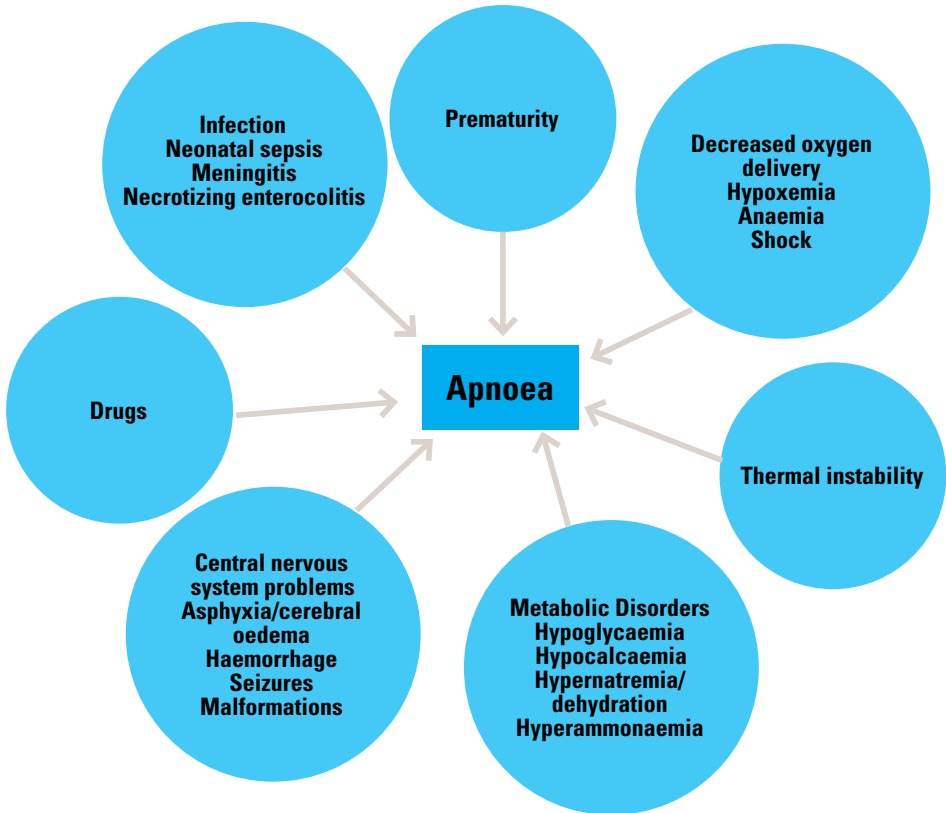
- Chronic respiratory problems.
- Pulmonary hypertension.
- Heart failure.

The best way to manage BPD is prevention. Judicious use of mechanical ventilation and supplemental oxygen is imperative. Otherwise neonates with BPD will require supportive and symptomatic interventions and routine follow up as they grow older.

4.1.4 APNOEA

- Apnoea is a pause in breathing of longer than 15 to 20 seconds, often associated with bradycardia < 100 beats/minute, cyanosis or both. It is a developmental disorder in preterm infants, which occurs as a direct consequence of immature respiratory control.
- In an infant less than 37 weeks GA, apnoeic spells are considered clinically significant if the episodes are greater than 20-second duration or when shorter episodes are accompanied by hypoxemia and/or bradycardia.
- Almost all ELBW infants (birth weight below 1000g) are affected by apnoea.

Figure 6: Causes of apnoea



Adapted from Klaus MH, Fanaroff AA. Care of the High-Risk neonate. 5th ed. Philadelphia. WB Saunders, 2001:268

Types of apnoea

- Central apnoea is due to impaired signal from the central nervous system to the respiratory muscles. This may be due to brainstem immaturity or excessive vagal stimulation (e.g. suctioning).
- Obstructive apnoea is due to obstructed airflow within the upper airway.
- Mixed apnoea is a combination of both and is the most common.

- If child is apnoeic and does not respond to tactile stimulation, then positive pressure ventilation may be needed.
- Correct any underlying causes.
- For chronic apnoea, consider:
 - » **Caffeine citrate**
 - Loading dose 20mg/kg/dose IV/PO.
 - Maintenance: 5mg/kg/day OD.
 - Therapeutic level: 8-20ug/ml.
 - » **Aminophylline**
 - Loading dose: 5-6mg/kg/dose IV.
 - Maintenance: 1-2mg/kg/dose q 6 to 8 hourly IV.
 - Therapeutic level: 6-12ug/ml.
 - Infuse slowly over minimum of 20 minutes to avoid cardiac arrhythmias.
 - » **Theophylline**
 - Loading dose: 5mg/kg/dose PO x 1.
 - Maintenance: 3-6mg/kg/24 hour divided every 6 to 8 hours.
 - Therapeutic level: 6-12ug/ml.
- CPAP for obstructive or mixed apnoea.
- Synchronized intermittent mandatory ventilation (SIMV) using minimum pressures.

4.1.5 NEONATAL VENTILATION

There are broad categories of mechanical ventilation: non-invasive mechanical ventilation and invasive mechanical ventilation.

Types

- CPAP.
- Conventional or intermittent mechanical ventilation (IMV).
- High frequency oscillating ventilation (HFOV).

Goals

- Optimize gas exchange.
- Optimize patient work of breathing.
- Optimize patient comfort.
- Minimizing ventilator-induced lung injury.

CPAP

Reduces the need for mechanical ventilation. It provides a set distending pressure equal to positive end-expiratory pressure (PEEP) to maintain alveoli for maximum recruitment. It also allows a clinician to avoid the disadvantages of intubation and invasive ventilation such as barotrauma and ventilator-acquired pneumonia.

Indications

- Signs of respiratory distress.
- Oxygen requirement 30% or more to maintain oxygen saturation between 90-94%.
- RDS.
- Apnoea of prematurity.
- Post extubation in preterm.
- Pneumonia.
- Mild meconium aspiration.



The neonate must have a respiratory drive.

How to use

- Start with PEEP of 4-8 cm H₂O.
- Titrate oxygen to keep saturation between 90 to 94%.
- Use gas flow at lowest effective level to achieve desired pressure.

Weaning

- Wean oxygen to 21% first.
- Once at 21%, then wean pressure by 1cm H₂O until achieving pressure of 4cm H₂O.

CPAP failure is defined by any of the following:

- FiO₂ >60% required to maintain normal oxygen saturation.
- Respiratory acidosis with a PH <7.2.
- Recurrent apnoea requiring mask ventilation.

CONVENTIONAL VENTILATION

Indications

- RDS.
- Apnoea not responsive to CPAP.
- Infection such as sepsis or pneumonia.
- Post-operative recovery.
- PPHN.
- MAS.
- Congenital anomalies, e.g. congenital diaphragmatic hernia.
- Failure of CPAP.

Review dosages

Rapid sequence intubation/premedication done prior to intubation for comfort and ease of intubation and ventilation:

1. Anticholinergic
 - a. Atropine for rapid sequence intubation: 0.01mg/kg/dose IV over 1 minute.
2. Sedation/analgesia
 - a. Fentanyl: 1-2 mcg/kg/dose IV q 30 to 60 minutes (PRN) (Bolus) over 3 to 5 minutes (if dose over 5mcg give over 5 to 10 minutes).
 - b. Morphine: 0.1-0.2mg/kg/dose IV q 2 to 4 hourly PRN pain over 5 min.

3. Muscle paralysis (have on standby in case of fentanyl-induced chest rigidity)
 - a. Succinylcholine: 1-2mg/kg/dose IV over 30 secs.

*** If morphine is used instead of fentanyl, then give morphine first, then atropine, then succinylcholine if paralytic is needed.**

Table 8: Ventilator settings

INITIAL VENTILATOR SETTINGS	Premature neonate	Term neonate
Mode	Pressure control	Pressure control
Rate	40 to 60	30 to 60
PEEP	3 to 7	3 to 6
Inspiratory time	0.3 to 0.4sec	0.3 to 0.4sec
Peak inspiratory pressure (PIP)	18 to 22 (if RDS)	18 to 20
Tidal volume	4 to 6mls/kg	6 to 8mls/kg

For ELBW babies the minimum PIP guidelines are as in Table 9.

Table 9: Minimum PIP guidelines for ELBW*

WEIGHT (G)	MINIMUM PIP (CM H2O)
<750	13
750-1000	14
1001-1500	15
>1500	16

*The Neonatal Survival Guide Michalec J, Southgate M, Taylor S, Cox T, Finch, C 2007.

Table 10: Manipulating oxygenation by manipulating mean airway pressure

DESIRED OUTCOME	AIM AND POSSIBLE ACTIONS	EVALUATION
To increase oxygenation (increase mean airway pressure (MAP))	<ul style="list-style-type: none"> ▪ Increase FiO₂ in increments of 5%-10% ▪ Increase MAP by increasing PIP or PEEP in increments of 1-2cm H₂O ▪ Increase it but no higher than 0.4 seconds for preterm neonates ▪ Consider adding pressure support ventilation if on SIMV ▪ Consider HFOV if MAP and FiO₂ increase significantly 	<ul style="list-style-type: none"> ▪ Observe oxygen requirement, pulse oximetry, PaO₂ on blood gas ▪ Look for improvements in lung compliance, e.g. chest expansion ▪ Observe pulmonary dynamics/graphs such as volume/pressure loop and pressure graph
To decrease oxygenation when condition improves and/or during weaning (decrease MAP)	<ul style="list-style-type: none"> ▪ Aim to get FiO₂ to an acceptable level ▪ Reduce MAP by reducing PIP or PEEP in 1-2cm H₂O increments ▪ It can be reduced to aim for 0.3 to 0.4 seconds ▪ Stop pressure support ventilation ▪ Change to trigger mode to synchronize with neonate's breathing 	<ul style="list-style-type: none"> ▪ As above

Table 11: Manipulating ventilation or CO₂ elimination by manipulating minute volume

DESIRED OUTCOME	AIM AND POSSIBLE ACTIONS	EVALUATION
To clear more CO ₂	<ul style="list-style-type: none"> ▪ Increase rate in increments of 5-10bpm to increase minute ventilation ▪ Increase PIP in 1-2 cm H₂O increments with caution, to increase Tidal volume (V_t) ▪ Decrease PEEP with caution as this may also decrease oxygenation. In addition, decreasing PEEP too low will increase atelectasis and thus increase CO₂ ▪ If on volume control, increase the tidal volume 	<ul style="list-style-type: none"> ▪ Observe measured V_t and MV on the ventilator ▪ Check CO₂ on blood gas and/or transcutaneous monitoring
To clear less CO ₂ when weaning	<ul style="list-style-type: none"> ▪ Reduce rate in increments of 5-10bpm and/or reduce PIP in increments of 1-2 cm H₂O ▪ Consider reducing PEEP as the PIP is reduced ▪ If on volume control, then reduce V_t 	<ul style="list-style-type: none"> ▪ As above

HIGH FREQUENCY VENTILATION

Indications

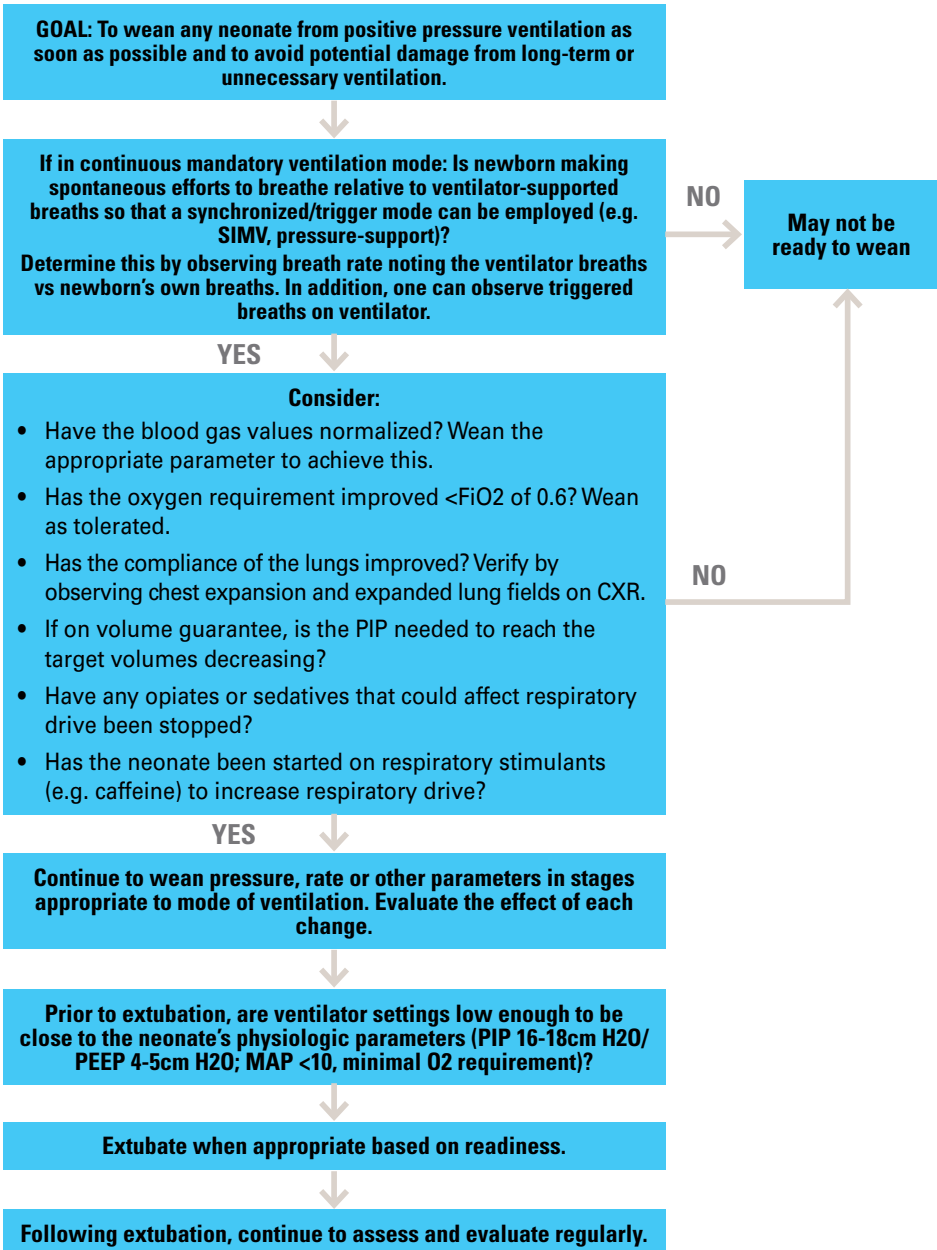
- Hypercarbia, hypoxia or respiratory acidosis with PH < 7.25 despite optimal conventional ventilation (typically if PIP > 22-24 cm H₂O or rate > 65 bpm).
- Initial settings:
 - » Freq 10 Hz.
 - » Inspiratory: expiratory ratio 1:2 or T_i = 30%.
 - » Start with MAP at 2 cm above that used on conventional ventilation.
 - » If air leak or hyperinflated previously, consider lower MAP.
 - » For infants being oscillated without prior ventilation use a MAP of 8 cm H₂O.

- » Set amplitude (Delta P) to achieve visible oscillation of the chest usually 30 to 35cm H₂O.
- » Do CXR and ensure normal lung inflation of 8 to 9 posterior ribs.
- » Target of therapy:
 - Normal oxygen saturation with progressively decreasing FiO₂.
 - PaCo₂ 5 to 7kPa with pH >7.25.

Table 12: High frequency ventilation

DESIRED OUTCOME	AIM AND POSSIBLE ACTIONS	EVALUATION
To increase oxygenation (increase MAP)	<ul style="list-style-type: none"> ▪ Increase FiO₂ in increments of 5%-10% ▪ Increase MAP in increments of 1-2cm H₂O 	<ul style="list-style-type: none"> ▪ As for conventional ventilation ▪ Ensure CXR is done
To decrease oxygenation when condition improved and/or during weaning	<ul style="list-style-type: none"> ▪ Aim to get FiO₂ to an acceptable level ▪ Reduce MAP in increments of 1-2cm H₂O increments 	<ul style="list-style-type: none"> ▪ As above
To clear more CO ₂	<ul style="list-style-type: none"> ▪ Increase amplitude (Delta P) in increments of 2-5cm H₂O according to blood gas (CO₂) and chest wiggle ▪ Decrease frequency (Hz), allowing for greater efficiency of oscillations to reach the peak and trough of the pressure wave 	<ul style="list-style-type: none"> ▪ As above ▪ Observe for chest wiggle or bounce
To clear less CO ₂ when weaning	<ul style="list-style-type: none"> ▪ Reduce amplitude in increments of 1-2cm H₂O according to CO₂ and chest wiggle 	<ul style="list-style-type: none"> ▪ As above

Figure 7: Considerations when weaning ventilation



Taken from Petty J, BSc, MSc, PGCE, MAAp, RGN, RSCN. "Understanding Neonatal Ventilation: Strategies for Decision Making in the NICU". Neonatal Network. Vol 32, No4 July/August 2013.

4.2 GASTROINTESTINAL CONDITIONS

4.2.1 NEONATAL JAUNDICE



NEONATAL JAUNDICE

Yellow staining of the skin and mucous membranes due to hyperbilirubinaemia.

Table 13: Types of jaundice

FEATURES	PHYSIOLOGICAL JAUNDICE	PATHOLOGICAL JAUNDICE
Clinical onset of jaundice (after birth)	>36 hours	≤24 hours
Duration of jaundice	Term <10 days Preterm <14 days	Term >10–14 days Preterm >14 days
Peak total serum bilirubin (TSB) (days after birth)	Term Day 3 Preterm Day 5-7	Early or late
Peak TSB	<275µmol/L	>275µmol/L
Rise in TSB per 6 hours		>50µmol/L
Conjugated serum bilirubin	Only unconjugated fraction increased	>34µmol/L
Evidence of haemolysis	No	Yes/No
Underlying illness	No	Yes/No
Hepatomegaly	No	Yes/No
Pale stools/dark urine	No	Yes/No

RED FLAGS:

Pathological jaundice

- Mother rhesus (Rh) negative.
- Mother blood group 0. If known, check TSB at 6 hours post delivery.
- Baby Coombs positive.
- Anaemia.

- Evidence of haemolysis.
- Preterm.
- Acidosis, hypocalcaemia, hypothermia.
- Features of kernicterus (high pitched cry, poor feeding, cycling movements, abnormal muscle tone).
- Bilirubin levels not decreasing despite effective phototherapy, i.e. 17-34 μ mol/L within 4-6 hours.
- Family history of pathological jaundice.

Table 14: Causes of pathological jaundice

UNCONJUGATED	CONJUGATED		
Excessive haemolysis <ul style="list-style-type: none"> ▪ ABO incompatibility ▪ Rhesus disease ▪ Enclosed haemorrhages ▪ Polycythaemia ▪ Infections 	Infective	Viral	Hepatitis A, B, cytomegalovirus (CMV), HIV, rubella, herpes simplex
		Bacterial	Syphilis, septicaemia, UTI
		Protozoal	Toxoplasmosis gondii
Defective conjugation <ul style="list-style-type: none"> ▪ Prematurity ▪ Infection ▪ Hypoxia ▪ Hypoglycaemia ▪ Hypothyroidism ▪ Breast milk jaundice 	Biliary	Biliary atresia, choledochal cyst, Alagille's syndrome, bile plugs, cystic fibrosis	
		Genetic/metabolic	Alpha 1 – antitrypsin, tyrosinemia type 1, galactosemia, Wilson's disease, hypothyroidism, hypopituitarism, familial intrahepatic cholestasis, rotor and Dubin-Johnson syndrome
	Drugs/toxins	TPN	
	Autoimmune	Autoimmune hepatitis	

UNCONJUGATED HYPERBILIRUBINAEMIA

History and investigations

- Determine whether or not the baby is breastfed.
- Collect urine for microscopy, culture and sensitivity and reducing substances to exclude galactosemia.
- Check liver enzymes.
- Exclude hypothyroidism.
- Exclude haemolysis, check reticulocytes and Hb.
- Hereditary enzyme defects such as Gilbert's and Crigler-Najjar syndromes are rare.
- Measurement of bilirubin level.
- Blood type and Rh determination in mother and infant.
- Direct antiglobulin test (DAT) in the infant (also known as the direct Coombs test).
- FBC and peripheral smear.
- In rare cases, look for other causes of haemolysis.

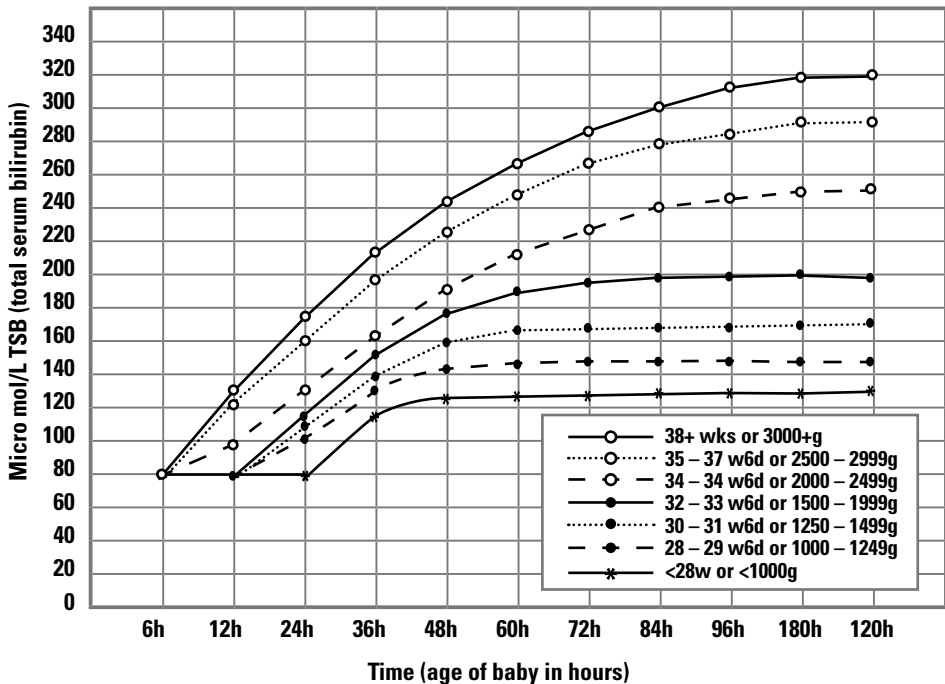
Management

Phototherapy

- See Figure 8 on phototherapy guideline charts.
- Indicated for unconjugated hyperbilirubinaemia.
- Cover the eyes with gauze pads and place infant naked under the lights (nappy untied). Remove eye pads during feeds and observe for conjunctivitis.
- Turn infant every 2-3 hours.
- Monitor infant's temp and ensure adequate fluid intake.
- In cases of severe jaundice, check the TSB 3-hourly.
- Position the phototherapy until not more than 40cm away from the infant.
- Visual assessment of jaundice is unreliable once the infant is under phototherapy.

- Successful phototherapy should produce a decline in TSB of 17-34 $\mu\text{mol/l}$ within 4-6 hours and the TSB should continue to fall.
- Stop phototherapy if the TSB is $\geq 50\mu\text{mol/l}$ below the phototherapy line.
- Complications: rashes, loose stools, dehydration, hypo/hyperthermia and separation from mother.
- Light source required: 420-460nm (ensure the light source is maintained at the required strength).
- Consider the use of aluminium foil around the sides of the warmer or cot to maximize amount of skin exposure to phototherapy.

Figure 8: Phototherapy guidelines

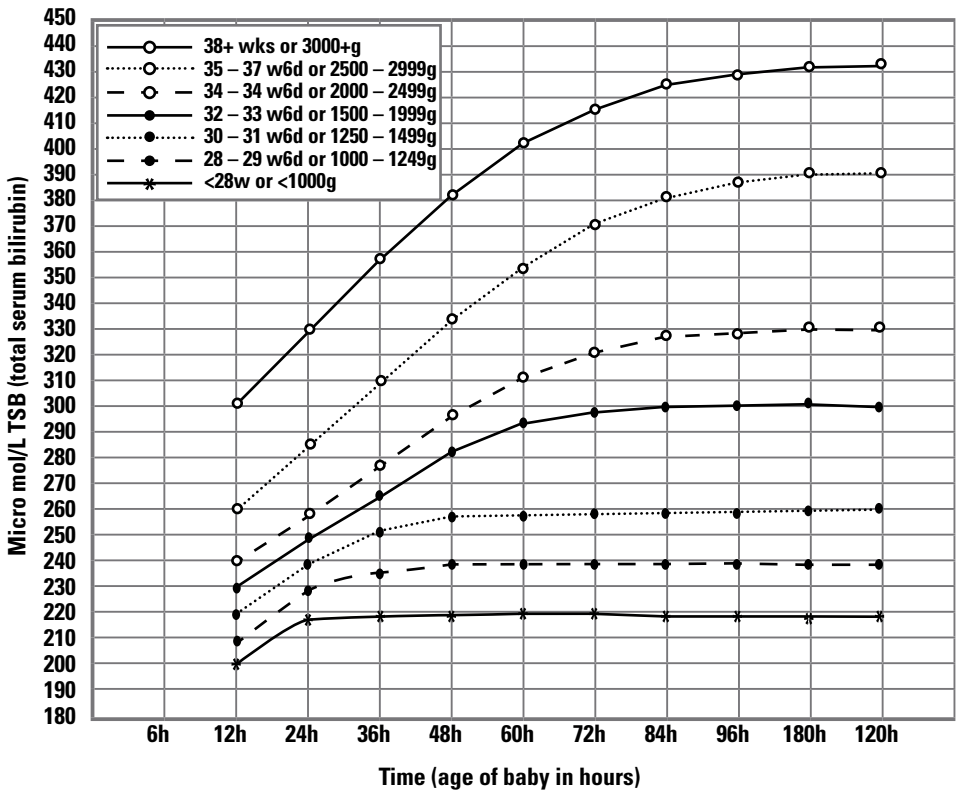


Phototherapy guidelines for all weights and gestations. In presence of sepsis, haemolysis, acidosis or asphyxia, use one line lower (gestation below) until <1000g.

Exchange transfusion (indications)

- See exchange transfusion guideline charts (Figure 9).
- Any infant with clinical signs of acute bilirubin encephalopathy.
- Infants with severe anaemia complicated by cardiac failure who need a blood transfusion; consider and exchange transfusion.
- Method: double exchange = 160ml/kg (term) or 180ml/kg (preterm) whole blood.

Figure 9: Exchange transfusion guidelines



In presence of sepsis, haemolysis, acidosis or asphyxia, use one line lower (gestation below) until <1000g.

Intravenous gamma globulin/polygam (indications)

- Babies with Rh disease unmodified by antenatal treatment.
- Babies with potential ABO – blood groups, haemolytic disease of the newborn (HDN) where a previous sibling has had severe HDN requiring exchange transfusion.
- Babies with signs of bilirubin encephalopathy.
- If there is a delay in obtaining blood for exchange transfusion beyond 4 hours and/or the TSB is continuing to rise $>8.5\mu\text{mol}/\text{hour}$ despite optimal phototherapy and hydration.

Dose: 0.5g/kg given over 2 hours.

Conjugated hyperbilirubinaemia

- History and examination.
- Liver function tests and cholesterol.
- Examine stools daily. Acholic (white) stools require urgent referral to exclude biliary atresia.
- Exclude infective causes.
- Exclude metabolic causes.
- Exclude genetic conditions.

Investigations

- Liver function tests.
- FBC.
- Clotting profile.
- Coombs.
- Urinalysis and electrolytes (U&E).
- Calcium, magnesium, phosphorus (CMP).
- Glucose.
- Blood culture.

- Urine culture.
- TORCHES screen.
- Hepatitis screen.
- HIV screen.
- Urine reducing substances.
- Thyroid function test.
- Abdominal ultrasound.
- CXR.

Management

- Treat the underlying cause.
- Dietary adjustment for prolonged conjugated hyperbilirubinaemia to neutralize the malabsorption of fat and fat-soluble vitamins (A, D, K).
- Avoid lactose containing feeds, i.e. breast milk and lactose-containing formulae, when galactosemia is suspected.
- Regularly follow up until the underlying condition has been resolved.

Recommendations

A patient with the following presentation should be referred for specialist management:

- Pathological jaundice, unconjugated and/or conjugated, where the underlying cause cannot be identified.
- Serum unconjugated bilirubin at exchange transfusion level.
- Jaundice, unconjugated and/or conjugated, not improving on adequate treatment.
- Conjugated hyperbilirubinaemia due to conditions requiring surgical intervention, e.g. biliary atresia.
- Prolonged neonatal jaundice, excluding breast milk jaundice.

4.2.2 NECROTIZING ENTEROCOLITIS

NECROTIZING ENTEROCOLITIS



It is a syndrome characterized by abdominal distension, bilious aspirates, bloody stool and intramural air (pneumatosis intestinalis) on abdominal X-ray (AXR). There is inflammation of the bowel wall, which may progress to necrosis and perforation. It may involve a localized section of bowel (most often the terminal ileum) or be generalized.

Aetiology

- Prematurity (biggest independent risk factor).
- Infection.
- Hypoxia-ischemia to the bowel.
- Polycythaemia.
- Feeding regimen; more associated with formula feeds than breast milk; rapid increase in enteral feeds; hypertonic formula.

Clinical features

- Cardinal signs include: lethargy, feeding intolerance, abdominal distension and tenderness, absent bowel sounds, bloody stools, vomiting and discoloured abdominal walls.
- Other signs: temperature instability, jaundice, apnoea and bradycardia, hypo-perfusion, shock.
- Features occur more commonly from second week of life onwards in preterm infants; can occur in the first few days of life in term infants.

Investigations

They are inclusive of:

- AXR.
- FBC.
- CRP.
- Blood culture.
- U&E.

- Arterial blood gas.
- International normalized ratio (INR)/partial thromboplastin time (PTT).

Lab findings

- Raised acute-phase reactant (CRP or procalcitonin).
- Thrombocytopenia.
- Neutropenia, neutrophilia.
- Anaemia.
- Blood culture positive.
- Coagulation abnormalities.
- Metabolic acidosis.
- Hypoxia, hypercapnia.
- Hyponatremia, hyperkalaemia.
- Increased blood urea.
- Hyperbilirubinaemia.

Radiologic abnormalities

- Dilated loops of bowel.
- Thickened intestinal wall.
- Inspissated stool (mottled appearance).
- Intramural air (pneumatosis intestinalis).
- Air in portal venous system.
- Bowel perforation.
- Gasless abdomen/ascites.
- Pneumoperitoneum.
- Air below diaphragm/around the falciform ligament.

Modified Bell's staging

Stage 1. Suspected: clinically ill, X-ray normal to mild distension.

Stage 2. Definite: A; mild or B; moderate systemic illness, absent bowel sounds, abdominal tenderness, metabolic acidosis, platelets. AXR: pneumatosis intestinalis or portal venous gas.

Stage 3. Advanced: A; severely ill, marked distension, signs of peritonitis, hypotension, metabolic and respiratory acidosis, disseminated intravascular coagulation DIC. B: pneumoperitoneum if bowel perforation present.

Management

- Resuscitate: airway, breathing and circulation.
- Assess circulatory status; apply fluid and inotropic support judiciously.
- Stop enteral feeds immediately. Insert naso/orogastric tube, leave on free drainage, monitor output.
- Start broad spectrum antibiotics including adequate gram-negative cover.
- Serial abdominal examinations.
- Stage 1: reassess abdomen in 24-48 hours. Restart small volume feeds cautiously if examination is normal.
- Stage 2 and 3: keep NPO for 5-10 days. Start TPN preferably via a deep percutaneous venous line by 48 hours NPO.
- Patients with advanced disease may require repeat FBC and clotting profile. Blood products (i.e. packed red blood cells (RBC), platelets or fresh frozen plasma (FFP)) should be transfused if anaemic and/or DIC present.
- Surgery: operative intervention may be indicated if: pneumoperitoneum, fixed bowel loop, abdominal mass palpable or persistent metabolic acidosis. Paediatric surgeons should be consulted after initial stabilization.
- Peritoneal drainage can be used in patients who are too unstable for surgery or in whom ventilation is difficult due to abdominal fluid. Consult with paediatric surgeon.
- Only resume feeds, preferably breast milk, if abdomen is soft and bowel sounds are present. Restart feeds slowly (20-30ml/kg/day).
- Continue antibiotics until septic markers are normalized.
- Patients who have had surgery may return to the NICU with a stoma. Feeds may be resumed 5-7 days post-surgery once bowel sounds are present and the stoma is functioning.

4.3 NEUROLOGIC CONDITIONS

4.3.1 HYPOXIC ISCHEMIC ENCEPHALOPATHY



HYPOXIC ISCHEMIC ENCEPHALOPATHY

An acquired syndrome of acute brain injury characterized by neonatal encephalopathy (NE) and evidence of intrapartum hypoxia.

NE is characterized by an abnormal level of consciousness, abnormal tone, abnormal primitive reflexes, abnormal breathing and seizures may occur.

Intrapartum hypoxia may be suggested by the presence of one or more of the following features:

- An acute intrapartum event.
- Foetal bradycardia or reduced variability.
- Meconium stained liquor.
- Prolonged second stage.
- Resuscitation at birth for 5 minutes or longer.
- 5-minute Apgar score <7.
- Acidosis on cord or neonatal blood in the first hour of life (defined as PH <7 or base excess <-10).



The presence of features suggesting intrapartum hypoxia does not exclude cause of the encephalopathy other than hypoxic ischemic encephalopathy (HIE). If the history and/or clinical signs are not consistent then other causes should be sought.

On admission, before history documentation, ensure the following:

- Stabilize vital signs, check glucose early and perform a general and neurological examination with particular reference to the presence of congenital anomalies.

- Document the HIE score.
- Commence IV fluids.
- Initial investigations: blood gas, electrolytes, CMP, FBC, CRP, blood culture if sepsis cannot be excluded.

History documentation

Make particular note of the following:

Maternal and family history

- Previous pregnancies: Live/still born or miscarriages or neonatal deaths.
- Current pregnancy: Gestation, medication, complications results of booking investigations and scans.
- Labour and delivery:
 - » Augmentation, foetal heart monitoring, medication, sepsis, intrapartum events, length of second stage, presentation, method and indication for caesarean section or vacuum delivery.
 - » Resuscitation and evidence for intrapartum hypoxia:
 - Blood gas on cord or on infant (preferably arterial) as soon as possible after birth.
 - Apgar scores at 1, 5 and 10 minutes.
 - Need for intubation and details.
 - Time of first gasp and onset of heart rate >100bpm.
 - Time of onset of regular non-gasping respirations.
 - Drugs/fluids administered to infant.
 - » Placental information:
 - Record appearance and weight, send for histology with description of events.

Clinical management of hypoxic ischemic encephalopathy

Temperature and cooling

- Refer to cooling protocol.

Ventilation

- Aim for normal PaCO₂ and oxygen saturation.
- If oxygen is needed and respiratory effort is good, nasal CPAP is often adequate.
- Ventilate if apnoea or respiratory acidosis with PH <7.25.
- If pCO₂ <3.3kPa, wean ventilation rapidly and recheck within 30 minutes – consider extubation.
- Wean FiO₂ and PIP at the bedside observing saturation and chest wall movement.
- If ventilated do blood gases 6-hourly.

Blood pressure and Hb

- Monitor blood pressure and keep it in the normal range (MBP = 40-55).
- Avoid fluid boluses unless hypovolaemia is suspected.
- If hypovolaemia present, give a bolus of saline (10ml/kg).
- Metabolic acidosis alone is not an indication for a fluid bolus.
- If significant anaemia (Hb<10), transfuse the infant.
- Check coagulation in actively bleeding infants.
- Treat hypotension according to inotrope guidelines.
- Central access is preferable for sick infants requiring inotropes.

Fluid balance, acidosis and metabolic management

- Intrinsic renal failure and SIADH commonly occur.
- Initially restrict fluids to 40ml/kg/24hrs with potassium free 10% glucose and 1/5 to 1/2 normal saline.
- Adjust according to further monitoring.

- Check plasma glucose 4-hourly.
- Increase glucose concentration if plasma glucose $<2.6\text{mmol/l}$.
- Potassium containing fluid may be used if urine output and serum potassium are normal.
- Monitor urine output, electrolytes, blood glucose and blood gases.
- Hypocalcaemia and hypomagnesaemia should be anticipated and treated.
- There is no proven benefit of sodium bicarbonate to treat lactic acidosis.
- Treat hyponatremia $<130\text{mmol/l}$ with further fluid restriction – consider normal saline.
- Catheterize if urine retention or oliguria ($<1\text{ml/kg/hr}$).

Feeding

- NPO on admission.
- Introduce feeds slowly, preferably breast milk. Start at $10\text{-}20\text{ml/kg/day}$.

Sepsis

- Penicillin 12-hourly and gentamicin 36-hourly.
- Consider lumbar puncture if history and investigations suggest sepsis.
- Discontinue antibiotics at 48 hours if sepsis is ruled out.

Seizures

- Refer to seizure management guidelines.

Communication with parents

- Explain the clinical condition and potential for other causes.
- Explain the management.
- Prepare them for a potential poor outcome if signs and investigations are suggestive.

Clinical neurological assessment of encephalopathy

Clinical signs vary with time.

Table 15: Criteria for defining moderate and severe encephalopathy

CATEGORY	MODERATE ENCEPHALOPATHY	SEVERE ENCEPHALOPATHY
Level of consciousness	Lethargic	Stupor or coma
Spontaneous activity	Decreased activity	No activity
Posture	Distal flexion, complete flexion	Decerebrate
Tone	Hypotonia (focal or general)	Flaccid
Primitive Reflexes		
Suck	Weak	Absent
Moro	Incomplete	Absent
Autonomic System		
Pupils	Constricted	Deviated, dilated, nonreactive to light
Heart Rate	Bradycardia	Variable
Respiration	Periodic breathing	Apnoea

There are 3 stages of encephalopathy:

- **Stage 1 (mild):** irritability, increased tone, poor sucking and exaggerated Moro reflex.
- **Stage 2 (moderate):** lethargy, decreased tone and primitive reflexes, often with seizures.
- **Stage 3 (severe):** stupor or coma, flaccid tone and seizures often clinically less apparent.
- Moderately or severely affected infants typically develop increasingly obvious signs during the first 48-72 hours.
- Seizures are often clinically silent. Cycling, posturing and myoclonus may represent seizure activity.

Cooling protocol for hypoxic ischaemic encephalopathy

Criteria for cooling

1. GA of 36 or more weeks and weight >1800g.
2. Not more than six hours old at initiation of hypothermia.
3. Neonatal encephalopathy defined by:
 - » Electroencephalogram (EEG) suppression or seizures (clinical or electrical); OR
 - » Clinical signs of moderate-severe HIE; OR
 - » Depressed level of consciousness plus abnormal tone.
4. Suspected significant intrapartum hypoxia on the basis of the following factors:
 - » Base deficit of 12 or more or PH <7.0 in the first hour on cord or infant blood; OR
 - » 10-minute Apgar score of less than 7; OR
 - » Requiring assisted ventilation at age 10 minutes.

Contraindications to cooling

- Major congenital abnormalities likely to affect neurological outcome or moribund and unlikely to benefit from cooling.
- Uncontrolled bleeding.
- Severe pulmonary hypertension/systemic hypotension responding poorly to treatment.

Monitoring

1. Monitor electrolytes and blood gases while cooling. Ensure serum magnesium above 0.8mmol/l.
2. Beware of accumulation of anticonvulsant and sedatives.
3. Monitor vital signs continuously or hourly. Maintain BP at 40-55mmHg. If heart rate above 110bpm, check for overheating or consider inadequate sedation or consider hypovolaemia.
4. Ensure that humidifier gas temperature is delivered at 33-34°C.

NOTE:

Cooling may be continued if the infant continues breathing and if resources allow, but there is no evidence of benefit if EEG remains severely suppressed beyond 36-48 hours.

4.3.2 NEONATAL SEIZURES

Definition

- Abnormal synchronous electrical discharge of group neurons in the central nervous system.
- Status epilepticus; continuous seizures lasting 30 minutes or recurrent seizures occupying 50% of EEG recording for at least 60 minutes.

Causes of neonatal seizures

- Hypoglycaemia.
- Perinatal asphyxia.
- Central nervous system (CNS) infections.
- Intracranial haemorrhage.
- Electrolyte abnormality.
- Neonatal abstinence syndrome/drug withdrawal.
- Pyridoxine deficiency.

Clinical manifestations

- Absence of seizures.
- Subtle: eye deviation, eyelid fluttering, buccolingual movement or pedalling of arms and legs.
- Focal: tonic or clonic.
- Generalized: multifocal rhythmic jerking, generalized posturing or myoclonic.

Investigations

- Serum glucose, calcium, magnesium and sodium.
- Lumbar puncture if sepsis suspected.
- Head ultrasound.
- Metabolic screening (if inborn errors of metabolism are suspected).

Management

- Treat underlying cause when identified!
- Treat seizure with appropriate antiepileptics (see Figures 10 and 11).

Figure 10: Management of neonatal seizures

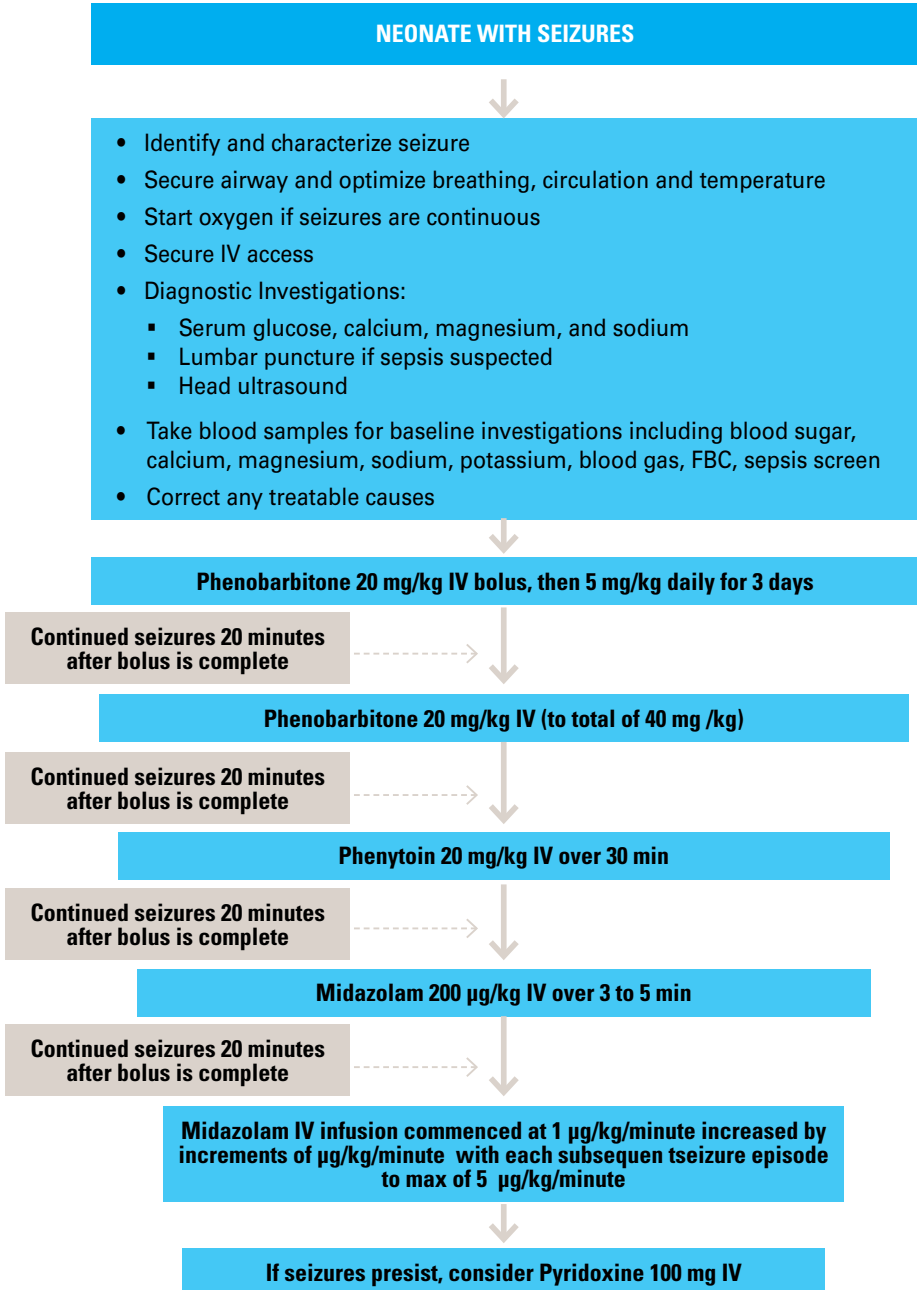
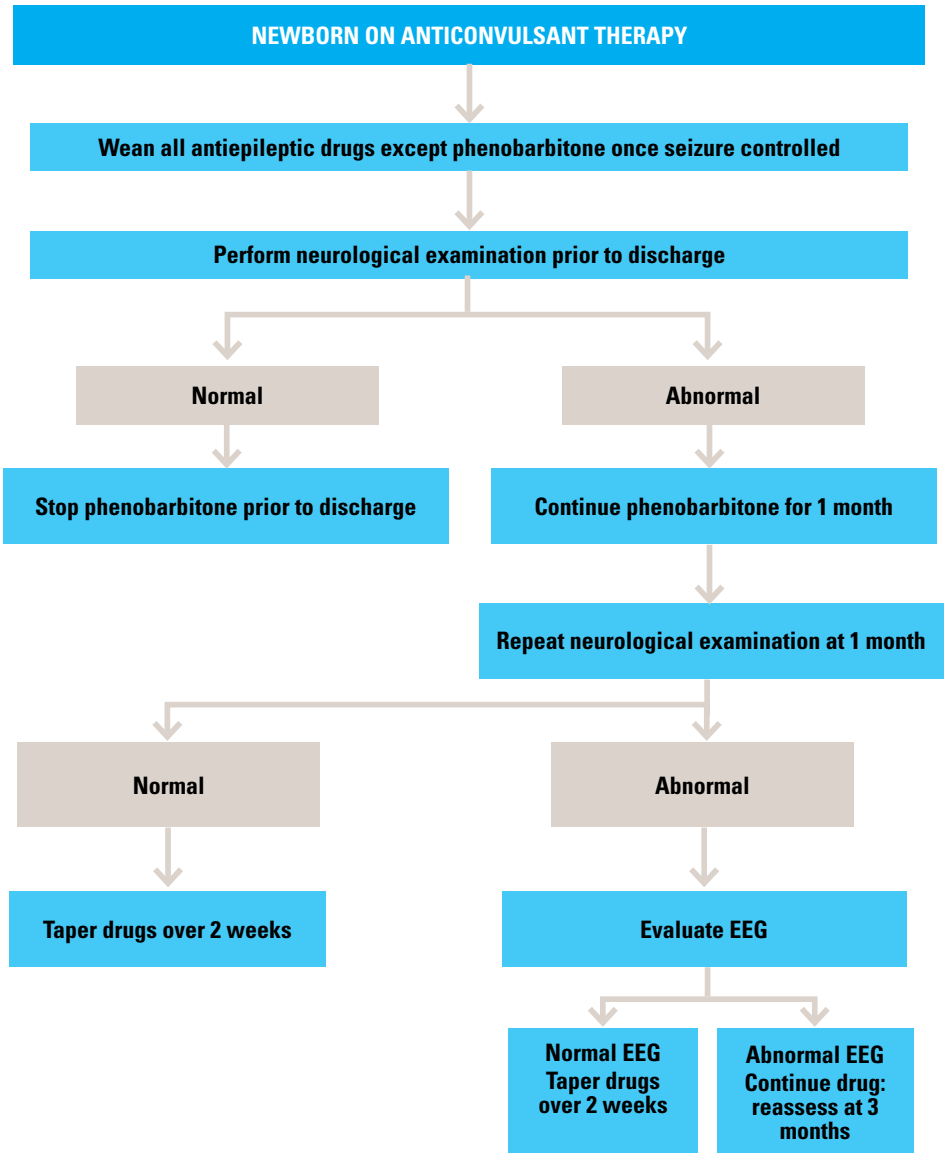


Figure 11: Weaning of neonate from antiepileptic medication



NB: Intractable seizures may need lifelong therapy, so may consider switching to other antiepileptic medications

4.4 HAEMATOLOGY

4.4.1 ANAEMIA IN THE NEWBORN

ANAEMIA



Infants are born with a physiologic polycythaemia due to relative hypoxia in utero. They are usually born with an average haemoglobin count of 17g/dl (15-18) and normal haematocrit is 45-55 for neonates. The levels continue to decline after birth till the third week of life when they hit 11g/dl.

Table 16: Normal Hb levels

WEEK	HAEMOGLOBIN LEVEL		
	TERM BABIES	PREMATURE BABIES (1200-2500G)	SMALL PREMATURE BABIES (< 1200G)
0	17.0	16.4	16.0
1	18.8	16.0	14.8
3	15.9	13.5	13.4
6	12.7	10.7	9.7
10	11.4	9.8	8.5

Source: Glader B, Naiman JL. Erythrocyte disorders in infancy. In Cloherty JC, Stark AR, eds. *Manual of Neonatal Care*. 7th ed. Philadelphia, PA: Lippincott-Raven; 2011

Causes

Anaemia with jaundice

Haemolysis

- Immune (Rh or ABO incompatibility or other red cell antibodies).
- Enzyme deficiency (G6PD deficiency, pyruvate kinase deficiency).
- Red blood cell membrane defects (spherocytosis).
- Acquired (infection, disseminated intravascular coagulopathy).

*Anaemia without jaundice***Blood loss**

- Foetal (foetomaternal, twin-twin transfusion).
- Obstetrical (placental abruption, placenta praevia, cord accidents).
- Neonatal (cephalohaematoma, subgaleal haemorrhage, intracranial haemorrhage, bleeding into abdominal organs).
- Iatrogenic (blood sampling, accidental loss from an arterial line).

Diminished red blood cell production

- Infection: Diamond-Blackfan.
- Congenital: e.g. parvovirus.

Table 17: Clinical presentation of anaemia of the newborn

HISTORY	EXAMINATION
History: blood loss	<ul style="list-style-type: none"> ▪ Pallor
Family history: anaemia, jaundice, splenomegaly from haemolytic disease	<ul style="list-style-type: none"> ▪ Jaundice from haemolysis ▪ Apnoea and bradycardia ▪ Tachycardia
Obstetric history: antepartum haemorrhage	<ul style="list-style-type: none"> ▪ Heart murmur - systolic ▪ Flow murmur
Maternal blood type: Rh or other red cell antibodies, potential for ABO incompatibility (mother O, infant A or B)	<ul style="list-style-type: none"> ▪ Respiratory distress ▪ Heart failure ▪ Hepatomegaly ▪ Splenomegaly, hydrops
Ethnic origin: haemoglobinopathies and G6PD deficiency more common in certain ethnic groups	<ul style="list-style-type: none"> ▪ Inadequate weight gain from poor feeding

Investigations

- Full blood count.
- Reticulocyte count.
- Blood group.
- DAT/Coombs test.
- Bilirubin level.
- Blood smear.
- Cranial ultrasound.

Management

Blood transfusion

Indications for red blood cell transfusion

1. Hb \leq 12g/dl OR HCT $<$ 35% and any of:
 - a. Hypovolemic shock.
 - b. Severe respiratory distress and mechanical ventilation with $FiO_2 >$ 50%.
 - c. Severe congenital heart condition; cyanosis, heart failure.
2. Hb \leq 10 OR HCT $<$ 30% and any of:
 - a. Moderate respiratory distress with $FiO_2 >$ 35%.
3. Hb \leq 8 OR HCT $<$ 25% and any of:
 - a. Mild respiratory distress.
 - b. Repeated apnoea.
 - c. Sustained tachycardia.
 - d. Inadequate weight gain.
4. Severe anaemia; Hb $<$ 7g/dl OR HCT $<$ 20.

Volume of transfusion

Usually packed red cells 15-20ml/kg.

To calculate volume based on observed and desired haematocrit, estimated blood volume of 80ml/kg.

Calculation

(Desired haematocrit - observed haematocrit) x (weight x 80 ml) Haematocrit of blood to be given (typically 60-80%)

NOTE:

Whole blood should be given to correct the anaemia of rapid blood loss. If haematocrit is not available: give 10ml/kg, monitor.

For mild anaemia, nutritional supplementation of iron, folate and vitamin E may be prescribed for a period of time.

Prevention: Infants at risk of iron deficiency should receive supplemental oral iron (2-4mg of elemental iron/kg/day) once they are tolerating full enteral feeds.

At risk infants include preterms and those with substantial blood loss via bleeding or phlebotomy.

4.4.2 ANAEMIA OF PREMATUREITY

Introduction

Erythropoiesis decreases after birth as a result of increased tissue oxygenation due to the onset of breathing and closure of the ductus arteriosus, and a reduced production of erythropoietin. In term infants, the haemoglobin level typically reaches an average nadir of 11g/dl at approximately 8 to 12 weeks after birth.

In preterm infants who are already born with a lower haematocrit, this decline, referred to as anaemia of prematurity, occurs earlier and is more pronounced in its severity than the anaemia seen in term infants.

Pathogenesis

- Impaired erythropoietin production.
- Blood loss through phlebotomy.
- Reduced red cell life span.
- Iron depletion.

Management

- Blood transfusion.
- Erythropoietin.
- Minimize blood loss during phlebotomies.

4.4.3 BLEEDING IN THE NEWBORN

Bleeding in the newborn may be manifested by:

- Shock.
- Anaemia.
- Signs related to pressure from 'hidden' bleeding (e.g. intraventricular haemorrhage).
- Bleeding from the gastrointestinal tract, respiratory system or skin. For gastrointestinal tract bleeding, rule out swallowed maternal blood using an Apt test.

Once abnormal bleeding in the newborn is identified, the first management approach is to ensure cardiorespiratory stability. A diagnosis to aid in more specific management may then be made.

An approach to the bleeding newborn

History

- A family history of a bleeding disorder.
- Pregnancy and birth history.
- Infant illness.
- Maternal illness.
- Maternal thrombocytopenia.
- Maternal drugs, e.g. thiazides, acetylsalicylic acid, anticonvulsants, rifampicin and isoniazid.

Physical examination

- Determining whether the patient is sick or well.
- Sick infant: consider DIC, viral or bacterial infection or liver disease.
- Well infant: consider inherited coagulation disorder vitamin K deficiency, immune-mediated thrombocytopenia.
- Jaundice suggests infection, liver disease or resorption of a large haematoma.
- Large bruises: vitamin K deficiency, liver disease, DIC, clotting factor deficiencies.
- Petechiae or purpura in the skin are more characteristic of thrombocytopenia.
- Enlarged spleen suggests possible congenital infection.

Laboratory investigation should include:

- Clotting profile (activated partial thromboplastin time, prothrombin time, INR).
- Full blood count.
- Peripheral smear.
- Additionally, all sick newborns should have fibrinogen and fibrin degradation products measured, blood culture, liver function tests (LFTs) and CRPs.

Management



Management should ensure cardiorespiratory stability, which may require replacement of intravascular volume and occasionally other cardiorespiratory support.

- Correct the underlying aetiology (e.g. infection).
- Vitamin K for every bleeding newborn.
- FFPs for DIC, liver disease.
- Platelets for thrombocytopenia.
- Fresh whole blood for acute blood loss.
- Cryoprecipitate for inherited coagulation disorder.

Table 18: Guidelines for platelet transfusion

PLATELET COUNT (X10 ³ /MCL)	
Less than 30	Transfuse all
30-49	Transfuse if: <ul style="list-style-type: none"> ▪ Birth weight below 1500g and less than 7 days old ▪ Clinically not stable ▪ Prior to surgical procedure ▪ Post op ▪ Concurrent coagulopathy
50-100	<ul style="list-style-type: none"> ▪ Active bleeding ▪ Before or after surgical procedures

- Transfuse 10-15mls/kg over 2 hrs.

4.5 CARDIAC

4.5.1 CARDIAC LESIONS

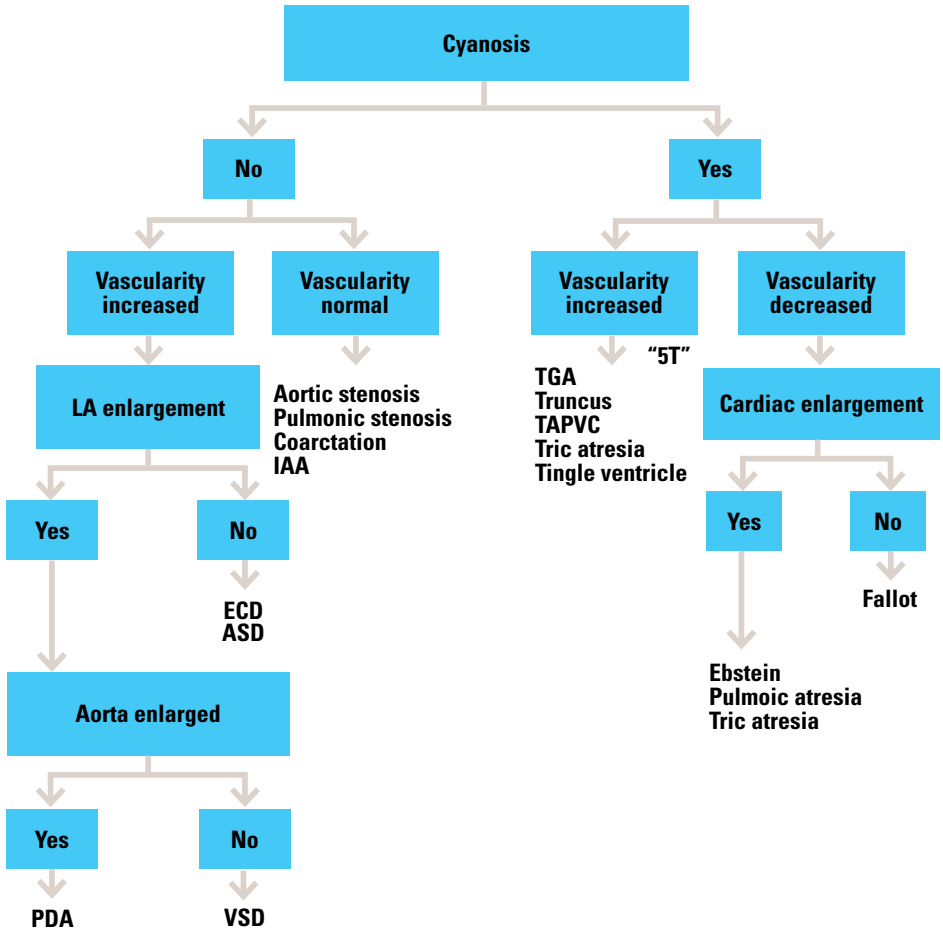
Acyanotic and cyanotic congenital heart diseases are often missed, so care should be taken to identify them.

Clinical presentation of heart disease in neonates

The first signs and symptoms of cardiac lesion include:

1. Central cyanosis (not acrocyanosis).
2. Signs of heart failure:
 - a. Respiratory distress.
 - b. Poor feeding/sweating while feeding.
 - c. Lethargy.
 - d. Hepatomegaly.
 - e. Low urine output.
 - f. Oedema.
3. Heart murmur.
4. Arrhythmia.

Figure 12: Approach to cardiac lesions



Hyperoxia test (100% oxygen test): Because of intracardiac right-to-left shunting, the newborn with cyanotic heart disease (in contrast to the infant with pulmonary disease) is unable to raise the arterial saturation, even in the presence of increased ambient oxygen.

- Determine PaO₂ while infant is on room air.
- Give 100% oxygen for 10-20 minutes by mask, hood, or endotracheal tube.
- Obtain an arterial blood gas level while the infant is breathing 100% oxygen.

In cyanotic heart disease, **these babies are usually unable to achieve a PaO₂ above 100mmHg after 100% inspired oxygen for 10-20 minutes.**

In acyanotic heart disease, **these babies will achieve PaO₂ levels of over 100mmHg under the same conditions as noted above.**

Investigations

Blood gas, CXR, ECG and echocardiographic images.

Management

- Management of congenital heart disease begins with supportive oxygen therapy.
- Do initial resuscitation:
 - » Maintain airway.
 - » Vascular access, volume resuscitation and inotropic support.
 - » Correction of metabolic acidosis to improve cardiac output and tissue perfusion.
 - » Referral to the specific department IMMEDIATELY.
- Cyanotic heart lesions:
 - » After confirming with paediatrician; start:
 - Prostin E2: 50mcg/kg/dose PO/NG/OG q hourly. Take one tablet (500mcg tablet) in enough sterile water for total of 10ml for concentration of 50mcg per ml.
 - Provide enough oxygen to keep saturation between 85 to 90%.

4.5.2 PATENT DUCTUS ARTERIOSUS

PDA is the persistence of the ductus arteriosus (DA) after birth. The DA is an essential cardiovascular structure needed during foetal development, but if it persists after delivery may cause complications (see Figure 13).

Risk factors

- Preterm.
- LBW.
- RDS.
- Fluid overload.

Clinical presentation

- Cyanosis.
- Tachypnoea.
- Tachycardia.
- Hyperdynamic precordium.
- Bounding femoral pulses.
- Systolic murmur.
- Pulmonary oedema.
- Feeding intolerance.
- Decreased urine output.
- Necrotizing enterocolitis.
- Metabolic acidosis.
- Congestive heart failure.

Investigations

- FBC.
- U&E.
- Blood gas.
- CXR.
- Echocardiogram.

Lab findings include metabolic acidosis and thrombocytopenia. CXR may show increased cardiac silhouette. The gold standard for diagnosis is an echocardiogram.

Treatment

Medical

- Ventilator support.
- Fluid restriction.
- Inotropes and diuretics when necessary.
- Platelet transfusion (if needed).
- Conservative management by monitoring until spontaneous closure.

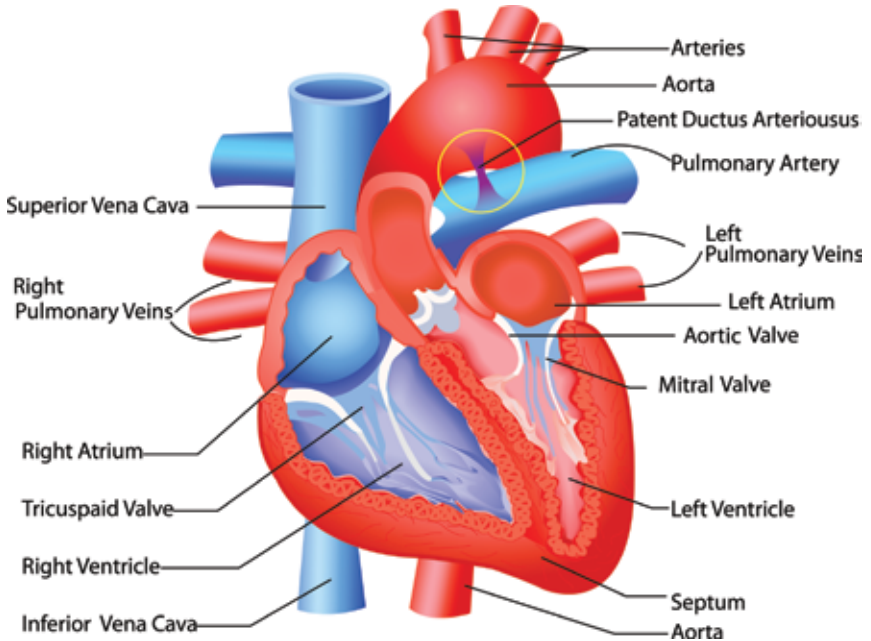
Pharmacological

- Ibuprofen
 - » Give 3 doses that are 24 hours apart:
 - First dose 10mg/kg IV.
 - Second dose 10mg/kg IV.
 - Third dose 5mg/kg IV.
 - » Infuse over 15 minutes, preferably undiluted but may be diluted with normal saline or 5% DW.
 - » Contraindications:
 - Urine output <0.6ml/kg/hour or anuria.
 - Signs of renal failure.
 - Platelet count <60,000.
 - Necrotizing enterocolitis or gastritis.
- Paracetamol IV
 - » 15 mg/kg/dose IV every 6 hours for 3 days.

Surgical ligation

- Due to risks of complications, only done if medical and pharmacological treatment fail or not indicated.

Figure 13: Diagram of patent ductus arteriosus



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4.5.3 CONGESTIVE HEART FAILURE

CONGESTIVE HEART FAILURE



Congestive heart failure (CHF) refers to the inability of the heart to pump as much blood as is needed for the body, resulting in systemic and pulmonary congestion. The overall result is low cardiac output for the demands of the body.

Clinical findings

- Feeding difficulties.
- Excessive sweating.
- Poor weight gain.
- Tachycardia >180/min.

- Tachypnoea.
- Vomiting.
- Poor activity.
- Oedema.
- Hepatomegaly.
- Decreased perfusion (delayed cap refill, weak distal pulses).
- S3 gallop on heart auscultation.
- Signs of cardiomegaly on exam.

Table 19: Some causes of congestive heart failure by age

AGE OF BABY	CAUSES
Foetal	<ul style="list-style-type: none"> ▪ Supraventricular tachycardia ▪ Complete heart block ▪ Anaemia ▪ Severe tricuspid regurgitation ▪ Myocarditis
First day of life	<ul style="list-style-type: none"> ▪ Myocardial dysfunction due to asphyxia, hypoglycaemia, hypocalcaemia or sepsis ▪ Tricuspid regurgitation (e.g. Ebstein's anomaly)
First week of life	<ul style="list-style-type: none"> ▪ Pulmonary hypertension ▪ Coarctation of the aorta ▪ Aortic arch interruption ▪ Total anomalous pulmonary venous connection ▪ PDA (especially in preterm) ▪ Adrenal insufficiency
Second week of life	<ul style="list-style-type: none"> ▪ Ventricular septal defect (VSD) ▪ PDA ▪ Left coronary artery arising from the pulmonary artery

Investigations

- FBC.
- Glucose.
- Electrolytes.
- CXR (cardiothoracic ratio >55% in the neonate).
- ECG.
- Echocardiogram.

Management

- Treatment of the cause.
- Management of precipitating events.
- Control of the low cardiac output state:
 - » Reducing the pulmonary or systemic congestion with diuretics.
 - » Reducing the elevated afterload with vasodilators angiotensin-converting enzyme (ACE) inhibitors.
 - » Increasing contractility with inotropes.
- Nutritional support:
 - » 120-150kcal/kg/day of caloric intake.
 - » 2-3mEq/kg/day of sodium.
- Nursing support:
 - » Head elevated.
- Mechanical ventilation in severe cases.
- Oxygen supplementation tailored to the patient:
 - » Lower accepted oxygen saturation (85 to 88%) in patients with left to right shunts since too much oxygen may worsen CHF due to pulmonary vasodilation and systemic vasoconstriction and in ductal dependent lesions.
 - » Increased oxygen demand needed in patients with pulmonary oedema and hypoxia.

4.6 INFECTIOUS DISEASES

4.6.1 NEONATAL SEPSIS



Neonatal infection is a serious condition that needs to be investigated and treated vigorously.



NEONATAL SEPSIS

Neonatal sepsis is a clinical syndrome of systemic illness accompanied by bacteraemia occurring in the first 28 days of life. Bacterial or fungal invasion of blood before or after birth may spread to involve other organs/systems leading to meningitis, pneumonia, osteomyelitis and pyelonephritis.

Risk factors

- Maternal fever (temp $>38^{\circ}\text{C}$) during labour or within 24 hours after delivery.
- Maternal UTI in current pregnancy or bacteriuria.
- Rupture of membranes >12 hours before delivery.
- Uterine tenderness or foul-smelling amniotic fluid.
- Obstetric diagnosis of chorioamnionitis.
- MAS.
- Resuscitation at birth.
- Invasive procedures.
- Preterm delivery.
- Prolonged labour.
- Home delivery.

Signs and symptoms

- Tachycardia, bradycardia, tachypnoea, lethargy, hypotonic, irritability- (always look at trends in the observation chart over last 24 hours).

- Abdominal distension (+/- skin + colour changes, e.g. shiny, darkened skin).
- Feeding problems (e.g. poor feeding, stopped feeding, increasing residuals, vomiting).
- Organomegaly.
- Jaundice.
- Signs of respiratory distress.
- Petechiae, haemorrhage, anaemia.
- Diarrhoea.
- Convulsions.
- Temperature instability - including hypothermia or hyperthermia.
- Apnoea, desaturations or cyanosis.
- Sclerema.
- Bulging fontanel.

Complications

- Dehydration.
- Septic shock.
- Hypoglycaemia.
- DIC and/or thrombocytopenia.
- Osteomyelitis +/- septic arthritis.
- Anaemia.
- Respiratory failure.
- Meningitis.
- Necrotizing enterocolitis.
- Bronchopneumonia.
- Cardiac failure.
- Renal failure.
- Multi-organ failure.

Investigations

- Blood, urine and CSF cultures.
- Blood count and differential count (white blood cells (WBC) <5000 or >20000; neutrophils >70%).
- CRP.
- CXR (if signs of respiratory distress).
- Lumbar puncture (if there are no contraindications).



All babies with suspected sepsis should have a lumbar puncture, urine and blood culture.

Management

Non-pharmaceutical

- Admit to the neonatal unit or NICU, if available.
- Ensure adequate nutrition.
- Insert naso/orogastric tube.
- Oxygen to maintain saturations 90-95%.
- CPAP if available and meets criteria.

Monitor infants for the following:

- Ensure a temperature of baby is 36.5-37.5°C.
- Blood glucose level greater than 2.6 mmol/l (45mg/dl).
- Haematocrit of 40-45%, Hb 12-15g/dl (see blood transfusion guideline).
- Vital signs within their normal physiological ranges:
 - » If sick/unstable - every hour.
 - » If stable and improving - every 3 hours.

Pharmaceutical

If sepsis is suspected, give:

- Ampicillin 50mg/kg per dose every 12 hours.
- Gentamicin 5mg/kg per dose every 24 hours for neonates above 32 weeks and every 36 hours for neonates less than 32 weeks.
- Second line: Cefotaxime 50mg/kg per dose over 12 hours.
- Third line: Meropenem.

Refer to Table 20 for more details.

If meningitis is suspected, first line therapy: ampicillin + cefotaxime.

NOTE:

If the infant does not have adequate urine output, use a second line (cefotaxime) instead of gentamicin.

Table 20: Neonatal infections management

ANTIBIOTIC COVERAGE SUMMARY BY CONDITION FOR INFANTS < 1 MONTH OF AGE					
Condition	Clinical condition	Laboratory results	Treatment recommendation	Duration of therapy	Comments
Sepsis evaluation: Negative	Normal vital signs, well appearing	Normal WBC, Differential, CPR, CXR	Ampicillin+ gentamicin	48 hours	
Sepsis/ pneumonia	Abnormal vital signs, ill appearing	Abnormal WBC, Differential, CPR, CXR	Ampicillin + gentamicin	7 days	
Sepsis/ pneumonia	Abnormal vital signs, ill appearing, poor response to antibiotics after 48 hours	Abnormal WBC, Differential, CPR, CXR	Cephalosporin Stop gentamicin	7 to 14 days	Cefotaxime
Meningitis	Abnormal vital signs, ill appearing, poor, abnormal neurological exam	Abnormal WBC, Differential, CPR, CXR, CSF	Cephalosporin	14 days if gram-positive 21 days if gram-negative	Cefotaxime
Urinary tract infection	Abnormal vital signs, ill appearing	Urinalysis concerning for UTI	Ampicillin + gentamicin	7 days	Generally considered in infants 7 days

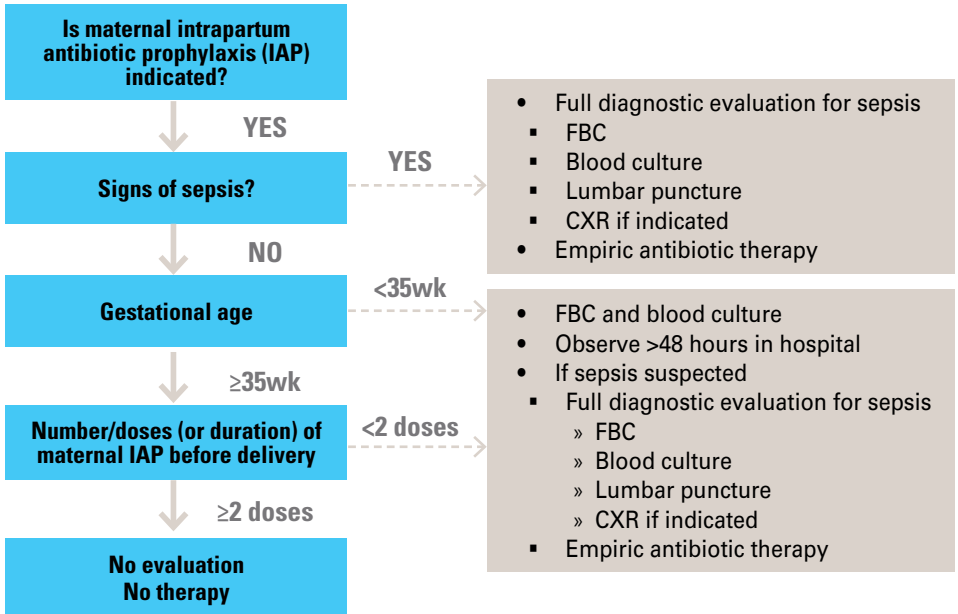
Inotropic support in septic shock

- If correct blood pressure cuff available, MBP should not be less than the gestational age (weeks) of the infant plus 5-10mmHg (e.g. a 34-week gestation infant should have an MBP of 34mmHg).
- If BP is <60/40mmHg in term infant, <50/35mmHg in preterm infant:
 - » Give *dopamine*, IV, 5-15mcg/kg/minute as a continuous infusion.
 - » Continue with *dopamine* as long as it is necessary to maintain the BP.

Recommendation

- Refer all patients to NICU with:
 - » Septicaemia with complications.
 - » Septicaemia not responding to treatment.
- *Cefotaxime*: To replace *gentamicin* in the treatment of sepsis in the setting of renal dysfunction, or to treat presumed meningitis due to poor CNS penetration of gentamicin, preferred to ceftriaxone, especially in setting of hyperbilirubinaemia.
- *Ceftriaxone*: Do not use in setting of hyperbilirubinaemia because it displaces bilirubin from albumin, do not administer within 48 hours of IV calcium in infants <28 days of age due to risk of lethal precipitation.

Figure 14: Management of neonate of a group b streptococcus positive mother



Recommendations for maternal IAP for GBS

- Vaginal/anorectal screening cultures positive for GBS at 3 to 37 weeks gestation, OR
- One or more of the following:
 - Previous infant with invasive GBS diseases
 - GBS bacteriuria during pregnancy
 - Delivery at <37 weeks gestation
 - Ruptured membranes for >18 hours
 - Intrapartum temperature >38°C
 - Unknown GBS status

4.6.2 NEONATAL MENINGITIS



NEONATAL MENINGITIS:

A bacterial infection of meninges in the first month of life. Meningitis should be considered in any neonate being evaluated for sepsis or infection as most organisms implicated in neonatal sepsis and neonatal meningitis are similar.

Causes/risk factors

- Gram-positive: Group B fi-haemolytic streptococcus, *S. epidermidis*, *S. aureus*, *Listeria*.
- Gram-negative: *E. Coli*, Klebsiella, Citrobacter, Enterobacter.
- Open defects or with indwelling devices such as ventriculoperitoneal (VP) shunts.

Signs and symptoms

- Tachycardia, bradycardia, tachypnoea, lethargy, hypotonia, irritability (always look at trends in the observation chart over last 24 hours).
- Temperature instability.
- Altered level of consciousness.
- Hypoglycaemia.
- Bulging/full fontanel.
- Vomiting.
- Convulsions.
- Feeding problems.
- Apnoea (+/- desaturations).

Investigations

- Lumbar puncture
 - » The CSF appears cloudy.

- » Protein concentration is increased above age-appropriate normal values (see Table 21).
- » Leucocyte count is increased with a predominance of polymorph nuclear leucocytes.
- » Glucose concentration is low, $<2/3$ of blood glucose.
- » Gram stain, microscopy, culture and sensitivity of CSF.
- » Blood cultures: for microscopy, culture and sensitivity.

See Table 21 for more details.

Table 21: Cerebrospinal fluid normal values

	WBC/ MM ³	% POLYS	PROTEIN IN G/L (MEAN)	CSF/BLOOD GLUCOSE	OPENING PRESSURE IN LATERAL RECUMBENT POSITION IN MM H ₂ O
Preterm <7d	0 – 30	0 – 28%	0.5 – 2.9 (1)	At least 50% of serum glucose. Low levels may persist for weeks after IVH.	8 – 11
Preterm >7d	2 – 70	0 – 60%	0.5 – 2.6 (0.9)		
Term <7d	0 – 30	0 – 66%	0.3 – 2.5 (0.6)		
Term >7d	0 – 10	0 – 66%	0.2 – 0.8 (0.5)		

Complications

- Cerebral oedema.
- Convulsions.
- Raised intracranial pressure.
- Hydrocephalus.
- Vasculitis, with haemorrhage.
- Subdural effusions.
- Ventriculitis.
- Brain abscess.
- Ischaemia and infarctions of the brain.
- SIADH.

- Neurological sequelae:
 - » Blindness.
 - » Deafness.
 - » Mental retardation.

Management

Non-pharmaceutical

- Admit to NICU, if available.
- Maintain infant temperature between 36.5-37.5°C.
- Monitor neurological status including:
 - » Pupil reaction to light and size of pupils.
 - » Neurological exam (reflexes and tone).
 - » Note any seizures.
 - » Head circumference (once per day during the acute illness, once per week when stable).
- Monitor:
 - » Vital signs.
 - » Blood glucose.
 - » Haematocrit.
 - » Fluid balance (hydration).
 - » Blood gases (if available).
- Ensure adequate nutrition:
 - » Limit total daily fluid intake, IV and oral, do not exceed the daily requirements for age to prevent fluid overload - monitor daily weight.

Pharmaceutical

NOTE:

Do not delay antibiotic treatment. Start antibiotics immediately after lumbar puncture. If lumbar puncture has to be delayed, start the antibiotics.

- Antibiotic choice based on culture result

- » Group B (3-haemolytic streptococci)
 - *Cefotaxime* for 14 days (for dosages, refer to Annex V).
- » *Listeria monocytogenes*
 - *Ampicillin* for 21 days and *gentamicin* for only the first 7 days (for dosages, refer to Annex V).
- » Gram-negative bacteria
 - *Cefotaxime* for 21 days (for dosages, refer to Annex V).
- For patients with no response to empiric antibiotics after 5-7 days and a negative CSF culture, or patients intolerant of ampicillin and cephalosporins:
 - » Consider anaerobic bacteria, and treat with:
 - *Metronidazole* 5-7 days (for dosages, refer to Annex V).
 - » Methicillin resistant staphylococci, and treat with:
 - *Vancomycin*, IV, for 14 days (for dosages, refer to Annex V).
 - » Sensitive staphylococci, and treat with:
 - *Cloxacillin*, IV for 14 days.
 - » *Pseudomonas aeruginosa*, and treat with:
 - *Ceftazidime*, IV, for 14-21 days.
 - » For fever, give:
 - *Paracetamol*, orally, 10mg/kg/dose, 6-hourly when needed until fever subsides.
- Convulsions, see neonatal seizures.
- Raised intracranial pressure or cerebral oedema:
 - » Avoid fluid overload (monitor daily weight).
 - » Reduce to 2/3 of the maintenance dose IV and oral.
 - » Do not exceed the maintenance requirements for age.



Refer neonates with meningitis not responding to adequate treatment to paediatrician.

4.6.3 CONGENITAL INFECTIONS



CONGENITAL INFECTIONS:

Infections acquired in utero. Maternal infection can be asymptomatic.

- Route of infection: trans placental.
- Time of presentation: at birth or months/years later.

Causes

- Viral: CMV, rubella, parvovirus, varicella zoster virus (VZV), HIV.
- Others: toxoplasmosis, syphilis, malaria, TB.

Clinical features

- Intracerebral calcification.
- Hydrocephalus.
- Microcephalus.
- Cataracts.
- Microphthalmia.
- Retinitis.
- Deafness.
- Heart defects (cardiomegaly, PDA).
- Pneumonitis.
- Splenomegaly.
- Hepatomegaly, jaundice, hepatitis.
- Anaemia, neutropenia, thrombocytopenia.
- Bone abnormalities.
- Rash.
- Intrauterine growth restriction.

Table 22: Congenital infections

	TIME OF EXPOSURE	MATERNAL IMMUNITY	MANIFESTATION AT BIRTH	DIAGNOSTIC TESTING	TREATMENT	PREVENTION
Viruses						
CMV	Mostly during delivery and breastfeeding	Primary infection > reinfection	Asymptomatic (90%) Blueberry muffin rash, petechial rash, hepatosplenomegaly, microcephaly, ocular involvement, intracranial calcifications, jaundice, thrombocytopaenia, abnormal LFTs. Hearing loss	CMV IgM within 3 weeks of birth Cell culture from urine, stool, respiratory tract, CSF, peripheral blood leukocytes	Intravenous ganciclovir 6 mg/kg/dose IV q 12 hours for 6 weeks Valganciclovir 16 mg/kg/dose PO twice daily	
Parvovirus	Mostly during the first 20 weeks	Primary infection	Hydrops foetalis Anaemia	IgM = infection in previous 4 months	Supportive care *Possibly IVIG	
Varicella Zoster	Mostly during the first 20 weeks	Primary infection	Asymptomatic Congenital scarring of skin, Cutaneous defects, Bullous lesions, Asymmetric limb hypoplasia and autonomic dysfunction, Eye defects, Seizures, Mental retardation	Immunohistochemical staining of epithelial cells PCR	VZ immunoglobulin post-exposure Aciclovir <35 week: 40 mg/kg/24 hour div 12-hourly x 14-21 days >35 week: 60 mg/kg/24 hour div 8-hourly x 14-21 days	Vaccination before pregnancy

Bacteria	Mostly in the first trimester (80%)	Primary infection	Asymptomatic IUGR Thrombocytopenic purpura, hepatosplenomegaly, lymphadenopathy, jaundice, eye involvement, cardiac abnormalities, pneumonitis, meningoencephalitis, bone lesions, cryptorchidism, haemolytic anaemia. Progressive disease in some patients.	IgM positive at birth – 3 months of age Eye examination Echocardiogram	Supportive care	Vaccination before pregnancy
Rubella (German measles)						
Protozoa	Highest risk of infection acquired late in pregnancy (5-15% risk in the first trimester, 25-40% in the second trimester, 30-75% in the third trimester)	Mostly primary infection, but congenital infections described following reactivations	TRIAD: 1. Chorioretinitis 2. Intracranial calcifications 3. Hydrocephalus OTHERS: Asymptomatic, IUGR, hepatosplenomegaly, petechiae, skin rash, pneumonitis, diarrhoea, hypothermia, intracranial and hepatic calcifications, eye involvement, encephalitis +/- seizures, hearing impairment	IgM or IgA Persistence of IgG beyond 12 months of age Eye examination CT Brain: Cerebral calcifications	Pyrimethamine and sulfadiazine + folic acid for 12 months	Avoid raw meat and cat faeces; requires handwashing if in contact with cat faeces
Toxoplasmosis						

Figure 15: Congenital syphilis management

<ul style="list-style-type: none"> ▪ Mother's RPR <ul style="list-style-type: none"> ▪ +ve, titre > 1:4 ▪ Untreated ▪ Treated <1 month before delivery ▪ Unknown 	<ul style="list-style-type: none"> ▪ Hepatosplenomegaly ▪ Petechiae ▪ Pallor ▪ Low birth weight ▪ Respiratory distress ▪ Blisters on hands and feet ▪ Osteitis ▪ Large pale placenta 	<ul style="list-style-type: none"> ▪ Moher RPR positive AND ▪ Any of the clinical signs listed 	CONGENITAL SYPHILIS	<ul style="list-style-type: none"> ▪ Notify ▪ Admit to neonatal unit ▪ Procaine Penicillin 50 000 units/kg IM daily for 10 - 14 days, or ▪ Penicillin G 150 00 units/kg IV 12 hourly for 10 - 14 days
		<ul style="list-style-type: none"> ▪ Mother RPR positive AND ▪ Mother treated < 1 month before delivery AND ▪ Baby is well 	INCOMPLETELY TREATED FOR SYPHILIS EXPOSURE	<ul style="list-style-type: none"> ▪ Administer Benzathine Penicillin 50 000/kg IM - one dose only to baby ▪ Ensure mother completes treatment
		<ul style="list-style-type: none"> ▪ Mother RPR status is not known AND ▪ Baby is well 	UNKNOWN MATERNAL RPR, PROPHYLAXIS REQUIRED	<ul style="list-style-type: none"> ▪ Administer Benzathine Penicillin 50 000 units/kg IM - one dose only to baby ▪ Ensure mother has a RPR test and reclassify
		<ul style="list-style-type: none"> ▪ Mother RPR Positive AND ▪ Fully treated at least one month before delivery ▪ Baby is well 	COMPLETED TREATMENT FOR SYPHILIS EXPOSURE	<ul style="list-style-type: none"> ▪ No treatment required



For the symptomatic patients: lumbar puncture to rule out neuro-syphilis.

Newborn of mother with Hepatitis B

- If the mother is HBsAg positive, there is a risk of transmission during pregnancy and delivery.
- Administer the first dose of *anti-hepatitis B vaccine* within the first 12 hours following delivery: 0,5 ml IM in the quadriceps muscle to the baby.
- If *anti-hepatitis B immunoglobulin* are available, administer 200 IU IM in the first 24 to 48h of life.

Care of HIV-exposed newborns with HIV-positive mothers

- Provide ARV prophylaxis: refer to national guidelines on PMTCT.
- Encourage exclusive breastfeeding.
- Counsel mothers on adherence for ART and prophylaxis for the baby.
- Counsel on infant HIV testing according to national guidelines.

4.6.4 NEWBORNS WITH MINOR INFECTION

Cutaneous infections: pustules and vesicles

- Clean lesion with antiseptic (chlorhexidine base).
- Apply *violet gentian 0.5%* solution or, if not available, any available antiseptics.
- If there are no signs of generalized infection (no danger signs), start *Cloxacillin 25mg/kg/dose* 2 times a day orally for 5 days.
- If there are danger signs or if the pustules are extensive, hospitalize the newborn and treat with antibiotics against staphylococcus aureus.

Figure 16: Congenital tuberculosis

EXPOSURE TO TB	CLINICAL SIGNS	INVESTIGATE	SIGNS	CLASSIFICATION	PROVIDE ANTI-TUBERCULOSIS TREATMENT
<p>Tuberculosis exposure in mother or close family contact</p> <ul style="list-style-type: none"> ▪ Mother has tuberculosis and on TB treatment for < 2 months ▪ Mother has tuberculosis on TB treatment for > 2 months but has not shown good clinical response ▪ Mother on TB treatment > 2 months and is responding to treatment, sputum negative 	<p>Does the baby have?</p> <ul style="list-style-type: none"> ▪ Poor feeding and poor weight gain ▪ Abdominal distention or hepatosplenomegally ▪ Prolonged jaundice ▪ Pneumonia not responding to treatment 	<p>Gastric washings</p> <ul style="list-style-type: none"> ▪ TB culture ▪ GeneXpert <p>Chest X Ray</p> <ul style="list-style-type: none"> ▪ Miliary pattern ▪ Lymph nodes ▪ Cavitations <p>Abdominal sonar</p> <ul style="list-style-type: none"> ▪ Large lymph nodes <p>Placental biopsy</p> <ul style="list-style-type: none"> ▪ TB culture (in saline) ▪ Histology (in formalin) 	<p>TB meningitis</p>	<p>TB MENINGITIS</p>	<p>6 months treatment of all 4 drugs below</p> <ul style="list-style-type: none"> ▪ INH - 15 - 20mg/kg/day ▪ Rifampicin 15 - 20mg/kg/day ▪ Pyrazinamide 35mg/kg/day ▪ Ethionamide 15 - 20mg/kg/day <p>Check ALT and watch for jaundice. Give BCG on completion of treatment Prednisone 2 - 4mg/kg/day x 4 weeks then taper over 2 weeks.</p>
			<p>Miliary Tuberculosis Cavitating TB Extrapulmonary TB</p>	<p>DISSEMINATED TUBERCULOSIS</p>	<p>Treat with</p> <ul style="list-style-type: none"> ▪ INH10 - 15mg/kg/day x 6 months ▪ Rifampicin 15 - 20 mg/kg/day x 6 months ▪ Pyrazinamide 3 - 40 mg/kg/day x 2 months ▪ Ethionamide 15 - 20 mg/kg/day x 2 months <p>If HIV infected</p> <ul style="list-style-type: none"> ▪ Fast-trak for ARV treatment ▪ Add Pyridoxine 12.5mg daily for 6 months <p>Give BCG on completion of treatment if HIV positive give BCG if asymptomatic</p>

	Give BCG on completion of TB treatment													
<p>CONGENITAL TB</p>	<p>HIGH TB EXPOSURE RISK</p>	<p>Give BCG on completion of treatment, if HIV uninfected. If HIV infected give BCG if asymptomatic. Give INH for 6 months at 10mg/kg/day</p> <table border="1" data-bbox="688 164 908 699"> <thead> <tr> <th>Body Weight (kg)</th> <th>Daily Isoniazid (INH) (100mg tablet)</th> </tr> </thead> <tbody> <tr> <td>< 2kg</td> <td>10mg/kg daily</td> </tr> <tr> <td>2 - 3.4</td> <td>10mg/kg daily</td> </tr> <tr> <td>3.5 - 4.9</td> <td>1/4 tablet</td> </tr> <tr> <td>5 - 7.4</td> <td>1/2 tablet</td> </tr> <tr> <td></td> <td>3/4 tablet</td> </tr> </tbody> </table>	Body Weight (kg)	Daily Isoniazid (INH) (100mg tablet)	< 2kg	10mg/kg daily	2 - 3.4	10mg/kg daily	3.5 - 4.9	1/4 tablet	5 - 7.4	1/2 tablet		3/4 tablet
Body Weight (kg)	Daily Isoniazid (INH) (100mg tablet)													
< 2kg	10mg/kg daily													
2 - 3.4	10mg/kg daily													
3.5 - 4.9	1/4 tablet													
5 - 7.4	1/2 tablet													
	3/4 tablet													
<p>Positive TB test or CXR</p>	<p>Mother has TB and < 2 months of treatment or is not responding to TB treatment</p>	<p>LOW RISK TB PROPYLEXIS</p> <p>Mother > 2 months of TB treatment and is smear negative AND Baby asymptomatic</p>												

Candidiasis (buttocks)

- Nappy candidiasis will appear as a red nappy rash often involving the skin creases and may have satellite lesions.
- Apply *nystatin/clotrimazole cream* 2 times a day or after every nappy change for 14 days minimum.

Thrush (oral candidiasis)

- Apply *nystatin oral* solution in the mouth 4 times a day. Continue treatment for 14 days minimum (see Annex V for dosage).
- Apply *nystatin cream* after each feed on the mother's breasts until the end of the treatment.
- If not responding or extensive, give oral fluconazole (see Annex V for dosage).

Neonatal conjunctivitis

- Characterized by redness of conjunctivas or purulent eye secretions in the newborn.
- The eyes must be washed with physiologic serum or boiled water (boiled, then let to cool down) with a sterile gauze.
- Apply antibiotic ointment (for example *tetracycline 1%* eye ointment) 4 times a day until resolved.
- If gonococcal conjunctivitis is suspected (conjunctivitis appearing at birth or very shortly thereafter), also give a single dose of *IM Ceftriaxone 50mg/kg* (maximum 1mg) in addition to local treatment. If Ceftriaxone is contraindicated, use Cefatoxime.
- If a chlamydial conjunctivitis is suspected, give Azithromycin 20mg/kg/day orally OD for 3 days OR *Erythromycin 50mg/kg/day* orally, twice a day for 14 days in addition to local treatment.

CHAPTER 05

SURGICAL CONDITIONS

5.1 GASTROSCHISIS AND OMPHALOCELE



GASTROSCHISIS

Is a centrally located, full-thickness abdominal wall defect with two distinctive anatomical features.

- a. The extruded intestine never has a protective sac covering it.
- b. The umbilical cord is an intact structure at the level of the abdominal skin, just to the left of the defect. The opening on the abdominal wall is 2-4cm in diameter, and the solid organs (liver and spleen) reside in the peritoneal cavity.



OMPHALOCELE

Is a herniation of the bowel and occasionally other organs (including stomach and liver) into the umbilical cord. These are usually covered by a peritoneal sac which may rupture prior to or during birth. There is a high association with other congenital anomalies which need to be ruled out prior to surgical intervention.

Diagnosis

Prenatal ultrasonography identifies gastroschisis or omphalocele.

Management

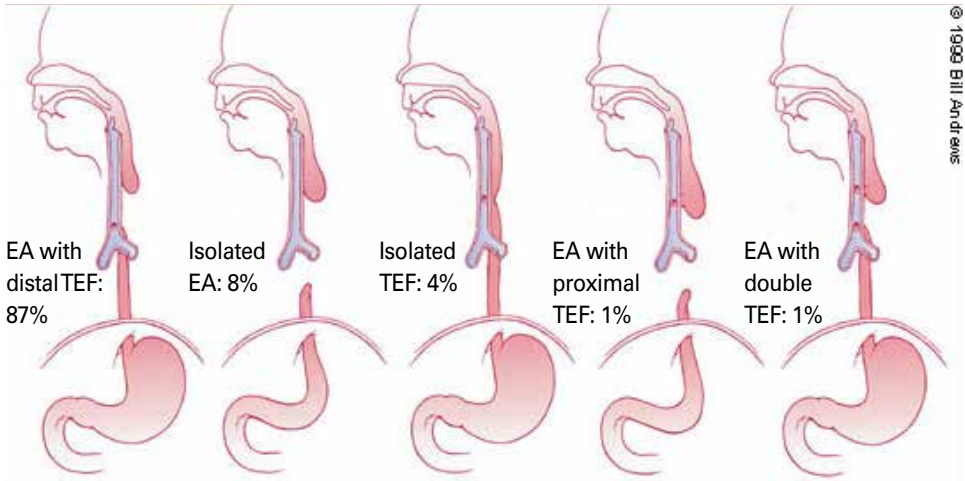
- Notify surgeon and paediatrician to be present at birth.
- Temperature regulation: maintain body temperature at 36.5 to 37°C.
- Protective covering: put a warm, moist abdominal swab (soaked with saline) over the intestines to prevent evaporative heat loss. Wrap the abdomen in layers of cellophane.
- Nasogastric decompression with the nasogastric tube.
- Broad spectrum antibiotic coverage.
- Intravenous fluid neolyte or TPN if available.
- Consult a general surgeon, refer if none available in facility.

5.2 BOWEL DISORDERS

5.2.1 TRACHEOESOPHAGEAL FISTULA

Oesophageal atresia, with or without tracheoesophageal fistula, is a common congenital disorder that all physicians should consider in the differential diagnosis of a neonate who develops feeding difficulties and respiratory distress in the first few days of life. Prompt diagnosis with appropriate clinical management and expeditious referral to a tertiary care centre improves survival of these infants.

Figure 17: Anatomic variations of oesophageal atresia with or without tracheoesophageal fistula and the incidence of these variations



Source: Dwayne C. Clark et al.

Table 23: Associated congenital anomalies reported in patients with oesophageal atresia

SYSTEM AFFECTED	POTENTIAL ANOMALIES
Musculoskeletal	Hemivertebrae, radial dysplasia or amelia, polydactyly, syndactyly, rib malformations, scoliosis, lower limb defects
Gastrointestinal	Imperforate anus, duodenal atresia, malrotation, intestinal malformations, Meckel's diverticulum, annular pancreas
Cardiac	Ventricular septal defect, patent ductus arteriosus, tetralogy of Fallot, atrial septal defect, single umbilical artery, right-sided aortic arch
Genitourinary	Renal agenesis or dysplasia, horseshoe kidney, polycystic kidney, ureteral and urethral malformations, hypospadias

Clinical presentation and diagnosis

- The first sign of oesophageal atresia in the foetus may be polyhydramnios in the mother (prenatal ultrasonogram no foetal stomach bubble).
- Classically, the neonate with oesophageal atresia presents with:
 - » Copious, fine, white, frothy bubbles of mucus in the mouth and the nose. *These secretions may clear with aggressive suctioning but eventually return.*
 - » Presence of rattling respirations, episodes of coughing, choking and cyanosis. *These episodes may be exaggerated during feeding.*
 - » Abdominal distention develops as air builds up in the stomach if fistula. *The abdomen will be scaphoid if no fistula exists.*
 - » If oesophageal atresia is suspected, a radiopaque 5-8 French (in preterm infants) or 8-10 French (in term infants) nasogastric or feeding tube should be passed through the nose to the stomach. In patients with atresia, the tube typically stops at 10 to 12cm (*normal distance 17cm*). *Chest radiographs (posteroanterior and lateral views) should be obtained to confirm the position of the tube. The radiograph should include the entire abdomen.*
 - » In patients with oesophageal atresia, air in the stomach confirms the presence of a distal fistula, and the presence of bowel gas rules out duodenal atresia.
 - » The chest radiograph provides information about the cardiac silhouette, the location of the aortic arch and the presence of vertebral and rib anomalies, as well as the presence of pulmonary infiltrates.

NOTE:

Contrast studies are seldom necessary to confirm the diagnosis. Such studies increase the risk of aspiration pneumonitis and reactive pulmonary oedema, and usually add little to plain film radiographs.

Management and treatment

Once a diagnosis of oesophageal atresia is established, preparations should be made for surgical correction.

- Measures should be taken to reduce the risk of aspiration:
 - » The oral pharynx should be cleared, and an 8 French sump tube placed to allow for continuous suctioning of the upper pouch.
 - » The infant's head should be elevated.
 - » Intravenous fluids (10% DW) should be started.
 - » Oxygen therapy to maintain normal oxygen saturation.
 - » In infants with respiratory failure, endotracheal intubation should be performed.
 - » Bag-mask ventilation is not appropriate since it may cause acute gastric distention requiring emergency gastrostomy.
- Empirical intravenous antibiotics because of the increased risk of aspiration.

Outcome

Most neonates who undergo repair of oesophageal atresia and tracheoesophageal fistula have some degree of:

- Oesophageal dysmotility.
- Gastroesophageal reflux disease.

In cases of surgical problems such as bowel obstruction, mal-rotation or volvulus, and imperforated anus:

- Place a nasogastric tube with continuous suction.
- Keep NPO.
- Ensure proper fluid hydration and electrolyte balance.
- Keep the baby sleeping supine at a 30-45° angle.
- Request for the surgeon's consultation or refer to the next appropriate level of care.

5.2.2 IMPERFORATE ANUS



IMPERFORATE ANUS

Imperforate anus is the lack of an anal opening, proper location or size.

Clinical presentation

- Delayed passing of meconium (most healthy babies pass meconium within 24 hrs of birth).
- Abdominal distention.
- Vomiting.

Diagnosis

It is by inspection and calibration of any perineal opening. All babies with imperforate anus should have X-ray studies of the lumbosacral spine and urinary tract, because there is a high incidence of dysmorphism in these areas.

Differential diagnosis

- Hirschprung's disease.
- Meconium ileus.
- Meconium plug.
- Intestinal dysmotility especially in SGA.

Management

- Admit to nursery.
- Parenteral feeding.
- Keep NPO until senior clinician reviews.
- Request for AXR.
- Discuss with surgeon for corrective surgery (colostomy, then correction later).

5.3 NEURAL TUBE DEFECTS

MYELOMENINGOCELE:



Protrusion of the spinal cord into a sac on the back through deficient axial skeleton with variable dermal covering. Approximately 80% occur in the lumbar region.

SPINA BIFIDA OCCULTA:

Are disorders of caudal neural tube which are covered by intact skin.

Contributing factors of neural tube defects

- Chromosomal abnormalities.
- Single mutant genes.
- Teratogens: nitrates, antifolates drugs, i.e. antiepileptic drugs and Methotrexate.
- Thalidomide.
- Maternal diabetes.
- Nutritional deficiency: folic acid, zinc and vitamin B12.
- Maternal hyperthermia.

Management

- A multidisciplinary approach is required which includes the physician, geneticist, genetic counsellor, neonatologist, urologist, neurosurgeon, orthopaedic surgeon and social worker.
- Closure of the back lesion within 24 or 48 hours to prevent infection and further loss of function is essential.

Immediate management

- Ensure sterile dressing and care of defect.
- Ensure proper fluid hydration.
- Prophylactic antibiotics to prevent infection for open or ruptured neural tube defect.

- Precautions regarding the neural tube defect:
 - » Special precautions must be taken after delivery to protect the exposed neural elements (distal spinal cord, neural placode, nerve, etc.) against mechanical trauma, bacterial assault and even oxidation.
 - » Therefore, these children are placed either prone or in lateral position.
 - » The defect is covered with non-adherent gauze.
 - » Sponges soaked with normal saline or lactate ringer.
 - » Latex precautions should be followed due to the high prevalence of latex allergy in these children.
 - » The head circumference should be recorded on a daily basis, mainly after the closure of the defect.
- Post-operative care:
 - » Antibiotic coverage for 7 to 10 days cycle, depending on the size of the initial defect and the complexity of the reconstruction.
 - » Position:
 - Direct pressure points should be avoided on the incision.
 - Children are kept either prone or in lateral position for few days.
 - » Wound care:
 - Cover with sterile dressings and protected with waterproof adhesive film.
 - Dressings should be changed daily or at any moment if they are wet or soaked with stools.
 - » General care:
 - Feeds are resumed within 12 hours after surgery.
 - Head circumference is recorded daily.

5.4 RENAL ABNORMALITIES

Congenital anatomic anomalies of the genitourinary tract are more common than those of any other organ system. **Urinary tract anomalies** predispose patients to many complications, including UTI, obstruction, stasis, calculus formation and impaired renal function.

Genital anomalies may cause voiding or sexual dysfunction, impaired fertility, psychosocial difficulties or a combination. Genitourinary anomalies frequently require surgical reconstruction.

Many genitourinary anomalies are diagnosed in utero via routine prenatal ultrasonography. Some congenital renal anomalies (e.g. autosomal dominant polycystic kidney disease, medullary sponge kidney, hereditary nephritis) typically do not manifest until adulthood.

Overview of congenital genitourinary anomalies

- Bladder anomalies.
- Cryptorchidism.
- Penile and urethral anomalies.
- Prune-belly syndrome.
- Renal anomalies.
- Testicular and scrotal anomalies.
- Ureteral anomalies.
- Vaginal anomalies.
- Vesicoureteral reflux.

Some of the abnormalities may be diagnosed antenatal through ultrasound (e.g. hydronephrosis).

Management

- Discuss each case with a senior clinician.
- The baby can remain with the mother in postnatal ward if well.
- Ensure that the baby has passed urine prior to discharge.
- Transfer to nursery if there are concerns:
 - » Baby not passing urine.
 - » Posterior urethral valves (PUV) suspected.
 - » Signs of respiratory distress present, possibly indicating pulmonary hypoplasia.

- » Antenatal history of oligo-/anhydramnios.
- In case of PUV, pass a urinary catheter to decompress upper renal tracts.
- Routine U&E is not necessary if the patient is well and passing urine.
- Routine prophylactic antibiotics for UTI prevention are not required.
- Prior to discharge, discuss follow up plan with senior clinician and arrange referral:
 - » Unilateral lesions are usually followed up in 1 month for an ultrasound ±MAG3 (a MAG3 Lasix scan is a nuclear medicine test that provides images of the kidneys to look for kidney function, size, shape, position and blockage of urinary flow).
 - » Unilateral pelvic-ureteric junction obstruction >15mm will require follow up in one week for an ultrasound.
 - » All bilateral lesions will be followed up in one week for an ultrasound.
- Arrange referral.
- At discharge, discuss danger signs, i.e. irritability, lethargy, poor feeding or vomiting, with parents as detailed in the referral letter.

Urinary tract infections in neonates

- UTI in neonates (infants ≤ 30 days of age) is associated with bacteraemia and congenital anomalies of the kidney and urinary tract.
- Upper tract infections (i.e. acute pyelonephritis) may result in renal parenchymal scarring and chronic kidney disease.
- Neonates with UTI should be evaluated for associated systemic infection, and anatomic or functional abnormalities of the kidneys and urinary tract.

CHAPTER 06

METABOLIC & ENDOCRINE DISORDERS

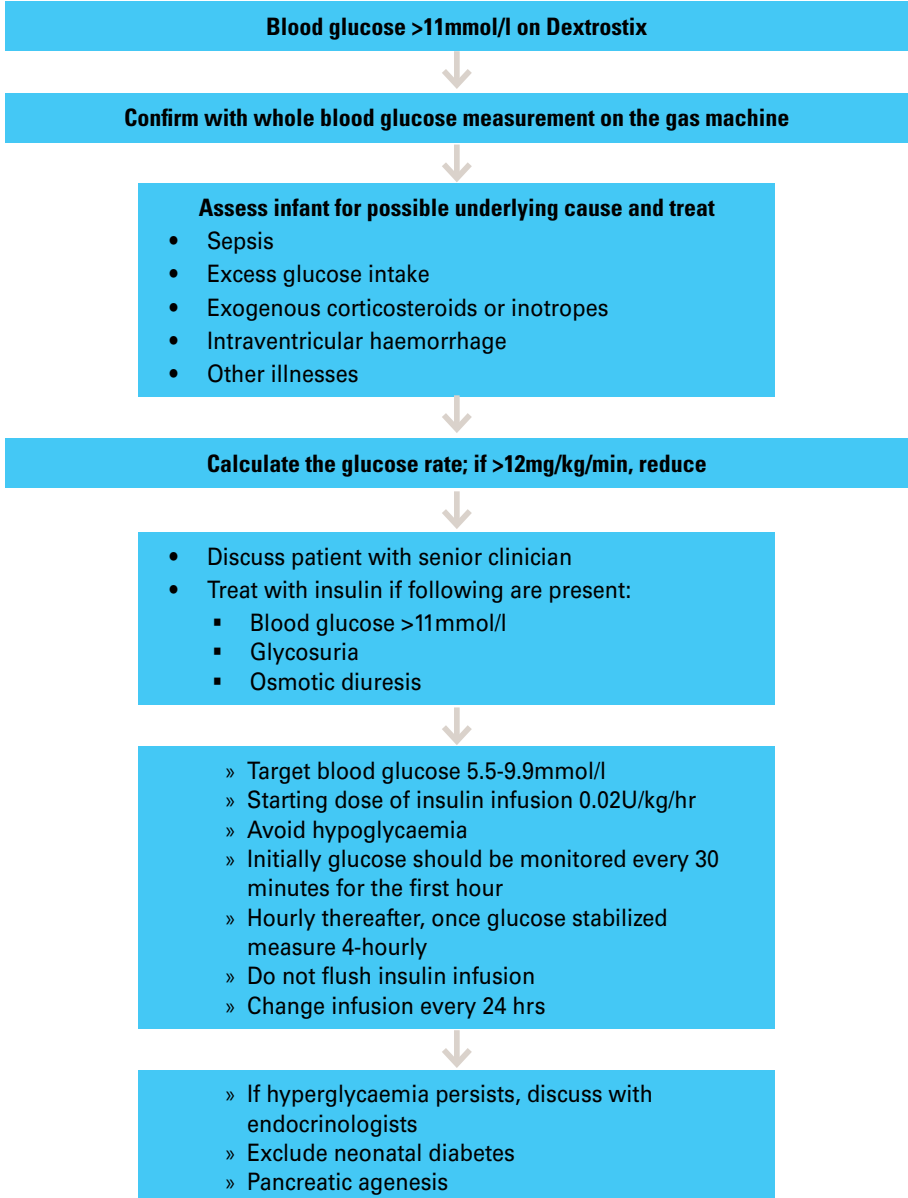
6.1 NEONATAL HYPOGLYCAEMIA

Figure 18: Management of neonatal hypoglycaemia



6.2 NEONATAL HYPERGLYCEAMIA

Figure 19: Management of hyperglycaemia

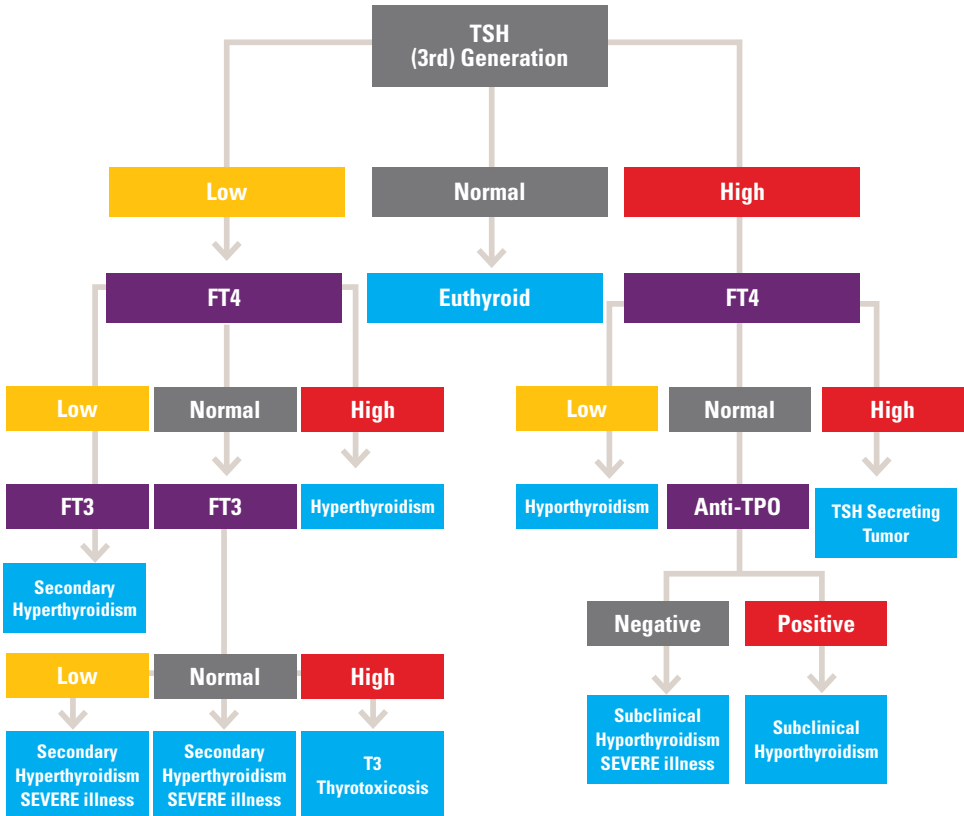


6.3 THYROID DISEASE

6.3.1 CLINICAL USE OF THYROID FUNCTION TESTS

The thyroid function tests are used in a variety of clinical settings as part of routine newborn screening. The following tests may be performed in a newborn with high suspicion of dysfunction: TSH, T4, T3 and free T4 (or T3) concentration.

Figure 20: Algorithm for thyroid testing



Most laboratories use serum thyroid-stimulating hormone (TSH) as the initial screening test as follows:

- Serum TSH normal — no further testing performed.
- Serum TSH high — free T₄ added to determine the degree of hypothyroidism.
- Serum TSH low — free T₄ and T₃ added to determine the degree of hyperthyroidism.

Some exceptions:

- Measure both serum TSH and free T₄ if pituitary or hypothalamic disease is suspected.
- Measure serum free T₄ if the patient has convincing symptoms of hyper- or hypothyroidism despite a normal TSH result.

6.3.2 CONGENITAL HYPOTHYROIDISM

Congenital hypothyroidism can cause mental retardation unless thyroid therapy is initiated within two weeks of birth. Most infants with congenital hypothyroidism appear unaffected at birth, probably because of placental transfer of thyroid hormone. Screening and treatment improvements, including regimens that more aggressively target early correction of TSH levels, have led to improved intellectual and neurologic prognoses.

There are three screening strategies for the detection of congenital hypothyroidism:

- TSH measurement with backup thyroxine (T₄) determination in infants with high TSH levels.
- T₄ measurement with backup TSH assessment in infants with low T₄ levels.
- T₄ and TSH levels screening of all infants should be performed between two and four days of birth.

False-positive TSH elevations may be found in specimens collected at 24 to 48 hours after birth and false-negative results may be found in critically ill newborns or post-transfusion infants. However, screening before discharge or transfusion is still preferable to missing the diagnosis.

Infants with suspected congenital hypothyroidism should be treated with levothyroxine (L-T4) PO.

Starting at a dose of 10 to 15mcg/kg up to 50mcg/day.

The aim of treatment is to keep the serum T4 or free T4 concentration in the upper half of the normal range. Infants and children should be monitored closely during treatment and the L-T4 dose adjusted to maintain serum T4 or free T4 and TSH levels in the target ranges.

6.3.3 HYPERTHYROIDISM (GRAVES' DISEASE)

There are several important issues that must be considered when hyperthyroidism occurs during pregnancy.

Natural history - neonatal Graves' hyperthyroidism resolves spontaneously in 3 to 12 weeks as the maternal TSHR-Ab disappears from the infant's circulation.

The clinical manifestations of hyperthyroidism in neonates are those of hyperthyroidism in general plus some features unique to neonates.

Table 24: The characteristic abnormalities

Intrauterine growth restriction	Premature birth
Microcephaly	Frontal bossing and triangular facies
Warm, moist skin	Irritability, hyperactivity, restlessness and poor sleep
Tachycardia with a bounding pulse	Cardiac arrhythmias or heart failure
Hyperphagia, but poor weight gain, and diarrhoea	Hepatosplenomegaly
Diffuse goitre, usually small	Stare and occasionally exophthalmos (presumably true Graves' ophthalmopathy)

Table 25: Treatment of hyperthyroidism

THE ANTITHYROID DRUG	A BETA BLOCKER	IODINE
<ul style="list-style-type: none"> ▪ Carbimazole 0.75mg/kg/day divided 8-hourly ▪ Methimazole, 0.25 to 1.0mg/kg per day 8-hourly 	<ul style="list-style-type: none"> ▪ Propranolol 2mg/kg per day every eight hours) ▪ Atenolol 1mg/kg daily} can be used 	<ul style="list-style-type: none"> ▪ Lugol's solution (126mg iodine/ml) in the form of one drop (8mg) every eight hours orally ▪ SSKI (potassium iodide) one to two drops daily, can be given to inhibit thyroid hormone release

Once improvement is evident, treatment should be gradually decreased and then discontinued.

Prognosis

- With adequate therapy, initiated promptly, most neonates with hyperthyroidism improve rapidly. Nevertheless, some of these patients have IQs in the 80s when measured at school age, even if they were treated promptly for hyperthyroidism during the neonatal period.

6.4 AMBIGUOUS GENITALIA



AMBIGUOUS GENITALIA

The genitalia of the baby are abnormal if you cannot decide if the baby is male or female.

- Discuss case with senior clinician and endocrinologist.
- Do not be pushed into pronouncing the gender if you are not sure.
- Reassure the family that the baby's sex will be determined definitely as soon as possible.
- Refer to the baby as 'the baby' and not he or she and persuade everyone to do the same.
- Discourage the parents from choosing a gender-ambiguous name.

- Ideally, the parents should not register a birth until the gender is assigned.
- Remember that chromosomal sex may not be the same as the appropriate gender for the child.
- Ensure privacy for the baby and family.

Apparent male

- Bilateral non-palpable testes in a full-term infant.
- Hypospadias associated with separation of the scrotal sacs.
- Undescended testes with hypospadias.

Indeterminate

- Ambiguous genitalia.

Apparent female

- Clitoral hypertrophy of any degree.
- Foreshortened vulva with single opening.
- Inguinal hernia containing a gonad.

6.4.1 CONGENITAL ADRENAL HYPERPLASIA

Presentation: 21-hydroxylase deficiency is the commonest cause of ambiguous genitalia, resulting in virilization of female infants. CAH should be considered the most likely diagnosis in any infant with ambiguous genitalia and in many cases the safest course is to treat before confirming the diagnosis and stop if you are wrong. In an ill or collapsed infant with possible CAH, give steroids even if all blood and urine testing is impossible. Testing with adrenocorticotrophic hormone (ACTH) will establish the diagnosis later.

It is important to avert a salt-losing crisis, which may result in death or permanent neurological damage.

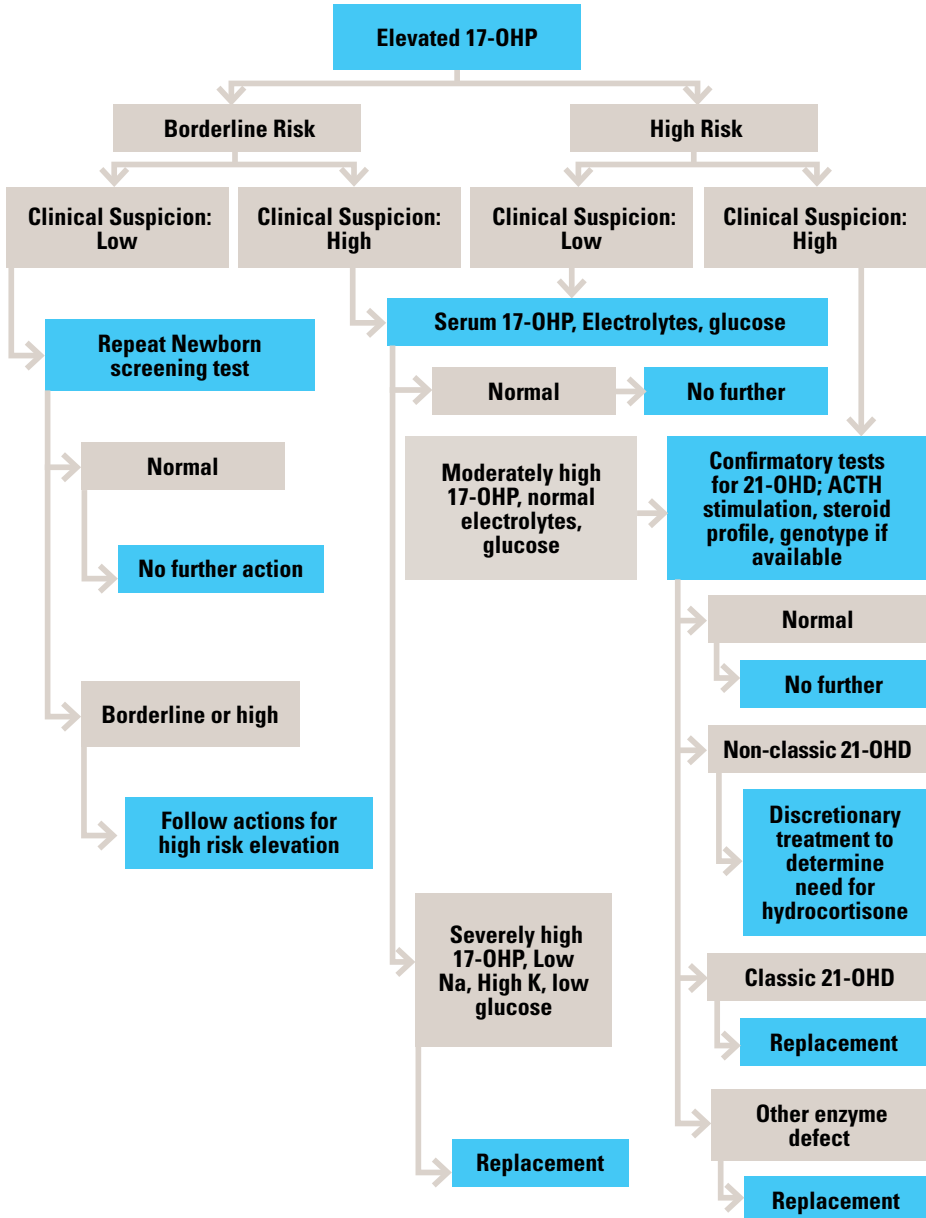
Other presentations of CAH

- Salt loss (falling sodium or unusually high sodium requirements).
- Salt-losing crisis (collapse with low BP, low sodium, high/normal potassium).
- Poorly-virilized male infants (not 21-hydroxylase deficiency, but 3 β -hydroxysteroid dehydrogenase deficiency and lipoid adrenal hypoplasia).
- Virilization in childhood.
- Male genitalia may be pigmented in CAH but this is not a reliable sign in practice.

Investigations

- Serum cortisol (which may be normal).
- Pelvic ultrasound. If the child is a virilized female, the uterus is present. The uterus is fairly large in the neonatal period – about 3cm long. If you cannot find the uterus at ultrasound, reconsider the diagnosis.

Figure 21: Elevated 17-OHP congenital adrenal hyperplasia



Initial management

- Inform a senior clinician.
- Electrolyte replacement.
- A large sodium deficit will require replacement even after steroids are started.
- Steroid replacement; give mineral corticoid and glucocorticoid.
- Contact paediatric endocrinologist for management advice.

Table 26: Glucocorticoid and mineralocorticoid dosages for initial treatment and maintenance therapy

	HYDROCORTISONE (MG/M ² /DAY DIV 8 HOURLY)	FLUDROCORTISONE (MG/DAY DIV 8 TO 12 HOURLY)	SODIUM CHLORIDE (3G/KG/DAY DIV 3 TO 8 HOURLY)
Initial treatment	25 – 100	0.025 – 0.2	0.1 – 0.2
Maintenance therapy	10 – 20	0.025 – 0.2	0.1 – 0.2

Table 27: Stress dosing of hydrocortisone

PHYSICAL STRESS	CONDITIONS	HC DOSE
Mild	Vaccination Upper respiratory infection up to low-grade fever	Maintenance dose
Moderate*	Infection Associated with high fever (> 38.5°C) Vomiting, diarrhea, poor feeding, sluggishness Minor surgery, trauma, dental treatment, burn	3- to 4-fold maintenance dose or 50-100 mg/ m ² /d**
Severe*	Sepsis, major surgery	100mg/m ² /d**

* If adrenal crisis is suspected, prior to surgery under general anesthesia or stress is difficult to control orally, a parenteral bolus administration of HC 50 mg/m² (infant, 25mg; child, 5mg; adult, 100mg) is first performed (9). If an intravenous line is difficult to place, succinate ester of HC can be intramuscularly injected (only phosphate ester of HC is allowed to be intravenously administered in Japan).

**For intravenous injection, continuous administration is preferable to bolus injection at 6-h intervals (105).

Follow up

- Babies with CAH will require oral sodium supplements until they are weaned.
- Do not allow home until electrolytes are stable on steroids and sodium replacement and arrange regular electrolytes measurements as an outpatient for the first few weeks.
- If surgery is required for ambiguous genitalia, an early referral should be made to surgeons with expertise in this area.
- The need for steroids is life-long. Parents should be clear about the need to increase the dose for illness and to consult medical help if the child vomits the steroids.
- Arrange for a follow up plan prior to discharge.

Genetic advice

- CAH is an autosomal recessive disorder. Antenatal treatment with dexamethasone will reduce or abolish virilization of the female infant. Treatment must start early in pregnancy and thus genetic testing must be arranged in advance.

Differential diagnosis

- **21-hydroxylase deficiency** (commonest). Female infants are virilized and male infants are normal. May present with salt-losing crisis. 17-hydroxyprogesterone is elevated.
- **11 β -hydroxylase deficiency**. Female infants are virilized and male infants are normal. 17-hydroxyprogesterone is elevated. Salt-losing crisis does not occur.
- **3 β -hydroxysteroid dehydrogenase deficiency**. Male infants are under virilized and female infants are mildly virilized. 17-hydroxyprogesterone is not elevated. There may be very severe salt-losing crisis.
- **Lipoid adrenal hyperplasia**. All steroid hormones are reduced and male infants are under virilized. Presents with a severe salt-losing crisis.

Other causes of adrenal insufficiency in neonates:

- Hypopituitarism – usually presents with hypoglycaemia.
- Adrenal hypoplasia – almost always boys.
- ACTH resistance.

6.5 INBORN ERRORS OF METABOLISM

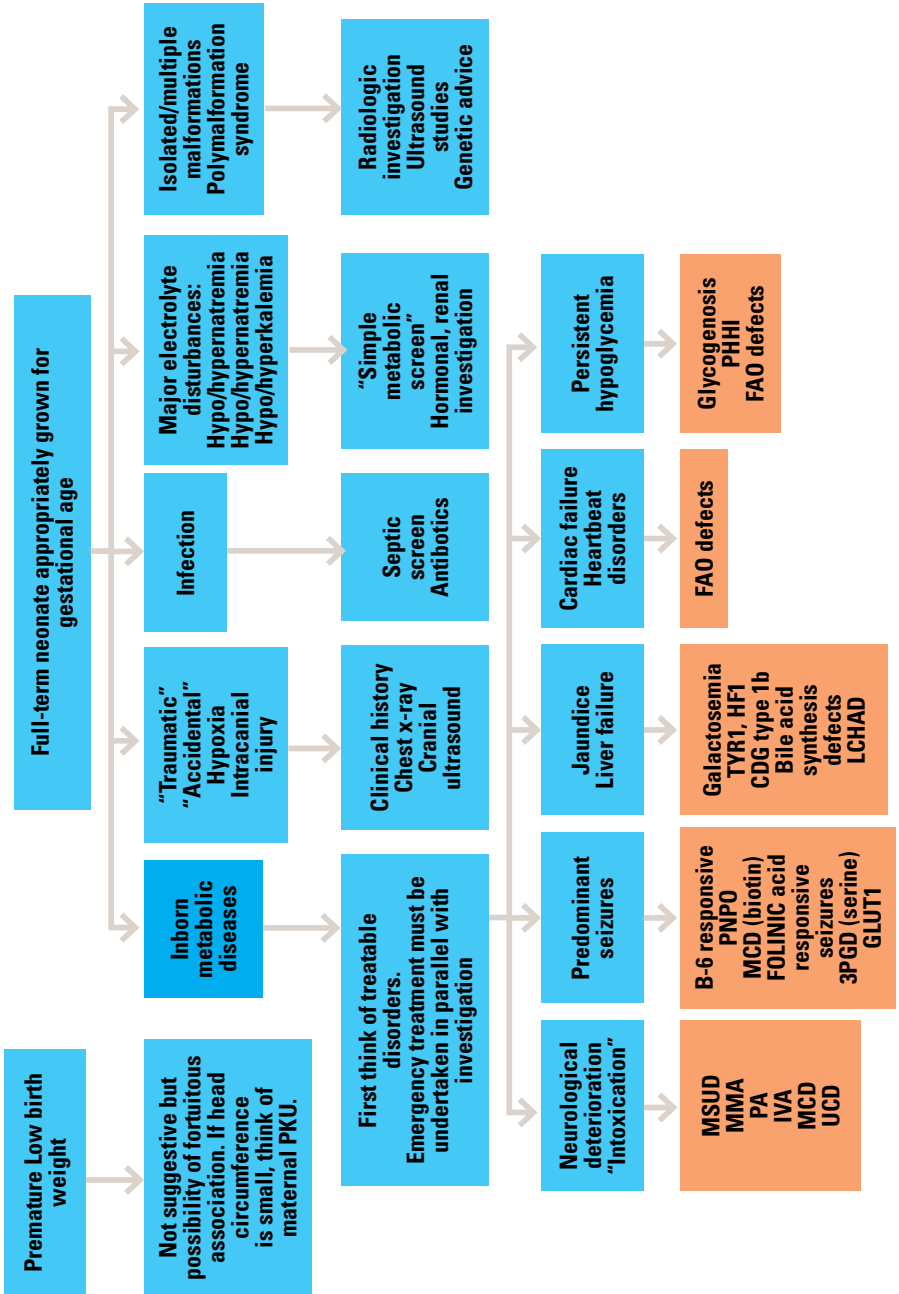
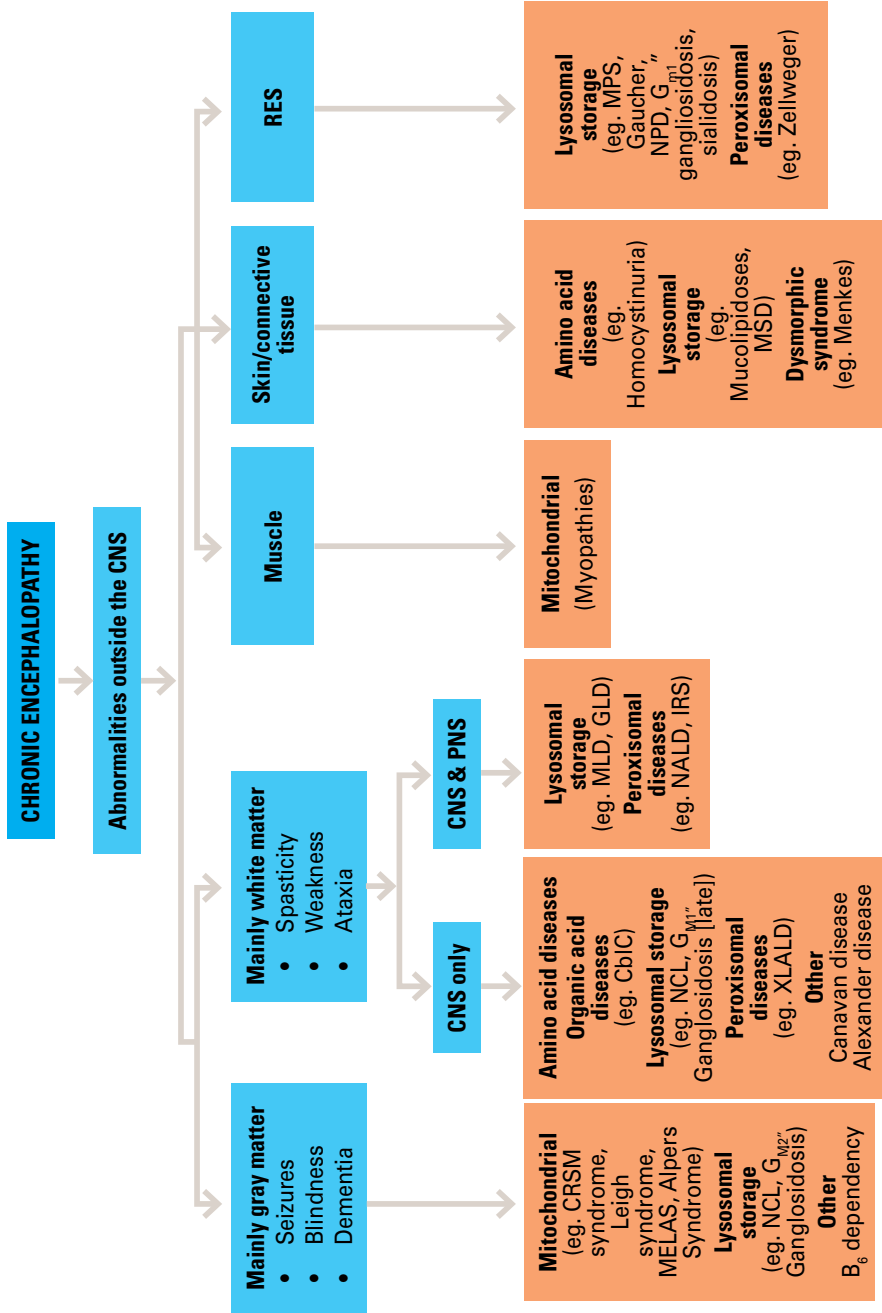


Figure 22: Inborn errors of metabolism

Figure 23: Inborn errors of metabolism causing chronic encephalopathy



CHAPTER 07

CONGENITAL ABNORMALITIES

7.1 THE DYSMORPHIC NEWBORN

The suspicion for many syndromes and chromosomal anomalies is often raised by major or minor anomalies picked up through physical examination.

Physical examination

Major anomalies: Defined as those that have medical, surgical or cosmetic consequences. These include structural brain anomalies, mental retardation and failure to thrive, cleft lip and palate, congenital heart defects, abnormal secondary sexual development, urogenital defects, skeletal dysplasias and severe limb anomalies.

Minor anomalies: Not having serious medical, surgical or severe cosmetic consequence. Include abnormally shaped ears and eyes, inverted nipples, birth marks, abnormal structures of hands and feet, and abnormal skin folds and creases.

Genetic diagnostic tests

- **Karyotype:** detects abnormal numbers of chromosomes and deletions, duplications, translocations and inversions that are large enough to be seen by light microscopy. It is indicated in patients with two major malformations or one major and two minor malformations.
- **Fluorescent in situ hybridization:** hybridization of fluorescently tagged deoxyribonucleic acid (DNA), used as a probe to identify defects in chromosomes. It allows detection of submicroscopic deletions and

duplications. Indicated for conditions like DiGeorge, Prader-Willi, velocardiofacial, Angelman, etc.

- **DNA analysis:** can detect many monogenic disorders.

Structural diagnostic tests

- Brain magnetic resonance imaging (MRI).
- Ophthalmologic examination: optic atrophy, coloboma, cataracts, retinal abnormalities, lens subluxation, corneal abnormalities.
- ECG.
- Abnormal ultrasound: polysplenia or asplenia, absent or horseshoe kidney, ureteral or bladder defects, abdominal situs inversus.
- Skeletal survey: abnormalities of bone length or structure.

Table 28: Clinical findings of Trisomy 13, 18, 21

CLINICAL PRESENTATION	TRISOMY 21	TRISOMY 18	TRISOMY 13
Craniofacial	<ul style="list-style-type: none"> ▪ Flat facial profile ▪ Slanted palpebral fissures ▪ Anomalous auricles 	<ul style="list-style-type: none"> ▪ Prominent occiput ▪ Short palpebral fissures ▪ Low-set “tulip” ears 	<ul style="list-style-type: none"> ▪ Microcephaly ▪ Sloping forehead ▪ Wide fontanels ▪ Microphthalmia ▪ Cleft lip ▪ Cleft palate ▪ Abnormal helices ▪ Cutis aplasia of the scalp.
Extremities	<ul style="list-style-type: none"> ▪ Dysplasia of mid phalanx of 5th figure ▪ Single palmar crease ▪ Sandal crease 	<ul style="list-style-type: none"> ▪ Clenched hand ▪ Short hallux 	<ul style="list-style-type: none"> ▪ Polydactyly ▪ Single palmar crease ▪ Posterior prominence of heel
Cardiac	<ul style="list-style-type: none"> ▪ Endocardial cushion defect ▪ VSD ▪ PDA 	<ul style="list-style-type: none"> ▪ VSD ▪ PDA ▪ Atrial septal defect (ASD) 	<ul style="list-style-type: none"> ▪ VSD ▪ PDA ▪ ASD

CLINICAL PRESENTATION	TRISOMY 21	TRISOMY 18	TRISOMY 13
Neurologic	<ul style="list-style-type: none"> ▪ Hypotonia 	<ul style="list-style-type: none"> ▪ Weak foetal activity 	<ul style="list-style-type: none"> ▪ Holoprosencephaly ▪ Deafness ▪ Seizures
Other	<ul style="list-style-type: none"> ▪ Excess skin on back and neck 	<ul style="list-style-type: none"> ▪ Polyhydramnios ▪ Small placenta ▪ Single umbilical artery ▪ Muscle hypoplasia ▪ Adipose tissue hypoplasia 	<ul style="list-style-type: none"> ▪ Single umbilical artery

Table 29: Clinical features of VACTERL and CHARGE syndromes

ASSOCIATION	AETIOLOGY	CLINICAL PRESENTATION
VACTERL	<ul style="list-style-type: none"> ▪ Unknown; more frequently seen in children born to mothers with DM 	<ul style="list-style-type: none"> ▪ Vertebral abnormalities ▪ Anal atresia ▪ Cardiac abnormalities ▪ Tracheoesophageal fistula with oesophageal atresia ▪ Renal anomalies ▪ Limb anomalies (radio dysplasia, polydactyly, syndactyly) ▪ Single umbilical artery
CHARGE	<ul style="list-style-type: none"> ▪ Mutations and deletions of the CHD7 gene (8q12) 	<ul style="list-style-type: none"> ▪ Coloboma ▪ Heart defect (tetralogy of fallot, PDA, complete atrioventricular canal) ▪ Choanal atresia ▪ Retarded growth and development ▪ Genital abnormalities (hypoplasia in males) ▪ Ear anomalies and/or hearing loss (sensorineural or mixed)

Indications for referral

All babies with congenital malformations should be referred to the paediatrician.

Indications for prenatal counselling

- Genetic disorder or birth defect in one of the parents.
- Known carrier of a genetic disorder.
- Previous child with known or suspected genetic disorder.
- Maternal age >35 years.
- Multiple early miscarriages, stillbirths or neonatal deaths.
- Exposure to teratogen or infections.

CHAPTER 08

NEONATAL PAIN

8.1 NEONATAL PAIN

Newborns experience pain. Pain in the neonate can be classified into three categories:

- **Acute or physiological pain:** from skin-breaking procedures or tissue injury caused by diagnostic or therapeutic interventions.
- **Established pain:** surgery or localized inflammatory (e.g. abscess or birth trauma).
- **Prolonged pain:** results from severe diseases like necrotizing enterocolitis or meningitis.

It is challenging to detect and measure the intensity of pain in neonates because of their inability to communicate with care providers. For example, preterm infants have less ability to demonstrate symptoms of pain.

Untreated or inadequately treated neonatal pain may have immediate and long-term effects including altered pain sensitivity and reactivity, and other adverse health outcomes.

Neonatal pain assessment tools

Available methods for neonatal pain assessment include physiologic, behavioural and contextual parameters.

Table 30: Neonatal pain assessment parameters

PHYSIOLOGIC PARAMETERS	BEHAVIOURAL RESPONSES
<ul style="list-style-type: none"> ▪ Changes in heart rate ▪ Respiratory pattern ▪ Blood pressure ▪ Oxygen saturation 	<ul style="list-style-type: none"> ▪ Crying ▪ Changes in facial expressions ▪ Body movements

In infants, total facial activity and cluster of specific facial findings (brow bulge, eye squeeze, nasolabial furrow and open mouth) are associated with acute and post-operative pain.

Recommendations for neonatal pain control programme

- Routine assessment for the detection of pain.
- Reduction of the number of painful procedures.
- Guidelines and protocols to prevent/reduce pain.
- Analgesia should be provided pre-emptively for any painful procedure.
- See Annex VI for specific pain management recommendations for various procedures.

Table 31: Neonatal pain control

NON-PHARMACOLOGICAL ANALGESIA	PHARMACOLOGIC AGENTS
<ul style="list-style-type: none"> ▪ Oral sucrose or glucose ▪ Breastfeeding ▪ Non-nutritive sucking ▪ Skin to skin contact (e.g. kangaroo care) ▪ Swaddling including facilitated tucking (defined as maintaining the arms and legs in a flexed position) ▪ Sensorial saturation – use of touch, massage, voice, smell and sight 	EMLA Lidocaine Opioids

For palliative care

- Give morphine 0.1mg/kg IV, may repeat as needed.
- Infants who have a devastating neurologic prognosis from congenital or acquired conditions, require special consideration.
- The severity of the expected outcome must be explained to the family honestly and clearly.

CHAPTER 09

DISCHARGE AND FOLLOW UP

9.1 DISCHARGE

Discharge criteria

- The baby must meet the following criteria before being discharged:

Feeding

- Baby does not require intravenous fluids.
- Baby is receiving at least 8 feeds per day (i.e. 3-hourly feeds) of a total of more than 120ml/kg/day or baby is demanding breastfeeding well.
- Baby has gained at least 15g/kg/day for at least 3 days and weighs more than birth weight, for preterm its 1800g.
- The mother/caregiver is confident to feed and look after the baby.
- Passing urine and stool normally.

Respiratory

- There are no signs of respiratory distress.
- For premature or low birth weight babies; no episodes of apnoea for 3 days without caffeine or *aminophylline*.

Temperature

- Baby can maintain own temperature 36.5-37°C without the use of incubator or radiant heater sources for at least 3 days.

General

- Has no danger signs including fever, jaundice, convulsions, abdominal distension.
- Drugs or supplements have been prescribed or given to mother/carer.
- Outstanding immunizations have been administered.
- Mother/caregiver has been advised on warning signs of illness.
- Mother/caregiver has been advised on safe methods of newborn care, e.g. sleeping positions, including self-care and nutrition guidance.
- Community support systems have been offered (e.g. HIV-positive mothers/adolescent or single carers).
- For HIV-exposed babies, prophylaxis (or treatment) has been provided and follow up arranged including review of drugs and serology testing.

Document the following parameters on discharge

- Contact details for follow up.
- Weight.
- Head circumference.
- Final diagnosis.
- Drugs prescribed.
- Place of discharge (e.g. home).
- If baby died, cause of death.

Discharge examination

- All babies discharged must have had a full examination during their stay.
- Weight and head circumference must be documented and plotted on growth charts.

Recommendations

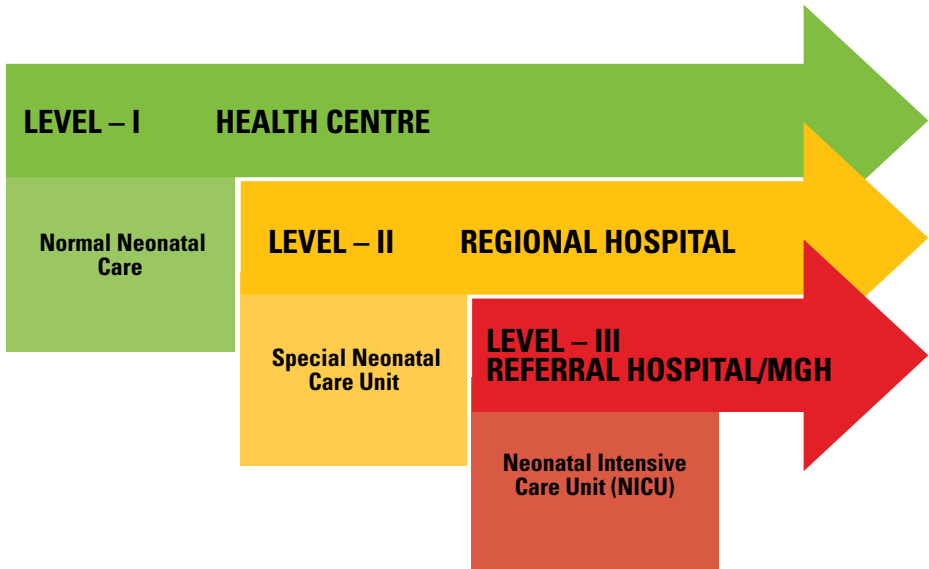
Babies with the following criteria should be followed up in 1-2 weeks at the outpatient clinic:

- Birth weight less than 2.0Kg.
- 32 weeks or less gestation at birth.
- Required alternative feeding methods >2 weeks.
- Infants with congenital malformations or a syndrome e.g. Downs.
- HIV-positive mother/are at risk of HIV infection.
- Required long-term oxygen therapy.
- Required ventilation.
- Rhesus disease requiring an exchange transfusion.
- Severe birth asphyxia.
- Confirmed meningitis.

9.2 NEONATAL REFERRAL AND TRANSPORT

Neonatal referral is an integral part of perinatal care programmes. The goal is to reduce neonatal mortality and morbidity when the management of a sick infant exceeds the ability of the level of care provided in a health facility.

All hospitals with established maternity services and level I or II neonatal care units should have agreements with higher perinatal care centres for perinatal consultations and neonatal transfer.

Figure 24: National neonatal care levels

Arranging for transport

Communication with the referral centre is done prior to transport to ensure the availability of a bed and availability of the services required for the baby (e.g. surfactant, surgery, etc.).

Information that should be available at the time of the consultation call:

- Parent's consent for referral and documented in the patient's medical record.
- Patient's name and date of birth.
- Names of the patient's mother and father.
- Prenatal history.
- Labour and delivery record.
- Neonatal resuscitation record.
- Apgar scores.
- Gestational age and birth weight.
- Vital signs (temperature, heart rate, respiratory rate, BP).

- Oxygen/ventilatory support requirements.
- Laboratory data obtained (glucose, calcium, haematocrit, blood gas value).
- Vascular access.
- Role of the referring hospital.

Preparation

Personnel

Transport teams consist of a combination of preferably two fully skilled personnel in the care of the high-risk neonate for adequate stabilization before, and effective management during, transportation.

Vehicle and equipment

An ambulance should be prepared with the following:

- Transport incubator.
- Monitors for heart rate, respiratory rate, temperature, arterial BP with different sizes of neonatal blood pressure cuff.
- Inspired oxygen concentration.

Record all findings and treatments

Make sure the birth is recorded to facilitate issuance of birth certificate and appropriate follow up if required.

ANNEXES

Annex I: Physical examination

		YES (1)	NO (2)	NOT SURE (NS)
1	1. Scrub/clean hands before exam			
2	2. Undress baby, except for diaper, keeping warm with radiant heater if possible			
3	3. Take advantage of quiet, non-crying state to adapt order of steps (explain)			
	4. Observe baby's general appearance, for:			
4	a. Colour (pink, cyanotic, jaundice)			
5	b. Tone (flexed, extended, limp)			
6	c. Respiratory status (distress, tachypnea, retractions, accessory muscle use, nasal flaring, grunting)			
7	d. Alertness (sleep, awake, fussy, irritable, crying – vigorous or weak)			
8	e. Obvious morphologic abnormalities (“syndromic”)			
9	f. Size (large, small, normal weight for gestational age)			
	5. Measurements			
10	a. Head circumference			
11	b. Length, with legs fully extended			
12	c. Explained about checking blood pressure with appropriately sized cuff			
	6. Examination of Head			
13	a. Evaluate for molding, caput, cephalohematoma			
14	b. Feel anterior fontanelle			
15	c. Check eyes for red reflex			
16	d. Inspect mouth and palate			
	7. Examination of Thorax			
17	a. Inspection (breast bud development)			
18	b. Palpate clavicles (for fracture)			
19	c. Auscultate posterior thorax (lung sounds, symmetry, respiratory rate)			

		YES (1)	NO (2)	NOT SURE (NS)
20	d. Auscultate anterior thorax (heart sounds, murmurs, heart rate)			
	8. Examination of Abdomen / Pelvis			
21	a. Inspect umbilicus (identify the three vessels)			
22	b. Auscultate for bowel sounds			
23	c. Palpate abdomen (for masses)			
24	d. Palpate femoral pulses			
25	e. Examine genitalia and anus			
26	f. Inspection of back and sacrum (turn baby over)			
	9. Examination of Extremities			
27	a. Assess hips for dislocation (Ortolani and Barlow tests)			
28	b. Examine hands and feet (count digits, nail colour, hand creases)			
	10. Neurologic examination			
29	a. Moro/startle, sucking, hand and foot grasp, and stepping reflexes			
30	11. Wash hands			

Annex III: Developmental milestones

MONTHS	GROSS-MOTOR	FINE-MOTOR-ADAPTIVE	COMMUNICATION	PERSONAL-SOCIAL
18	<ul style="list-style-type: none"> ▪ Walks well, arms down ▪ Pulls a toy ▪ Throws a ball ▪ Climbs on a chair 	<ul style="list-style-type: none"> ▪ Completes simple form board with reversal (trial and error) ▪ 3-4 cube tower 	<ul style="list-style-type: none"> ▪ 2 word utterances, 6-20 words ▪ Points to one body part ▪ Points to one picture 	<ul style="list-style-type: none"> ▪ Indicates wet/dirty nappy ▪ Pulls up pants ▪ Handles spoon and cup well
15	<ul style="list-style-type: none"> ▪ Walks alone - uneven steps, arms out for balance 	<ul style="list-style-type: none"> ▪ 2 cube tower ▪ Simple form board - replaces both circles 	<ul style="list-style-type: none"> ▪ Jabbers with expression ▪ Use 5 words (other than mama, dada) 	<ul style="list-style-type: none"> ▪ Pulls off socks ▪ Holds and drinks from a cup ▪ Attempts to feed with a spoon - spills most
12	<ul style="list-style-type: none"> ▪ Bear walks, walks around furniture, lifting one foot and stepping sideways, may walk alone 	<ul style="list-style-type: none"> ▪ Pincer grasp, releases object on request ▪ Simple form board (one circle in)* 	<ul style="list-style-type: none"> ▪ Knows own name ▪ 2-3 words with meaning 	<ul style="list-style-type: none"> ▪ Finger feeds ▪ Pushes arm into sleeve
10	<ul style="list-style-type: none"> ▪ Pulls to stand, walks with assistance 	<ul style="list-style-type: none"> ▪ Picks up small object between finger and thumb ▪ Clicks two cubes together 	<ul style="list-style-type: none"> ▪ Shakes head for no ▪ Waves bye bye 	<ul style="list-style-type: none"> ▪ Plays peek-a-boo with mother
9	<ul style="list-style-type: none"> ▪ Sits without support ▪ Crawls on hands and knees ▪ Pulls up to stand 	<ul style="list-style-type: none"> ▪ Immediately reaches out and holds a cube in each hand ▪ Exploratory mouthing 	<ul style="list-style-type: none"> ▪ Vocalizes deliberately ▪ Babbles 	<ul style="list-style-type: none"> ▪ Stranger anxiety ▪ Holds cup

MONTHS	GROSS-MOTOR	FINE-MOTOR-ADAPTIVE	COMMUNICATION	PERSONAL-SOCIAL
6	<ul style="list-style-type: none"> ▪ Pulls to sit: braces shoulders and pulls to sit ▪ Prone: lifts head and chest up, supports on extended arm ▪ Rolls from supine to prone 	<ul style="list-style-type: none"> ▪ Reaches for and grasps toy ▪ Transfers toy from one hand to the other 	<ul style="list-style-type: none"> ▪ Initiates conversation 	<ul style="list-style-type: none"> ▪ Takes everything to the mouth ▪ Pats mirror image
3	<ul style="list-style-type: none"> ▪ Pulls to sit: little or no head lag ▪ Prone: supports on forearms, lifts head, buttocks flat ▪ Rolls from prone to supine 	<ul style="list-style-type: none"> ▪ Follows through 180° ▪ Holds rattle when placed in hand 	<ul style="list-style-type: none"> ▪ Coos, chuckles and squeals 	<ul style="list-style-type: none"> ▪ Excited when sees mother ▪ Obvious pleasure at being handled
6 weeks	<ul style="list-style-type: none"> ▪ Pull to sit: some head control ▪ Prone: head to side, buttocks moderately high ▪ Moro reflex 	<ul style="list-style-type: none"> ▪ Stares ▪ Follows horizontally to 90° 	<ul style="list-style-type: none"> ▪ Startle response 	<ul style="list-style-type: none"> ▪ Smiles at mother
New-born	<ul style="list-style-type: none"> ▪ Ventral suspension: head drops, hips flexed, limbs hang ▪ Moro reflex, palmar & plantar grasp reflexes 	<ul style="list-style-type: none"> ▪ Hands fisted ▪ Closes eyes to sudden bright light 	<ul style="list-style-type: none"> ▪ Stills to sound ▪ Startles to sudden loud noises 	<ul style="list-style-type: none"> ▪ Alternates between drowsiness and alert wakefulness

Annex IV: Interpretation of blood gases

BLOOD GAS VALUES					
	pH	CO₂	O₂	Bicarbonate	Base
	7.25-7.28	48mmHg	18-22.5mmHg	n/a	-4
Cord (venous)	7.28-7.35	35-45mmHg	27-38mmHg	n/a	
Neonatal (arterial)	7.35-7.45	35-45mmHg	50-90mmHg Term 50-80mmHg Preterm	22-26mEq/l Term 20-24mEq/l Preterm Or 22-26mmol	+2 to -2

FOR UNCOMPENSATED GAS (PH IS ABNORMAL):					
	pH	CO₂	Bicarbonate	Base	Problem
	Low	High			Respiratory acidosis
	Low		Low	Large deficit	Metabolic acidosis
	Low	High		Large deficit	Mixed acidosis
	High	Low			Respiratory alkalosis
	High		High	Large excess	Metabolic alkalosis

FOR COMPENSATED GAS (I.E. PH IS NORMAL, BUT OTHER VALUES OUT OF RANGE)					
	pH	CO₂	Bicarbonate	Base	Problem
	Low normal	High	High		Compensated respiratory acidosis
	High normal	Low	Low		Compensated respiratory alkalosis
	Low normal	Low	Low		Compensated metabolic acidosis
	High normal	High	High		Compensated metabolic alkalosis

Permissive hypercapnia: To avoid over inflation of lungs, keep pH >7.25 and keep base deficit between -4 and +4.

Annex V: Quick Reference for medications and dosing chart for newborns

Medicine	Epinephrine/Adrenaline	Volume expansion Normal saline, and O Rh-neg. packed RBCs	Sodium bicarbonate (Not useful during the initial steps) Indication: severe metabolic acidosis
Route	IV: endotracheal	IV: umbilical vein	IV: umbilical vein
Dose	0.1-0.3ml/kg (consider higher dose, for endotracheal route only); dose can be repeated after 3-5 minutes	10ml/kg (another dose may be needed)	2mEq/kg (8.4% concentration)
Preparation	1:10,000 solution	Correct volume drawn into large syringe	Diluted 1:1 with appropriate diluent (glucose 5% or sterile water)
Rate	Rapidly, as quickly as possible	Slowly (over 5-10 minutes)	Slowly, no faster than a rate of 1mEq/kg/minute (to minimize the risk of intraventricular haemorrhage)

MEDICATIONS

	DOSE	AGE/ Weight	Frequency	Comment
Neonatal Resuscitation				
Adrenaline (Epinephrine) 1:10 000	0.1-0.3ml/kg IV		Give as rapid bolus	Follow by saline flush
Volume Normal saline O Rh negative PRBC	10ml/kg IV		As needed	Slowly over 10 minutes

	DOSE	AGE/ Weight	Frequency	Comment
Sodium bicarbonate	2mEq/kg (8.4% concentration)		As needed for SEVERE METABOLIC ACIDOSIS only	Diluted 1:1 with 5% dextrose or sterile water Give slowly at max rate of 1mEq/kg/minute to avoid intraventricular haemorrhage
Common antibiotics				
Abacavir	2mg/kg/dose PO 8mg/kg/dose PO	<30 days >30 days	12-hourly 12-hourly	
Acyclovir	20mg/kg IV 12 hourly 20mg/kg PO 6 hourly	<35 weeks >35 weeks	12 hourly IV; 6-hourly PO 8-hourly IV; 6-hourly PO	Treat 14 days if localized Treat 21 days if disseminated
Adrenaline (Epinephrine) 1:10 000	0.1-0.3ml/kg IV		Give as rapid bolus	Follow by saline flush
Amikacin	15mg/kg/dose IV/IM	<7 days If <32 weeks If >32 weeks >7 days	36-hourly 24-hourly 24-hourly	
Aminophylline	Loading dose: 5-6mg/kg/dose IV Maintenance: 1-2mg/kg/dose IV		6 to 8-hourly	Infuse slowly over minimum of 20 minutes to avoid cardiac arrhythmias Therapeutic level 6-12ug/ml
Amoxicillin	25-50mg /kg/ dose PO		12-hourly	

	DOSE	AGE/ Weight	Frequency	Comment
Amoxicillin-Clavulanate	45mg/kg/day div PO		12-hourly	
Ampicillin	50mg/kg/dose IV 100mg/kg/ dose IV for meningitis	<7 days 7 – 21 days >21 days	12-hourly 8-hourly 6-hourly	
AZT	>2kg: 12mg/ dose PO <2kg: 4mg/kg/ dose PO 1.5mg/kg/dose IV	> 2kg <2 kg	12-hourly 12-hourly 12-hourly	IV: give over one hour
Caffeine	Loading: 10mg/ kg PO Maint: 2.5- 5mg/kg/dose PO		Start 12 hours after loading dose, then 24-hourly	
Cefotaxime	50mg/kg/dose slowly IV/IM	<7 days 7-21 days >21 days	12-hourly 8-hourly 6-hourly	Preferred over Ceftriaxone due to safety profile
Ceftazidime	30mg/kg/dose IV	<7 days >7 days	12-hourly 8-hourly	Duration: 14 -21 days for P. aeruginosa meningitis
Ceftriaxone	Sepsis: 50mg/ kg/dose Meningitis: 80mg/kg/dose IV Gonococcal ophthalmia: 50mg/kg/dose IM		24-hourly 24-hourly 1 dose for GC ophthalmia	Avoid with any infusions containing Calcium Don't use for babies with hyperbilirubinaemia or jaundice

	DOSE	AGE/ Weight	Frequency	Comment
Cloxacillin	25-50mg/kg/ dose IV/PO 100mg/kg/ dose osteitis or intracranial infection	<7 days 7-28 days >28 days	12-hourly 8-hourly 6-hourly	
Dopamine	2-20ug/kg/min			Max dose 20 – 50 mcg/kg/min IV MUST be monitored closely
Dobutamine	2.5-15ug/kg/ min			Max dose 40mcg/ kg/min MUST be monitored closely
Erythromycin	12.5mg/kg/ dose PO		6-hourly	Give for 14 days for chlamydia or pertussis
Ferrous lactate	25mg/ml: 0.2ml PO	Start at 14 days	Daily	
Flucloxacillin	25mg/kg		6-hourly	
Gentamicin	5mg/kg/dose IV/IM	>32 weeks <32 weeks	24-hourly 36-hourly	
Glucagon	0.2mg/kg/dose IM/IV/SC		Single dose	Give before referral
Heparin	Load-50U/kg IV over 10 min then infuse at 25U/kg/hr			
INH	10mg/kg/dose PO		Daily	Give for 6 months if Mother has been on TB treatment for more than 2 months

	DOSE	AGE/ Weight	Frequency	Comment
INH/Rifampicin	RH (60, 60)			Give for 6 months of treatment if mother has had <2 months treatment or is HIV positive Give RH for 6 months and PZA for 2 months
Lamivudine (3TC)	2mg/kg/dose PO 4mg/kg/dose PO	<7 days >7days	12-hourly 12-hourly	
Lopinavir/Ritonavir	300/75mg/m2 PO 16mg/4mg/ kg PO	NOT BEFORE 42 weeks	12-hourly	Closely monitor renal function, signs of CNS depression, seizures, hypotonia, and complete AV block in first month
Meropenem	Non-CNS infection: <2kg: ▪ <14 days old: 20mg/kg/ dose 1 ▪ 15-28 days old: 20mg/kg/ dose >2 kg: ▪ <14 days old: 20mg/kg/ dose ▪ 15-28 days old: 30mg/kg/ dose Meningitis/ CNS and severe infections: 40mg/kg/dose		12-hourly 8-hourly 8-hourly 8-hourly 8-hourly	

	DOSE	AGE/ Weight	Frequency	Comment
Metronidazole	Load: 15mg/kg/ dose IV/PO Maint: 7.5mg/ kg/dose IV/PO		Loading dose once, then maintenance 12-hourly	For anaerobic coverage, including necrotizing enterocolitis
Naloxone	1mg/kg IV			Given if mother received narcotics in labour and neonate is still not breathing after bag and mask ventilation
Nevirapine	PEP: 2mg/kg/dose PO 4mg/kg/dose PO 10mg (1ml)/ dose PO 15mg (1.5 ml)/ dose PO 20mg(2ml)/ dose PO 30mg (3mL)/ dose PO 40mg(4mL)/ dose PO	<2kg Day 0 -14 >2kg Day 14 – 42 2-2.5 kg >2.5 kg >6 weeks – 6 mo >6 mo – 9 mo >9 mo	After birth and daily Daily for 6 weeks Daily for 6 weeks Daily for 6 weeks Daily while breastfed if mom not on ART or for 12 weeks if she started ART after 36 weeks or after delivery Daily while breastfed if not on ART	Concentration: 10mg/ml
Nystatin	1ml (100 000u) PO		6-hourly	Use cotton ear bud to administer to tongue and buccal mucosa until 3 days after thrush resolves

	DOSE	AGE/ Weight	Frequency	Comment
Paracetamol	Load: 24mg/kg IV/PO Maint: 15mg/ kg/dose	Term: 6-hourly Preterm 8-hourly		
Penicillin G (Benzyl)	Sepsis/ Syphilis: 50 000U/kg/ dose IV Meningitis: 100 000u/kg/ dose IV	Term Preterm <7 days >7days	6-hourly 12-hourly 8-hourly	Days of treatment: Syphilis: 10 Sepsis/pneumonia: 14 Meningitis: 21
Penicillin Benzathine	50 000u/kg/ dose IM		1 dose	Untreated or partially treated maternal syphilis
Penicillin Procaine	50 000u/kg/ dose IM		24-hourly	Symptomatic, congenital syphilis for 10 days NEVER GIVE IV
Phenobarbitone	Load: 20mg/kg IV over 10 min Maint: 4mg/ kg/dose PO/IV/ IM/PR		IV stat over 10 minutes 24-hourly	
Phenytoin	Load: 20mg/kg IV over 30 min Maint: 4-8mg/ kg/dose		Loading over 30 minutes PO/IV/PR 24-hourly	
Prostaglandin E2	25-50mcg/kg/ hour PO		Hourly	To keep ductus arteriosus open in cyanotic heart disease

	DOSE	AGE/ Weight	Frequency	Comment
Theophylline (oral),	Load: 5mg/ kg PO Maint: 3-6mg/ kg/dose		12-hourly	Preterm neonates for apnoea Therapeutic level 6-12ug/mL
Vitamin D2	400IU/kg/day PO		Daily	Preterm and breastfed infants
Vitamin K	1mg IM 0.5mg IM	>1000 g <1000 g		Oral vitamin K is NOT recommended

Annex VI: Summary of procedures and recommendations for pain relief

PROCEDURE	DRUGS	ADVANTAGES OF TREATMENT	DISADVANTAGES OF TREATMENT	OTHER COMMENTS
Mechanical ventilation	Fentanyl (1-3µg/kg), morphine (0.1mg/kg), midazolam (0.1-0.2mg/kg)	Improved ventilator synchrony, lower pain scores	Prolonged time on assisted ventilation, prolonged time to full feeds, increased bladder catheterization, hypotension	Use sedation as needed, not pre-emptively; midazolam associated with adverse short-term effects in NOPAIN Trial
Circumcision	Lidocaine (1mL), eutectic mixture of local anaesthetics	Less pain response up to 4 months post procedure	Allergic reaction, bruising at injection site	Ring block is more effective than dorsal penile nerve root block
Heel prick	Sucrose	Shorter crying, less changes in heart rate	None	Eutectic mixture of local anaesthetics cream is not effective
Venipuncture, arterial puncture, and lumbar puncture	Topical anaesthetic (eutectic mixture of local anaesthetics), sucrose	Lower premature infant pain profile scores, less crying	Local reaction, rare methemoglobinemia	Other nonpharmacologic treatments effective
Intubation	Morphine 0.1mg/kg, fentanyl 1-3µg/kg, remifentanyl 1mg/kg, midazolam 0.2mg/kg, propofol 2-6mg/kg, ketamine 1mg/kg, suxamethonium 2mg/kg	Shorter time to intubation, less trauma, less desaturation, better maintenance of vital signs	None	No accepted premedication opiates most common class used

PROCEDURE	DRUGS	ADVANTAGES OF TREATMENT	DISADVANTAGES OF TREATMENT	OTHER COMMENTS
More invasive procedures, such as cannulation for extracorporeal membrane oxygenation	Propofol 2-6mg/kg, ketamine 1mg/kg, fentanyl 1-3µg/kg	Maintenance of cardiovascular stability	Questionable neurotoxicity with ketamine	Ketamine may be neuroprotective
Postsurgical pain	Fentanyl 1-3µg/kg, morphine 0.1mg/kg, acetaminophen 15mg/kg	Lowered neuroendocrine response, faster recovery	Respiratory depression, hypotension with opiates	Acetaminophen for mild pain only
Endotracheal suctioning	Midazolam 0.2mg/kg, morphine 0.1mg/kg, fentanyl 1-3µg/kg	Anxiolytic	Respiratory depression, hypotension, dependence	Usually not treated
Imaging (MRI, CT)	Chloral hydrate 50-100mg/kg	Sedation	Respiratory depression, hypotension	Chloral hydrate provides sedation only

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