Chapter 8:

Neonatology

Basic definitions

Categorization of neonates by maturity

- Term babies: 37+0 - 41+6 weeks gestational age (GA)
- Preterm babies: < 37+0 weeks GA
- Extremely preterm: < 28+0 weeks GA
- Very preterm: 28+0 - 31+6 weeks GA
- Moderate to late preterm: 32+0 - 36+6 weeks GA
- Post-term babies: 42+0 weeks GA or more

Categorization of neonates by birth weight

- Macrosomia: >3999g
- Normal birth weight: 2500g - 3999g
- Low birth weight (LBW): <2500g
- Very low birth weight (VLBW): <1500g
- Extremely low birth weight (ELBW): <1000g
- Appropriate for GA (AGA): 10^{th} - 90^{th} centile
- Large for GA (LGA): > 90^{th} centile
- Small for GA (SGA)/small for date (SFD): < 10^{th} centile

Determining Gestational Age

- If the mother's last-known menstrual period (LNMP) is known and correct, use the LNMP for estimating GA
- If the LNMP is unknown or deemed to be incorrect, use the early antenatal ultrasound to estimate the GA
- If neither correct LNMP nor early ultrasound is available, use the **New Ballard Score** (or a similar maturity score) to estimate the baby's GA soon after stabilization (see figure)

The new Ballard Score

MATURATIONAL ASSESSMENT OF GESTATIONAL AGE (New Ballard Score)

NAME _____ SEX _____

HOSPITAL NO. _____ BIRTH WEIGHT _____

RACE _____ LENGTH _____

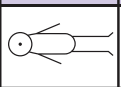
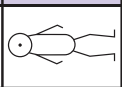
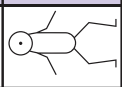
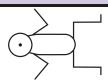
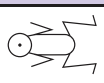
DATE/TIME OF BIRTH _____ HEAD CIRC. _____

DATE/TIME OF EXAM _____ EXAMINER _____

AGE WHEN EXAMINED _____

APGAR SCORE: 1 MINUTE _____ 5 MINUTES _____ 10 MINUTES _____

NEOMUSCULAR MATURITY

NEUROMUSCULAR MATURITY SIGN	SCORE							RECORD SCORE HERE
	-1	0	1	2	3	4	5	
POSTURE								
SQUARE WINDOW (Wrist)	 >90°	 90°	 60°	 45°	 30°	 0°		
ARM RECOIL		 180°	 140–180°	 110–140°	 90–110°	 <90°		
POPLITEAL ANGLE	 180°	 160°	 140°	 120°	 100°	 90°	 <90°	
SCARF SIGN								
HEEL TO EAR								
							TOTAL NEUROMUSCULAR MATURITY SCORE	

PHYSICAL MATURITY

PHYSICAL MATURITY SIGN	SCORE							RECORD SCORE HERE
	-1	0	1	2	3	4	5	
SKIN	sticky friable transparent	gelatinous red translucent	smooth pink visible veins	superficial peeling &/or rash, few veins	cracking pale areas rare veins	parchment deep cracking no vessels	leathery cracked wrinkled	
LANUGO	none	sparse	abundant	thinning	bald areas	mostly bald		
PLANTAR SURFACE	heel-toe 40–50 mm: -1 < 40 mm: -2	>50 mm no crease	faint red marks	anterior transverse crease only	creases ant. 2/3	creases over entire sole		
BREAST	imperceptible	barely perceptible	flat areola no bud	stippled areola 1–2 mm bud	raised areola 3–4 mm bud	full areola 5–10 mm bud		
EYE / EAR	lids fused loosely: -1 tightly: -2	lids open pinna flat stays folded	sl. curved pinna; soft; slow recoil	well-curved pinna; soft but ready recoil	formed & firm instant recoil	thick cartilage ear stiff		
GENITALS (Male)	scrotum flat, smooth	scrotum empty faint rugae	testes in upper canal rare rugae	testes descending few rugae	testes down good rugae	testes pendulous deep rugae		
GENITALS (Female)	clitoris prominent & labia flat	prominent clitoris & small labia minora	prominent clitoris & enlarging minora	majora & minora equally prominent	majora large minora small	majora cover clitoris & minora		
							TOTAL PHYSICAL MATURITY SCORE	

SCORE

Neuromuscular _____

Physical _____

Total _____

MATURITY RATING

SCORE	WEEKS
-10	20
-5	22
0	24
5	26
10	28
15	30
20	32
25	34
30	36
35	38
40	40
45	42
50	44

GESTATIONAL AGE (weeks)

By dates _____

By ultrasound _____

By exam _____

Reference

Ballard JL, Khoury JC, Wedig K, et al: New Ballard Score, expanded to include extremely premature infants. J Pediatr 1991; 119:417–423. Reprinted by permission of Dr Ballard and Mosby—Year Book, Inc.

Levels of Newborn Care: Services by provider at each level of care in Malawi

CENTRAL HOSPITAL (TERTIARY LEVEL)

Nurses/Midwives/General Practitioners/Paediatricians

- Nurses/Midwives/General Practitioners/Paediatricians
- Provide specialized care per appropriate guidelines for managing small and sick newborns.
- Manage respiratory distress including hypoxemia, treatment of moderate to severe respiratory distress, including mechanical ventilation/assisted ventilation and intubation, continuous monitoring and tailored provision of oxygen, treatment of pneumothorax, pleural effusion and emphysema and surfactant replacement therapy for intubation and ventilated newborns with respiratory distress syndrome.
- Mentor medical students, middle-grade doctors, nurses, clinical officers, upgrading staff and in-service teaching as these facilities are teaching and learning hubs for national quality improvement.
- Central hospitals have designated areas (i) to care for babies requiring ventilation, (ii) for babies on CPAP and/or those who are very ill requiring frequent nursing attention, and (iii) an area for babies on low flow oxygen with less frequent nursing needs.

DISTRICT HOSPITAL (SECONDARY LEVEL)

Medical Assistants/Nurses/Midwives

- Medical Assistants/Nurses/Midwives
- Manage small and sick newborns with birth asphyxia, infection, low birth weight, jaundice, and other conditions in the inpatient neonatal unit by providing oxygen, CPAP, intermittent and continuous KMC, fluids and feeding via nasogastric tube, cup and/or normal breastfeeding.
- Practice early feeding (with trophic feed for unstable babies). • Practice early intermittent KMC. • Manage stable low birth weight newborns in Kangaroo Care Unit when indicated.
- Conduct discharge planning, outpatient follow-up, and monitoring of discharged newborns.
- Evaluate infants born outside of the facility. • Perform assessment and triage, emergency management and monitoring of sick newborns.
- Continually assess sick newborns and infants and adjust plans based on findings. • Refer small and sick newborns if indicated for any signs of severe illness, injury or malformation.
- Assess patient comfort and manage pain.
- Practice thermal care (KMC for preterm infants weighing 1,500–2,000g and use of incubators for the very premature newborns/KMC for the stable preterm as per KMC guidelines).
- Practice respiratory care (neonatal resuscitation per guidelines, oxygen therapy using blended oxygen and appropriate delivery systems, monitoring initial management and referral for hypoxemia, oxygenation and encephalopathy, prevention of apnea).
- Infection control as per guidelines. • Monitor jaundice and serum bilirubin as per guidelines and provide phototherapy as needed.
- Support best feeding practices using cup, nasogastric tube, or orogastric tube.
- Prescribe presumptive antibiotic therapy for newborns at risk of bacterial infection (PSBI).
- Manage cases with signs of sepsis, meningitis, pneumonia, necrotizing enterocolitis, congenital syphilis, or ophthalmia neonatorum.

HEALTH CENTER (PRIMARY LEVEL)

Nurses/Midwives

- Resuscitate asphyxiated infants following Helping Babies Breathe
- Provide pre-referral treatment such as antibiotics for infants at risk of infection

COMMUNITY LEVEL

Community Health Workers

- Educate about exclusive breastfeeding and danger signs
- Identify/refer newborns with danger signs during postnatal care visits for early referral to a health facility

Source: A case study in establishing care for small and sick newborns in Malawi, PATH 2022

Neonatal Resuscitation

Introduction

- Birth asphyxia is a major problem, causing around 25% of neonatal deaths globally
- Neonatal resuscitation is one of the most important interventions in newborn care
- 90% will not require any assistance at birth
- 10%, will require some assistance
- About 1% will need active resuscitation

Anticipation for a neonatal resuscitation

- Alertness and preparedness for a resuscitation at all times is crucial

Risk factors for a newborn requiring resuscitation

Mother	Fetus/Neonate	Peri-partum
• 40 years of age • Lower socioeconomic status • Smoking, alcohol/drug abuse • Chronic/untreated medical conditions (e.g. diabetes, preeclampsia) • Worrisome obstetric/ gestational issues (e.g. premature rupture of membranes (PROM), placenta previa)	• Prematurity or • Postmaturity • Macrosomia • Intrauterine growth retardation • Multiple gestation Congenital anomalies	• Prolapsed cord • Utero-placental Bleeding • Breech presentation • Chorioamnionitis • Meconium-stained amniotic fluid

Prevention and promotion

- Improved Antenatal Care (ANC) and intrapartum care
- Awareness on effect of maternal age, drugs, underlying illnesses e.t.c. on birth outcomes

Goals of resuscitation

- Early identification of risk factors
- Anticipation of problems
- Early recruitment of equipment and qualified personnel
- Early formulation of a care plan
- Assist with the initiation and maintenance of adequate ventilation, oxygenation, cardiac output, tissue perfusion, normal core temperature and serum glucose

Preparing for a resuscitation

- Anticipate ⋙ Prepare ⋙ Evaluate risk factors ⋙ Communicat ⋙ Plan ⋙ Initiate
- Teamwork: Each member must have a clear role!

Requirements for a resuscitation

- Radiant warmer/resuscitaire (this must be on before the baby is delivered)
- Sterile, warm linen for receiving, drying and carrying the baby
- Thin plastic wrap if available
- Sterile procedure trays

- Sterile cord ties
- Glucometer
- Suction machine and catheters
- Pulse oximeter
- Feeding tube (8F catheter) – 20 mL Syringe, catheter tipped
- Meconium aspirator, suction catheters
- IV catheters (22 g) - tape and sterile dressing material
- Fluids and drugs: Isotonic sodium chloride solution saline, 10% dextrose water, adrenaline
- Intermittent Positive Pressure Ventilation (IPPV) equipment and accessories
- Intubation accessories
- Timer
- Umbilical catheters (2.5F, 5F)
- Chest tube (10F catheter)

Assess all newborns

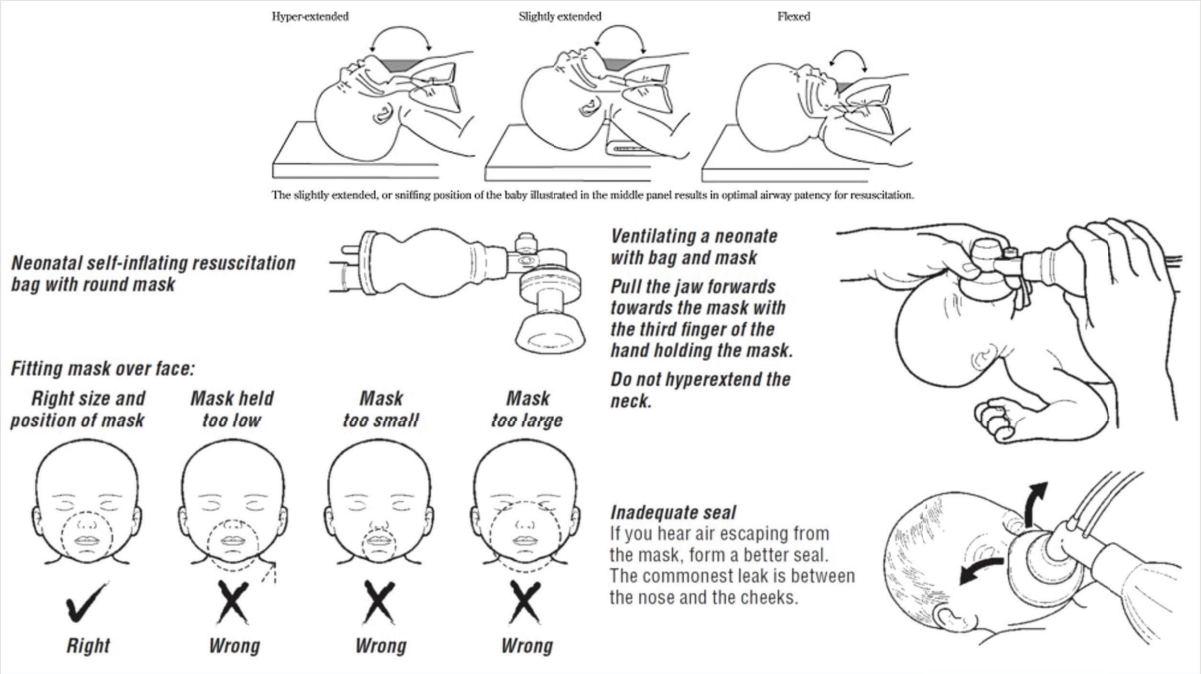
- The 2021 AHA/AAP/*ILCOR (*ILCOR = International liaison committee on resuscitation) guidelines include a rapid assessment of the neonate's clinical status based on the following questions: Does/ is the infant
    - Full-term?
    - Have good muscle tone?
    - Breathing or crying?
- If the answer to all three questions is yes, the newborn does not need resuscitation, should not be separated from the mother, and is managed by routine neonatal care.

ILCOR 2021 – Order of approach to a neonatal resuscitation
Initial stabilization >> Provide warmth, dry, stimulate >> Open airway for patency if necessary >> Assess breathing >> Ventilation and oxygenation if necessary >> Assess circulation >> Chest compressions if necessary >> Inotropes and/or volume expansion if necessary

A. Airway
- Positioning – place the baby in neutral position
- Routine suctioning NOT recommended, unless obvious obstruction from secretions
- Meconium staining NOT indication for suctioning if it is not blocking the airway
- Wiping or light suctioning should be done if copious secretions impair the airway

B. Breathing
- Look, Listen, Feel
- Start bag and mask (IPPV) if:
    - Gasping or apnoeic
    - HR < 100/min
        - Choosing mask size: 1 for > 2.5kg, 0 for < 2.5kg
        - Ventilation: BMV at ~30 breaths/minute (1 breath every 2 seconds)
        - Make sure there is chest movement
        - Avoid overinflating the lungs

Correct procedure for neonatal bag-mask ventilation



Source: WHO (who.mg-solutions.it.com/TraumainChildren.aspx)

Oxygen during neonatal resuscitation:

- For ≥ 35/40 GA, initiate resuscitation with room air
- For < 35/40 GA, initiate resuscitation with 21 to 30% oxygen
- Monitor SpO2 by pulse oximetry
- Adjust the O2 concentration (FiO2) to achieve targeted SpO2 levels.
- If HR < 60 bpm after 90 seconds of IPPV, increase the FiO_2 to 100% until normal heart rate.

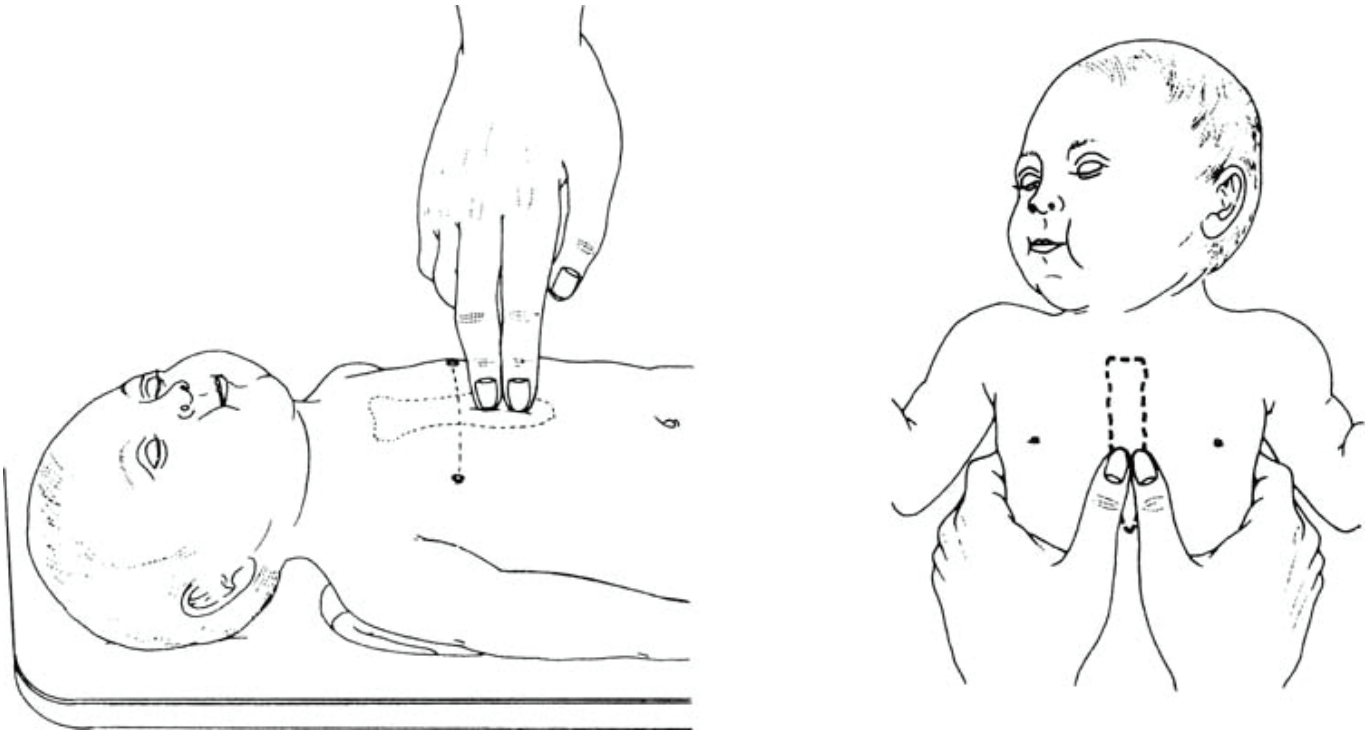
Normal range for SpO_2 levels after birth:

- 1 minute – 60 to 65%
- 2 minutes – 65 to 70%
- 3 minutes – 70 to 75%
- 4 minutes – 75 to 80%
- 5 minutes – 80 to 85%
- 10 minutes – 85 to 95%

C: Circulation

- Assess colour, central pulses, umbilical pulsation, capillary refill time.
- Chest compressions:
    - If HR remains < 60 beats per minute despite adequate ventilation for 30 seconds.
    - 90 compressions to 30 breaths/minute (3 to 1)
    - 1/3 the A-P diameter of the chest (1-1.5cm)
    - Evaluate the heart rate and breathing every 30 sec.
    - If shock – IVF normal saline 10ml/kg over 10 minutes. Can repeat once, then O-Rh-negative blood transfusion

Correct positioning for neonatal chest compressions



(Source: WHO (who.mg-solutions.it.com/TraumainChildren.aspx))

Medications during resuscitation
Drugs are rarely indicated in neonatal resuscitation!

- Fluids
  - Normal saline (volume expander), 10ml/kg over 5 to 10 minutes if hypovolaemic
  - 10% dextrose, 2ml/kg if hypoglycaemic
- Adrenalin (1:10,000) 0.1ml/kg
  - Indicated when HR < 60 despite adequate ventilation & compressions
  - Repeat every 3 minutes
- Naloxone
  - 0.1mg/kg IM, if documented exposure to opioids
  - Give once adequate supportive ventilation has been established
- Sodium bicarbonate (0.5mEq/ml)
  - Not shown to change the outcome, therefore not routinely recommended
- Calcium gluconate
  - Does not change the outcome, therefore not recommended

Reasons for failure to respond to positive pressure ventilation (PPV)

- Poor technique
- Mechanical block (eg, meconium, choanal atresia, malformations)
- Impaired lung functioning (pneumothorax, pleural effusions, congenital diaphragmatic hernia, pulmonary hypoplasia)
- Congenital heart disease – central cyanosis
- Heart block – persistent bradycardia
- Brain injury (hypoxic ischaemic encephalopathy)
- Congenital neuromuscular disorder
- Respiratory depression - from maternally administered opioids

Counselling of the mother and guardians

- Counselling of the mother and the guardian must be continuous right from the beginning.
- To the best of our ability, the mother and guardians must be regularly updated on progress
- Allow the mother, as much as possible, to be part of the decision making process as the care continues.

Difficult decisions

- Currently there is no routine ventilation available, therefore only babies who are able to breathe by themselves can survive.
- Babies not responding to full resuscitation after 10 minutes are unlikely to survive.
- Discuss with senior colleagues on further decision making for a newborn undergoing resuscitation.

Cessation of resuscitation

- If after 10 minutes of effective resuscitation, the baby is not breathing and pulse is absent.
- If after 20 minutes of effective resuscitation, there is no spontaneous breathing and pulse is not reaching 60/minute.

Referral

Primary level

- All newborns who have required bag and mask ventilation for more than 5 minutes, or have signs of encephalopaphy must be referred to the secondary level hospital

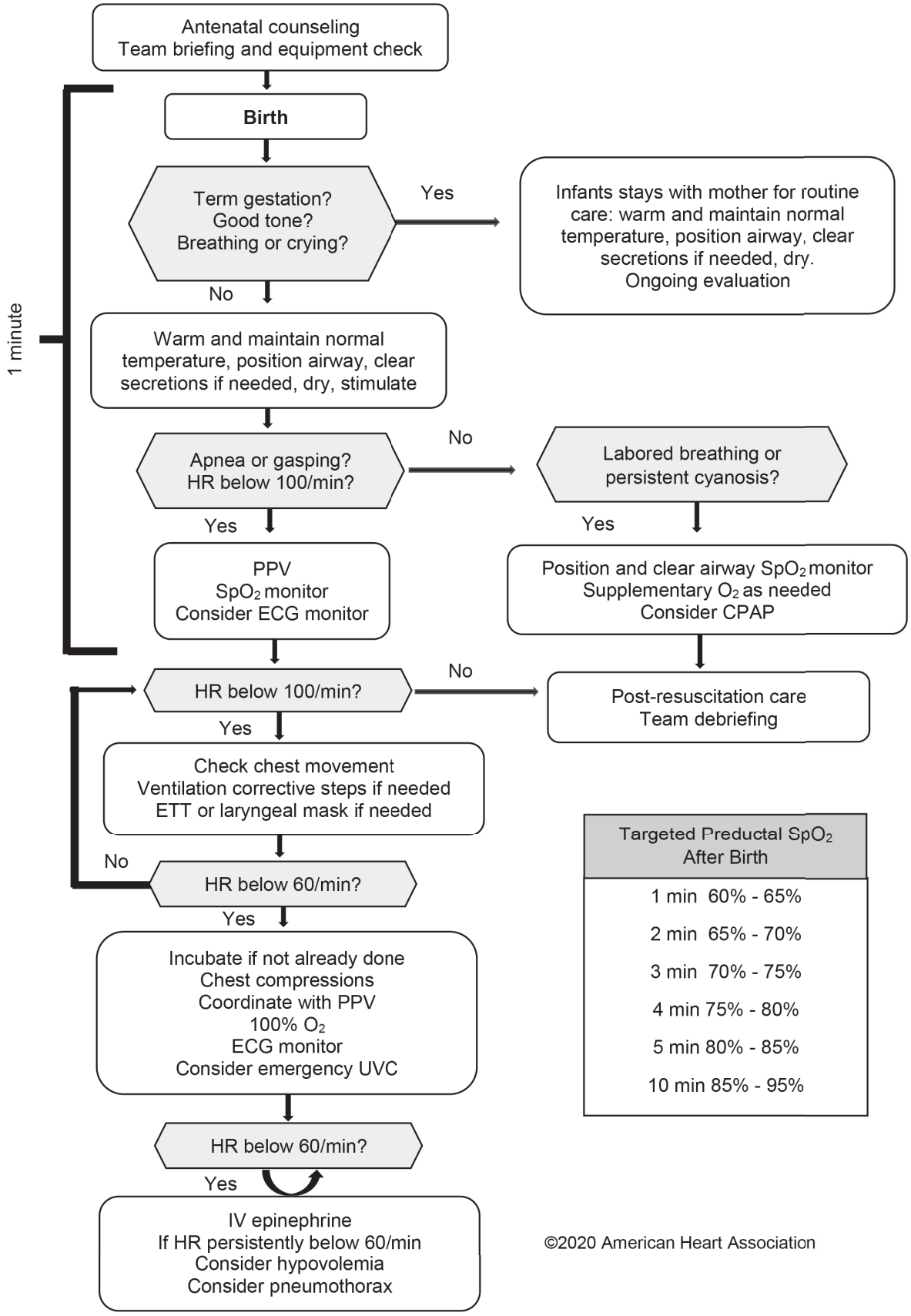
Secondary level

- All newborns with clinical features of moderate to severe HIE must be referred to the tertiary level hospital

Follow up

- All neonates with a diagnosis of birth asphyxia should be followed up at secondary or tertiary level for Neurodevelopmental assessment, audiology and visual assessments
- Refer to specific central hospital guidelines for scheduling

Neonatal resuscitation algorithm



- Our recommendation is to secure the airway and provide ventilation, using bag and mask or neopuff, throughout the resuscitation.

Birth asphyxia/Low Apgar score/Hypoxic Ischaemic Encephalopathy

Definition of birth asphyxia

- Failure to establish regular spontaneous respiration within 1 minute of birth. Results from failure of normal physiological processes at the time of labour and delivery.
- Therefore, commonest cause is compromised fetal or maternal oxygenation or perfusion.
- In some cases, longstanding adverse effects on the fetal brain, which can also present as birth asphyxia.

Definition of Low Apgar Score

- A low APGAR score is a score of less than 7/10 at 5 minutes.

APGAR Score Chart

Factor	0	1	2
Appearance	Blue or pale	Body pink; limbs blue	Body and limbs pink
Pulse	No pulse	Less than 100 beats per minute	Greater than 100 beats per minute
Grimace	No reaction	Grimacing or frowning	Coughing, sneezing or crying
Activity	No movement; limp	Weak; some arm & leg movement	Strong movement; flexing arms & legs
Respiration	Not breathing; not crying	Weak cry or whimper	Crying well and loudly

Definition Hypoxic Ischaemic Encephalopathy (HIE)

- Abnormal neurological state seen after birth asphyxia
- Affected infants may have problems with the pulmonary, CVS, GIT and renal systems
- Organ damage in latent phase: 6-24 hours after insult (up to >72 hours)
  - secondary phase: 6-72 hours
  - Usually results in chronic brain and other organ injury.
  - Therefore, the first 6 hours are crucial in the management of HIE.

Risk factors

Preconceptual	Antepartum	Intrapartum
Primigravida	Placenta praevia	Malpresentation
Teenager	Abruptio placentae	Maternal illness
Advanced maternal age	IUGR	Induction
Chronic maternal illness	Severe pre-eclampsia	Prolonged labour
	Other causes of APH	Instrumental delivery
	Fetal distress	Severe prematurity
	Maternal collapse	Maternal drugs
	In utero infection	Born outside health facility

- As HIE manifests end organ injury due to significant asphyxia, the risk factors for HIE are the same as those for birth asphyxia.

Prevention and promotion

- Improvements in the antepartum and intrapartum care of pregnant women
- Immediate and effective neonatal resuscitation
- Awareness on risk factors for birth asphyxia
- Empowerment of health workers on early anticipation, diagnosis and effective resuscitation of asphyxiated babies
- Early diagnosis and management of HIE

Clinical Presentation

- HIE is a multi-systemic pathology
- Refer to figure below

HIE staging (Thompson, Sarnat & Sarnat)

Stage 1 (Mild)	• Hyperalert, irritable, overactive reflexes, Sympathetic effects (tachycardia, large pupils) • Outcome – very good • Duration of symptoms - < 24 hrs
Stage 2 (Moderate)	• Obtunded, lethargic, hypotonia, decreased spontaneous movements with or without seizures • Outcome – 80% normal • Symptoms lasting > 5 days increases the probability of neurological deficit
Stage 3 (Severe)	• Stupor, flaccidity, continuous seizures, suppressed brain stem and autonomic functions, apnoeas • Outcome – 50% mortality, remainder with lasting neurological impairment

Differential diagnosis

- Brain trauma: haemorrhage, thrombo-embolism (“neonatal stroke”)
- Drugs eg. opioids
- Infections: meningitis, encephalitis, TORCH infections
- Metabolic and electrolyte abnormalities: hypoglycaemia, hypocalcaemia, hypokalaemia, hyponatraemia, hypernatraemia, hypophosphataemia
- Endocrine: hypothyroidism
- Inborn errors of metabolism
- Syndromes: Down Syndrome, muscular dystrophies, Prader-Willi, Marfan, etc.

Relevant investigations

- Arterial blood gas (ABG)
- Blood sugar: Hypoglycaemia is common and needs appropriate management.
- Consider septic screen if risk factors are available
- Specific tests for organ damage can be done to determine the degree of damage such as to the liver and kidneys
- Consider cranial USS to exclude intraventricular haemorrhage or other intracranial abnormalities.

Management

Important points in the history:
- Last menstrual period of mother (if known)
- Any complications/illnesses in pregnancy
- Maternal risk factors for infection e.g. fever, prolonged rupture of membranes
- History of labour – length of 1st + 2nd stage, any drugs administered to the mother

Important points in the examination:
- Assess and manage ABCDE
- Assess gestational age
- Any clinical seizures?
- Tone, reflexes, including ability to suck

Indications for admission:
- Low APGAR score (< 7) at 5 minutes of age
- Term babies with a low APGAR score at 5 minutes but who are active and vigorous at 10 minutes do not need admission
- Stabilize the patient (Refer to neonatal resuscitation section)

Primary level
- Resuscitate according to HBB protocol
- Manage hypoxia, stabilize
- Provide pre-referral antibiotics if indicated
- Refer all newborns who have required bag and mask ventilation for more than 5 minutes, or have signs of encephalopaphy to the secondary level hospital

Secondary level
- Resuscitate according to the COIN protocol/HBB
- Manage hypoxia, hypoglycaemia, fluid balance
- Manage convulsions
- If poor suck or reduced gag reflex, babies will require NG feed as they are at high risk of milk aspiration
- Monitor blood sugar and temperature
- Temperature instability is common but infections must always be considered and a full septic screen carried out if persistent temperature >38^{o}C
- Refer to the tertiary level if persistent seizures, cardio-respiratory or metabolic instability or signs of hepatic or renal impairment
- All newborns with clinical features of moderate to severe HIE must be referred to the tertiary level hospital

Tertiary level
- Resuscitate
- Manage hypoxia, acidosis, electrolyte and metabolic derangements
- Provide supportive management
- Observe for convulsions/apnoeas; if present treat as per protocol
- If poor suck or reduced gag reflex, babies will require NG feed as they are at high risk of milk aspiration
- Monitor blood sugar and temperature.
  - Temperature instability is common but infections must always be considered and a full septic screen carried out if persistent temperature >38°C.
  - Therapeutic hypothermia has not been proven to be effective in low resource countries.

Complications
- Moderate or severe on the Thompson score above is associated with neurodevelopmental impairment or death.
- Residual brain injury may not be apparent on discharge examination
  - Disabilities such as cerebral palsy or learning difficulties may only manifest as the child develops.
  - The parents should be counselled about this on discharge
- Periventricular leukomalacia
- Seizure syndromes
- Blindness; Hearing impairment

When to discharge
- The baby can cup/breast feed safely and is gaining weight
- When seizures have resolved.
- Mother and family have been thoroughly counselled

Follow up
- Babies with HIE should be reviewed after 1 week at either the secondary or tertiary level.
- Refer for audiology, and visual acuity assessments on discharge
- Refer for neurodevelopmental, physio, speech, occupational and physiotherapy follow up on discharge
- Refer to specific central hospital guidelines for scheduling

Care of premature, small for gestational age and low birth weight (<2.5kg) babies

Definitions

- **Refer to definitions above**
- Low birth weight, SGA and premature babies are at risk of a number of problems – it is important to try and anticipate these, and to recognize and treat.

Causes/Risk factors for prematurity and their prevention

Type	Risk factors	Examples	Prevention strategies
Spontaneous preterm birth	*Age at pregnancy and pregnancy spacing*	Adolescent pregnancy, advanced maternal age, short inter-pregnancy interval	Preconception care, including access to family planning from adolescence, after birth and throughout reproductive years
	Multiple pregnancies	Increased rates of twin and higher-order pregnancies with assisted reproduction	Introduce and monitor policies for best practice in assisted reproduction
	Infection	Urinary tract infections, asymptomatic bacteriuria, malaria, HIV, syphilis, chorioamnionitis, bacterial vaginosis	Sexual health programmes aimed at prevention and treatment of infections prior to and during pregnancy. Intermittent preventive treatment of malaria (context-specific), antenatal screening for lower genital tract infections and asymptomatic bacteriuria
	Underlying chronic medical conditions	Diabetes, hypertension, anaemia, asthma, thyroid disease, HIV	Maximize preconception control for pre-existing conditions, as well as screening and prompt management during pregnancy
	Nutritional	Undernutrition, micronutrient deficiencies	Assess and treat low nutritional status prior to conception and in early pregnancy. Consider supplementation (e.g. iron folate and zinc supplementation) for pregnant women without systemic illness

	Lifestyle and work-related	Smoking, excess alcohol consumption, recreational drug use, excess physical work and activity	Adopt laws and rights-based approaches to protect pregnant women, and ensure maternity leave. Behavioural and community public health interventions targeting pregnant women and women of reproductive age, e.g. pharmacological interventions for smoking cessation
	Environmental	Exposure to indoor and ambient air pollution, heat stress	Public health measures, antenatal counselling, avoidance of air pollution and excessive heat where possible
	Maternal psychological health	Depression, violence against women	Antenatal screening where capacity to provide a supportive response is available
	Genetic and other	Genetic risk (e.g. family history), cervical incompetence, intrauterine growth restriction, congenital abnormality	Individual-specific interventions e.g. cervical cerclage for women with singleton pregnancy and high risk of preterm birth
Health professional -initiated preterm birth	*Induction or caesarean birth for maternal indication*	Common indications include: pre-eclampsia/ eclampsia, placental abnormalities (e.g. placenta accrete) and pre-existing maternal conditions	Not applicable
	Induction or caesarean birth for fetal indication	Common indications include severe fetal growth restriction	Not applicable
	Induction or caesarean birth without medical indication	Non-medically indicated, due to physician or patient preferences or incentives	Programmes and policies to reduce the practice of non-medically initiated preterm birth. Midwifery-led continuity models of care have proved effective

(Source: 'Born too soon, decade of action on preterm birth', WHO 2023)

Prevention/promotion
- Awareness on risk factors for preterm delivery
- Strengthening ANC and post-natal care
- Improvement in obstetric care
- Antenatal steroids
- Strengthening KMC/IKMC

Clinical presentation and complications of prematurity
Preterm babies present with complications related to the immaturity of their physiological systems.
- **Respiratory*:*** Respiratory Distress Syndrome (RDS), aspirations, Bronchopulmonary Dysplasia(BDP)
- **Cardiovascular*:*** Hemodynamic instability
- **CNS:** Apnoea of prematurity, intraventricular haemorrhage, PVL
- **Ophthalmology*:*** Retinopathy Of prematurity(ROP)
- **CNS/Endocrine/Skin:** Temperature dysregulation, glucose dysregulation
- **GIT:** Feeding intolerance, reflux, NEC, Jaundice
- **Immunity:** Sepsis
- **Renal:** Fluid acid-base and electrolyte dysregulation.
- **Haematology:** Anaemia of prematurity

Investigations
- Thorough clinical examination
  - Quick examination – ABC
  - Maturity assessment, anthropometry and classification of growth
  - Systemic examination for pathology or complications of prematurity
    - Eg. FBC, blood cultures, U&Es, CXR etc
  - Head to toe examination for congenital anomalies

Management
- Stable babies:
  - >2000g: Counsel mothers and follow up at primary health care level
  - 1500g – 2000g: Admit at secondary care level for KMC and follow up
  - <1500g: Admit at tertiary care level for KMC and follow up
- All unstable preterm newborns should be stabilized, then discussed and referred to the next level care facility
- Preterm babies must be started on KMC as soon as possible after birth (Immediate KMC)
- Manage specific complications of prematurity (see specific chapters in the COIN manual)

Primary level
- ABCDE, stabilize, keep warm and refer all premature babies to the secondary level in KMC position

Secondary/Tertiary level
- Unstable babies
  - Stabilize and refer all preterm babies who are unstable
- Stable babies
  - Birth-weight 1500g – 2000g admit to the KMC ward
  - Birth-weight <1500g – refer to the tertiary level for care including KMC

Follow up:
- A baby, whose weight is less than 1800g, is followed up at the discharging facility or the nearest health facility every week until the baby reaches 1800g.

- Once 1800g is attained, subsequent follow-up is done every 2 weeks until the baby is 2500g.
- Ensure the mother is linked to the HSA in the community for continued KMC support.
- Provide nutritional supplements – refer to the COIN guidelines.

Small for Gestational Age

Definition
- Refer to Basic Definitions on page 212

Causes/risk factors/clinical presentation

Symmetrically small:
- low weight, short length and small head circumference
- Signifies early onset growth restriction e.g. intrauterine infection i.e. CMV, severe placental insufficiency, chromosomal abnormality, severe maternal disease such as renal disease or hypertension

Asymmetrically small:
- Discordance in plots between anthropometric measures; e.g. low weight but relative sparing of length and head circumference
- Due to onset in the last few weeks e.g. placental insufficiency, pre-eclampsia or maternal smoking, drug addiction or alcohol ingestion

Prevention/promotion:
- Early treatment of maternal disease
- Counselling
- Family planning

Investigations
- Take a good history
- Consider blood sugar test if unwell, jittery or poor feeding
- Consider checking for congenital infections and chromosomal disorders

Differential diagnoses
- Low birth weight
- Prematurity

Management

Primary level
- Feed as soon after birth as possible – NG /cup/breast
- Refer unstable babies to secondary level

Secondary/Tertiary level
- Feed as soon after birth as possible : NG/cup/breast
- Consider IV FLUIDS if too sick to tolerate oral feeds
- Give warmth (dry, nurse near heater, hat, IKMC)
- Consider antibiotics if symptomatic/risk factors – see sepsis protocol
- Secondary can refer to tertiary level upon discussion with consultants

Complications
- Hypoglycaemia
- Thermal instability (increased surface area, immature skin, low subcutaneous fat)
- Polycythaemia secondary to intrauterine hypoxia – exacerbates respiratory problems, hypoglycaemia and necrotizing enterocolitis.

Kangaroo Mother Care (KMC/(IKMC))

Definition

- **KMC:** When the baby is nursed on the mother's or surrogate's chest, in skin-to-skin contact

- **IKMC:** Immediate KMC is when skin to skin care is provided to the newborn as soon as possible after birth, irrespective of the baby's clinical condition, and continued in hospital or at home

- KMC and IKMC are provided together with counselling and support for exclusive breast feeding

Risk factors for KMC/IKMC

- See risk factors for prematurity

Benefits of KMC/IKMC

- When compared with conventional neonatal care, KMC in our setting leads to:
  - Better weight gain
  - Less temperature dysregulation
  - Less infection
  - Possibly less apnoea
  - Better short- and long-term survival (40% improvement in survival)

Implementing KMC

- Current WHO guidelines recommend KMC as routine care for all preterm or low-birth-weight infants. KMC can be initiated in the health-care facility or at home and should be given for 8–24 hours per day (as many hours as possible)
- KMC for preterm or low-birth-weight infants should be started as soon as possible after birth and continued thereafter IKMC
- Preterm babies being admitted to the neonatal unit must be transferred from the delivery area in skin-to-skin position either by the mother or available surrogate.
- KMC must continue for the LBW in the neonatal ward, as much as possible, depending on the availability of a stable mother or surrogate, and space for keeping the baby and the mother/surrogate together in the NICU (adapting towards IKMC)

Admission to the KMC ward

- The KMC ward remains a place for implementing skin to skin care for stable low birth weight babies (Refer to the Malawi KMC guidelines)
- Babies weighing >2000g and <2500g and being stable, are not admitted
- The mother should be referred to the KMC ward for counselling on outpatient KMC and the baby kept with the mother. (Please refer to the levels of care for premature babies to decide on the appropriate level of in-patient KMC)
- All babies with a weight <2000g, who are stable, should be admitted to the KMC ward.
- Babies who weigh 1800g – 2000g can be admitted briefly in the KMC ward, and discharged as soon as the baby is stable, tolerating feeds, gaining weight, and the mother is confident and competent to continue KMC at home.
- All babies with a weight <2kg, who are unstable, should be admitted to the neonatal ward, and KMC provided as much as possible when the mother/surrogate is available.
- Babies in the KMC ward should be weighed daily.
- Babies can be NGT fed when on KMC position.

Discharge from the KMC ward

- The following criteria must be met before a baby can be discharged from the KMC ward:
  - Baby has at least regained birth weight and has a minimum weight of 1500g
  - Baby has gained at least 15g/kg/day for three consecutive days
  - Kangaroo position is well tolerated by baby and mother
  - The baby remains in respiratory and haemodynamic stability
  - Temperature of the baby is stable
  - No other illnesses exist
  - Mother is capable of breast feeding and expressing breast milk
  - Mother is willing to continue with KMC at home, and has support of the family
  - For a baby with birth weight of 1800g; they can be discharged, as long as they remain stable and gaining weight, without necessarily regaining the birth weight.

Primary level

- ABCDE, stabilize, keep warm and refer all premature babies to the secondary level in KMC position
- Stabilize and refer all preterm babies who are unstable to tertiary care facilities.

Secondary level

- Unstable babies - Refer unstable babies to Tertiary level
- Stable babies
  - Birth-weight 1500g – 2000g admit to the KMC ward
  - Birth-weight <1500g – require tertiary level care including KMC

Tertiary level

- As above
- Consider iv fluids if too sick to tolerate oral feeds
- Give warmth (dry, nurse near heater, hat, IKMC)
- Consider antibiotics if symptomatic/ risk factors – see sepsis protocol

Follow up

- A baby, whose weight is less than 1800g, is followed up at the discharging facility or the nearest health facility every week until the baby reaches 1800g.
- Once 1800g is attained, subsequent follow-up is done every 2 weeks until the baby is 2500g.
- Ensure the mother is linked to the HSA in the community for continued KMC support.
- Any cardio-respiratory instability

Newborn Feeding

Scheduling of feeds

- All babies must be weighed at delivery, on admission to the neonatal ward, and daily subsequently
- For babies > 1500g, feeds are given every 3 hours
- Small babies (<1500g) should be fed every 2 hours (by breast or EBM by cup/NGT)

For detail on insertion of feeding tubes, refer to the **NEST 360 Clinical modules (https://nest360.org/project/clinical-modules/)**

Calculation of feeds

- The daily feed volume should be calculated as below, and divided by 8 to give the 3-hourly feed volume, or by 12 to give the 2-hourly feed volume
- In general start daily feeds at 60ml/kg/day for >1500g and 90ml/kg/day for <1499g
- On average, increase total daily feeds daily by 24-30ml/kg/day

Use the birth weight for calculations until the actual weight is above the birth weight!

Newborn fluid requirements in ml/kg/day

Day	1	2	3	4	5 onwards
1500g & above	60 ml/kg/day	80 ml/kg/day	100 ml/kg/day	120 ml/kg/day	150-200 ml/kg/day
<1500g	90 ml/kg/day	110ml/kg/day	130 ml/kg/day	150 ml/kg/day	150-200 ml/kg/day

- These numbers are for oral feeds
- These numbers can also be used for IV fluids
- If on IV FLUIDS, discuss with seniors once the total fluid intake reaches 120ml/kg/day to plan further management.

Example for feed calculation:

A baby with birth weight 1.6kg, now on day 3 of life with 1,5 kg, requires 100 ml x 1.6 kg = 160 ml/day ÷ 8 = 20 ml/feed

Monitoring of feeds

- Monitor feed tolerance and weight gain and adjust the feeds appropriately.
- Once 150ml/kg/day is reached, do not automatically increase the feed intake, adjust feeds based on weight gain and as tolerated.
- If feed volumes are not sufficient, supplemental IV fluids may be started where clinically indicated.
    - There is no need for supplementation with IV fluids if the baby is taking at least 120ml/kg/day feed volumes.

Cautious feeds in sick and unstable patients

Feeds should be started cautiously and after discussion with registrar or consultant in-charge in the following patients:

- Severe HIE
- Severe hydrops fetalis
- Severe metabolic acidosis
- Extreme prematurity or ELBW
- Abdominal distension with soft abdomen
- Shocked patients, post-resuscitation
- Any cardio-respiratory instability

Stopping feeds (Nil per mouth)

Patients with the following should be kept NPO:

- NEC
- Bile-stained NGT aspirates
- Tracheo-oesophageal fistula/atresia
- Tense abdominal distension
- Abdominal tenderness
- Suspected GIT bleed
- Persistent vomiting
- Any intestinal atresia
- Ileus
- Severe metabolic acidosis
- Septic shock

Hypothermia

Definition

Hypothermia is defined as rectal temperature <36.5℃.

- It is one of the biggest killers of newborn babies.
- With each 1℃ reduction in temperature, there is up to 28% increase in mortality.
- Therefore, at all costs, effort must be made to prevent and treat hypothermia in newborns, particularly the preterm and low birth weight.

Risk factors

- Premature baby
- Small for gestational age
- Intra-uterine growth restriction
- Sepsis
- Hypothermia
- HIE
- Maternal illness /Orphaned baby
- In-born errors of metabolism
- Born before arrival/in transit

Prevention/promotion:

- Awareness
- Manage risk factors of prematurity
- Early diagnosis and treatment of underlying conditions
- Improvement in delivery and transfer of neonates
- Optimizing nutrition

Prevention of hypothermia in the delivery room

- Keep a warm delivery room. Avoid draughts and open windows; room temperatures must be >26℃.
- Deliver the baby onto the mother's abdomen in skin-to-skin position
- Use warm linen to dry and wrap the baby and resuscitate the baby under a radiant warmer
- For very preterm babies (<32weeks), use sterile plastic wraps for heat conservation if available
- Follow optimal thermal care during delivery, resuscitation, transfer and care.
- Start IKMC in the delivery room

Prevention of hypothermia during transfer from delivery area

- The baby must be warmed up and normothermic before being transferred from the delivery area.
- The baby must be placed on the chest of the mother or surrogate in KMC position, and wrapped over with warm linen when being transferred (IKMC).
- Alternatively, a pre-warmed transfer incubator should be used.
- Communicate with the receiving ward team before transfer, and confirm that the radiant warmer is on in the 'pre-warm' mode on the receiving ward.

Admission in the neonatal ward

- There must always be a reserved radiant warmer on in readiness for the next admission.
- There must always be a nurse assigned to the admission station ready to receive new admissions as soon as they arrive.
- There must always be sufficient handover from the transfer team/person and the admitting team/person.

- It is the responsibility of the admitting person to ensure that they receive clear and sufficient handover, and that the transfer team has thoroughly completed the relevant maternal information on the admission sheet.
- On arrival in the ward, place the baby under a warmer already switched on and remove any cool or wet surfaces/linen.
- Place the temperature probe and monitor the baby's temperature, making sure that the baby does not warm up too fast.
- Once normothermia is achieved, put the settings on the radiant warmer in 'servo,' mode, to maintain the temperature within normal set limits.
- Every new admission must be seen by the clinician as soon as they arrive, and not more than an hour after admission.
- Every new admission must have a gestational age assessed by the admitting clinician, using the Ballard (or similar) score.
- Every new admission must have gestational age assigned by the admitting clinician using the scheme under the section "Categorization of neonates admitted to the Neonatal Unit by maturity."

Ongoing thermal management

- Ongoing specific management of the admitted neonate will proceed depending on the assessment on admission and in subsequent monitoring or reviews. These are covered under specific sections of this guideline.
- Keep the ward warm, ambient temperature >26°C.
- Ensure the baby is well wrapped and wearing a hat.
- Initiate early IKMC in all low birthweight babies where possible, when the mothers come for feeding, until the baby has been moved to the KMC ward.
- All babies <1500g must be nursed under a radiant warmer, a working enclosed incubator or in continuous KMC position.
- All babies 1500g - 2000g must be nursed in KMC position or if this is not possible, should be nursed well covered in open cot (room temperature > 26°C).
- If a baby is cold don't warm up faster than 1°C per hour.
- Start feeding early, unless there is a contraindication for enteral feeds.
- Keep the baby well hydrated
- Investigate and manage any risk factors, underlying causes and associated problems.

***For further information on the use of radiant warmers, see the NEST 360 clinical and technical modules on this link: https://nest360.org/project/clinical-modules/**

To minimize the risk of burn injuries to babies:
do not use warmed IV fluid bags to warm the baby
Monitor temperature of radiant warmers regularly.

Referral

- Primary level: Refer persistent hypothermia or hypothermia with underlying co-morbity to the secondary level
- Secondary level: Refer severe or persistent hypothermia to the tertiary level

Follow up

- Follow up will be decided depending on the baby's clinical condition during admission, response to treatment and underlying pathologies.

Neonatal Hypoglycaemia

Definition
A random blood glucose level <45mg/dl (< 2.5 mmol/l)

Risk factors/causes
Hypoglycaemia is common and must be suspected in the following newborn infants:
- Premature baby
- Small for gestational age
- Postmature
- Intra-uterine growth restriction
- Infant of a diabetic mother
- Macrosomic/large for gestational age
- Dysmorphic/syndromic baby (especially with hemihypertrophy and visceromegaly)
- Severe rhesus disease
- Prolonged labour
- Polycythaemia
- Sepsis
- Hypothermia
- HIE
- Maternal illness/orphaned baby
- Maternal antihyperglycaemic drugs
- In-born errors of metabolism

Prevention/promotion
- Early diagnosis and management of underlying pathologies
- Community awareness on KMC and breastfeeding
- Optimize nutrition
- Improvement in maternity and newborn care infrastructure

Signs and symptoms

Asymptomatic:
- Any asymptomatic neonate who has a risk factor for hypoglycaemia must have glucose level checked on first contact

Symptomatic:
- Lethargy, floppiness, sweating, convulsions, apnoea, abnormal neurological behaviour
- Any sick looking neonate must be investigated for hypoglycaemia

Examination
Perform a complete head to toe examination of the newborn and examine for:
- Signs of growth disorders (PT, LBW, SGA, IUGR, LGA, Post-maturity)
- Stigmata of endocrine or inborn errors of metabolism.
    - Syndromic features
    - Neurological impairment

Investigations

- RBS
- FBC
- Urine for reducing substances
- A blood gas analysis may help if there is unexplained hyperlactataemia
- Insulin and cortisol levels

Management

Primary level

- Emergency treatment for RBS < 45 mg/dL / < 2.5 mmol/L
    - Give 2 ml/kg of 10% dextrose IV (slow bolus) **OR,**
    - 1 mL/kg of 50% dextrose PO/NGT (bolus) **OR,**
    - 40% buccal glucose gel (200 mg/kg) = 0.5 mL/kg/dose (bolus)
- Follow with regular feeds (breastfeeding/NGT) or, if not tolerating oral intake, with an IV infusion 10% dextrose
- Repeat RBS after 30 minutes
- Stabilize and refer all neonates diagnosed with hypoglycaemia to the secondary level

Secondary level

Emergency treatment as above PLUS

- Repeat RBS after 30 minutes. If RBS remains < 2.5 mmol/L repeat treatment as above
- If RBS remains < 2.5 mmol/L after 2 doses of bolus treatment, start IV infusion with 10% dextrose, optimize feeds
    - Start at 90 mL/kg/day and monitor RBS every two hours. Calculate the glucose infusion rate*

***Calculation of glucose infusion rate (GIR):**

GIR (mg/kg/min) = Fluid Rate (mL/kg/day) x Dextrose% /10 x 0.07

(e.g. if giving 100 mL/kg/day of 10% Dextrose, GIR = 100 x 10/10 x 0.07 = 7.0 mg/kg/min)

- **Note: If GIR is more than 10mg/kg/min to keep RBS >45mg/dl, suspect hyperinsulinaemia**

- Monitor RBS every 2 hours. Adjust the dextrose infusion (glucose delivery rate) as appropriate.
- Feed the infant whenever possible. Increase the volume by 30 mL/kg/day until normal RBS is achieved
- Refer all patients with persistent hypoglycaemia to tertiary level (see below)

Tertiary level

- Manage as primary and secondary above
- Once 130 mL/kg/day reached, increase the dextrose concentration to 12.5%
    - A central line will be needed if dextrose concentration exceeds 12.5%
- Once the RBS level has normalized, start weaning the glucose delivery by 2 mg/kg/min every 6 hours
- If the infant is still hypoglycaemic after reaching the glucose infusion rate of 12 mg/kg/minute, consider endocrine or inborn errors of metabolism. Discuss with the consultant for possible further investigations
- In addition to managing the hypoglycaemia, thorough examination must be done to look for risk factors and underlying causes
- Appropriate investigations will depend on the differential diagnoses. All sick babies with hypoglycaemia should be investigated and presumptively covered for sepsis

Persistent Hypoglycaemia

- Hypoglycaemia lasts beyond 72 hours
- May be caused by an underlying metabolic or endocrine condition
- In our setting IUGR and sepsis are the commonest causes, but other causes are:

Persistent Hypoglycaemia

- Hypoglycaemia lasts beyond 72 hours
- May be caused by an underlying metabolic or endocrine condition
- In our setting IUGR and sepsis are the commonest causes, but other causes are:

    - Hepatic enzyme deficiencies:
        - Hepatic glycogen storage diseases (type 1)
        - Glycogen synthase deficiency
        - Disorders of galactose metabolism (galactosaemia)
        - Disorders of fructose metabolism (fructose intolerance, fructose-1,6-diphosphatase deficiency)
    - Disorders of amino-acid metabolism:
        - Maple syrup urine disease, propionic and methylmalonic acedaemia
        - Tyrosinaemia
        - 3-OH 3-methylglutaryl CoA lyase deficiency
    - Mitochondrial, fatty acid oxidation and ketogenesis defects
        - Carnitine/acylcarnitine defects
        - Acetyl-CoA dehydrogenase defects
        - Very long/long/medium/short chain acetyl-CoA dehydrogenase
        - Long chain 3-OH-acetyl-CoA dehydrogenase
    - Endocrine disorders
        - Hyperinsulinism
            - Primary - Nesidioblastosis
            - Secondary - Infant of diabetic mother, Beckwith-Wiedemann syndrome, Erythroblastosis fetalis
        - Hypopituitarism - Growth hormone deficiency
        - Adrenal disorders - Cortisol deficiency
        - Glucagon deficiency
    - Lack of substrate (neonatal growth)

    - Intrauterine growth retardation
    - Small for gestational age
    - Prematurity
- Medical
    - Sepsis
    - Asphyxia

Follow up

- Neurodevelopmental follow up.
- Visual and hearing assessments.
- Growth monitoring
    - Asphyxia

Follow up

- Neurodevelopmental follow up.
- Visual and hearing assessments.
- Growth monitoring

Neonatal Hyperglycaemia

Definition
Random blood glucose > 140mg/dL (> 7.8 mmol/L)

Most times hyperglycaemia is associated with an underlying problem, such as sepsis. Treatment of the underlying problem can result in the resolution of the hyperglycaemia.

Causes/risk factors
- Prematurity <35 weeks' gestation
- SGA / IUGR
- Sepsis
- Severe dehydration
- Other stress (eg intraventricular haemorrhage)
- Iatrogenic (eg dextrose infusion), drugs
- Maternal steroids
- Inborn errors of metabolism
- Rarely neonatal diabetes mellitus

Prevention/promotion
- Optimal antenatal care
- Appropriate prescription and use of IV dextrose
- Prevention, early detection and management of sepsis

Examination
- Perform a complete head to toe examination of the newborn
- Look for signs of shock, dehydration, sepsis growth restriction, IVH

Investigations
- Check blood glucose (preferably whole blood)
- Urine dipstick for glucosuria and ketonuria
- Blood gases for ketosis and electrolyte abnormalities
- Investigate for underlying causes (see specific chapters)

Management

Primary level
- Stabilize the patient (ABCD), refer to secondary level

Secondary level
- Resuscitate and stabilize the patient: ABCD
- Stop any glucose infusions.
- Treat dehydration and start maintenance **glucose-free IV fluids** (normal saline or ringers lactate)
- Monitor glucose levels 2 hourly
- Target glucose levels 95mg/dL – 135mg/dL
- Investigate for common aetiologies
- Refer to tertiary level, if the hyperglycaemia persists beyond 6 hours or the baby is clinically sick

Tertiary level

- Treat any dehydration, acidosis and electrolyte abnormalities
- Monitor glucose 2-hourly
- Investigate and treat underlying causes and complications
- Discuss with consultant on further management.
- Insulin
    - Not routinely indicated
    - If blood glucose > 200mg/dL **and** glycosuria **and** osmotic diuresis

Note: If glucose persistently >190mg/dl for more than 3 days with no other causes of the hyperglycaemia, neonatal diabetes mellitus could be a possibility.

Complications of neonatal hyperglycaemia:

- Retinopathy of prematurity
- Intraventricular Haemorrage (IVH)
- Necrotising Enterocolitis (NEC)
- Bronchopulmonary Dysplasis (BPD)

Follow up

- Neurodevelopmental follow up.
- Visual and hearing assessments.
- Growth monitoring

Neonatal Sepsis

Introduction

- Newborns are a vulnerable group, prone to developing infections.
- Premature babies, are exposed to additional risk factors for infections.
- Clinical features of infection in newborns are non-specific
- Need to maintain a low threshold for making a presumptive diagnosis of and starting treatment for sepsis in sick newborns.
- In every baby being admitted to the neonatal ward, assess for risk of infection by evaluating exposure to antenatal and postnatal risk factors of infection and for signs of clinical instability/disease.

Classification of neonatal sepsis

- Early onset sepsis:
    - presents within the first 3 days (72hrs) of life

- **Late onset sepsis:**
    - Presents after the first 3 days (72hrs) of life
    - Presentation of sepsis will be non-specific.
    - Presume every feature of instability presenting or persisting after the first 72 hours of life as a possible presentation of late onset neonatal sepsis.
    - Perform sepsis diagnostics in these babies and start appropriate antibiotics as per the guideline above.

Risk factors/causes

- Spontaneous preterm labour (SPTL)
- Pre-labour rupture of membranes (PROM)
- Prolonged ROM >18 hours (> 12 hours in preterm infants)
- Foul smelling amniotic fluid
- Positive antenatal GBS
- Positive Group B Streptococcus(GBS) in previous pregnancy or baby
- Maternal chorio-amnionitis
- Maternal fever

Prevention/promotion

- Avoidance of risk factors
- Antenatal antibiotic treatment
- Infection prevention measures

Signs and symptoms

- Non-specific
- Abnormal neurology (irritability, seizures, lethargy)
- Respiratory distress (tachy-dyspnoea, cyanosis, grunting, intercostal recessions, apnoea)
- Abnormal heart rate
- Abnormal acid-base balance
- Abnormal glucose
- Abnormal temperature (hypothermia, fever)
- Poor or refusal to feed, vomiting, diarrhoea
- Jaundice
- Any other features can be included as discussed and agreed with registrar or consultant

Differential diagnosis

- Congenital heart disease (especially coarctation of the aorta)
- Inborn errors of metabolism
- Gastroenteritis with dehydration
- Non accidental injury

Investigations

- Every (sick) newborn suspected of having sepsis must have:
    - Full blood count
    - Blood culture
    - CSF (If the baby is too sick to tolerate an LP this should be clearly documented)
    - Sterile urine culture (where possible),
    - Blood Sugar
- Consider Malaria screen
- Ideally the above investigations should be performed before antibiotics are given, but treatment should not be delayed if this is not possible!

Management

Primary level

Stable newborns in the first 72 hours of life

- ABCDE
- Give single dose of IV/IM antibiotic.
- Refer to the secondary or tertiary level

Sick/unstable newborns in the first 72 hours of life

- ABCDE

(A)irway

- If necessary, position the airway in the 'neutral position'. Proceed with airway manouvres as per the resuscitation guidelines (see chart)

(B)reathing

- Bag and mask if apneic. Proceed as per the resuscitation guidelines (see chart)
- Monitor SPO_2, RR, HR and for signs of respiratory distress
- Give O_2 if there is significant respiratory distress or cyanosis
- Scale up toCPAP if necessary.

(C)irculation

- If the baby is shocked, give 10 mls/kg IV bolus normal saline or ringers lactate slowly over 10 minutes
- Reassess and repeat until there are no signs of shock
- Monitor HR, BP
- After 3 boluses give blood
- Consider inotropes if no improvement; discuss with consultant

(D)isability

- If blood sugar is 45mg/dL or less: treat as per the hypoglycaemia management guideline
- Keep the baby warm rectal temperature 36.5-37.5 °C)
- Paracetamol should be used where necessary to relieve fever (15mg/kg tds) Paracetamol should not be continued more than 3 days without discussion with the consultant
- Observe for and treat any seizures

Secondary level

Stable newborns in the first 72 hours of life

- ABCDE
- Screen for sepsis (Blood culture, CSF analysis and Urine culture) and give antibiotics for 5 days if the following risk factors are present:
    - Evidence of suspected or confirmed maternal infection
    - Evidence of suspected or confirmed infection in the other twin
    - Any other factors, as discussed and agreed with registrar or consultant

Sick/unstable newborns in the first 72 hours of life

- ABCDE as above
- Screen for sepsis and start antibiotics (see antibiotics choices below) if any of the following are present:
    - Respiratory distress requiring CPAP in a term baby
    - Any baby who has a clinical deterioration, having been stable in the first few hours after birth
    - Shocked patients
    - Convulsions
    - Ileus or suspected NEC
    - Suspected meningitis
    - Any other features as discussed and agreed with registrar or consultant
- Manage any complications or co-morbidities
- Refer to the tertiary level if sepsis is suspected and the baby is deteriorating or not improving on treatment, or a neonate who through other criteria should not be managed at a secondary level facility.

Tertiary level

Stable newborns in the first 72 hours of life

- Stable newborns with one risk factor should screened for infection as above and treatment started:
    - If cultures available, stop antibiotics once blood culture is negative at 72hrs.
    - Where cultures are not available, continue antibiotics for 5 days.

Sick/unstable newborns in the first 72 hours of life

- ABCDE as above
- Start antibiotics if the conditions below are present:
    - Respiratory distress requiring CPAP in a term baby
    - Any baby who has a clinical deterioration, having been stable in the first few hours after birth
    - Shocked patients
    - Convulsions
    - Ileus or suspected NEC
    - Suspected meningitis
    - Any other features as discussed and agreed with registrar or consultant

Antibiotic choice

- We currently categorize antibiotics or combinations of antibiotics into first-line, second-line and third-line antimicrobials

- Guidance on these combinations is bound to depend on prevailing organisms and sensitivity patterns.
  - Current first-line: X-pen / Ampicillin and Gentamicin.
  - Current second-line: Ceftriaxone
  - Current third line: Meropenem

- First-line antibiotics can be started by the nurses, clinicians, junior doctors and senior doctors at all levels of care
- Second-line antibiotics should be started by the registrar or a junior doctor (in consultation with registrar or consultant) at secondary and tertiary care levels
- Third-line antibiotics should be started by the consultant or registrar (in consultation with the consultant) at tertiary care level
- Antibiotics outside these categories should be started by consultant or registrar in discussion with microbiology or infectious disease experts at tertiary care level.

  Early onset sepsis
  - The likely causative organisms will be antenatally or perinatally acquired organisms.
  - Start with the **first-line antibiotics** and subsequently evaluate based on clinical response and culture results in the first 72 hours of life.

    - IV Penicillin (Xpen) 50 000 IU/kg BD if < 7days, QDS if older
      - Double the dose (Xpen 100,000 IU/kg) if meningitis is suspected

      OR IV Ampicillin 50mg/kg B.D for <2000g; 50mg/kg TDS for >2000g

    - **Plus** IV Gentamicin 5 mg/kg OD if < 7days, 7.5 mg/kg OD if older
    - IM antibiotics should only be given if IV access has failed.
    - Steps should be taken to gain IV access for the subsequent doses.
    - It is the doctor's responsibility to check and confirm that there is good IV access in every newborn on antibiotics.
  - Consultation should be made with ward registrar/consultant or with anaesthetic department if a newborn on antibiotics has failed IV access

  Late onset sepsis
  - Likely caused by nosocomially acquired organisms.
  - Klebsiella spp., S. aureus, and Enterobacter spp. are the most common organisms found.
  - S. aureus joint/ bone infection present with reduced limb movement.
  - Coagulase negative staphylococcal septicaemia presents with non-specific signs, often in a baby who has been admitted for several days.
  - Include non-typhoidal Salmonella in your differential diagnosis
  - Start with the second line antibiotics and subsequently evaluate based on clinical response and culture results.
  - Other antibiotic choices will depend on clinical and microbiological considerations. These require discussion with the consultants.

- All culture results must be reviewed at around 72 hours after sampling, and a decision made about continuing, stopping or changing antibiotics depending on the clinical picture and culture and sensitivity results.

- These decisions must be made with the involvement of the paediatric registrar or consultant.
- The dosing, frequency and duration of antibiotics will be determined by the clinical picture, site of infection, the organism and sensitivity pattern.

Continued treatment/when to discharge

- This will be guided by the progress of the baby and results available.
- Consult a senior colleague for further advice.
    - If **blood culture and CSF are negative** and the baby is well, stop antibiotics thendischarge.
    - If **both are negative** but the baby remains sick, then antibiotics should be continued. Further attempts to localize a source of infection (e.g. urine sample) or further diagnoses may need consideration. Consult a senior colleague.
    - If the **LP is positive** give high dose antibiotics for 10 to 14 days.
    - If the **blood culture is positive**, give **7 to 10 days** of IM/IV antibiotics (depending upon organism).

Follow up

- Neurodevelopmental follow up.
- Visual and hearing assessments.
- Growth monitoring

Apnoea of prematurity

Definition

Neonatal apnoea is defined as cessation of breathing in a newborn, lasting 20 seconds or more.

- Very premature babies have immature respiratory centers in the brain and sometimes "forget" to breath.
- However, a newborn who stops breathing and is followed by hypoxia and bradycardia can be considered to have apnoea.

Risk factors/causes

- (Extreme) prematurity
- IVH
- Sepsis / Meningitis
- Hypothermia
- Hypoglycaemia
- Anaemia
- Acidosis
- PDA
- NEC
- Electrolyte abnormalities

Prevention/promotion

- Prevention of prematurity
- Administration of prenatal steroids to a mother with imminent preterm delivery
- Preterm babies should be started on prophylactic treatment with Aminophylline or caffeine
- Early diagnosis and management of underlying illness

Clinical presentation

- Cessation of breathing for more than 20 seconds
- Followed by hypoxia (desaturation) and (not always) bradycardia (< 100 bpm)
- Central: due to brain immaturity or disease
- Obstructive: obstructed airways (secretions, positioning, hypotonia)
- Combined: both components

Differential diagnosis

- IVH, meningitis, encephalitis
- Increased intracranial pressure
- Seizures
- Pulmonary disease
- Cardiac disease

Management

Prophylactic Treatment

- Give prophylaxis for newborns <34/40 corrected gestation OR <1500g using aminophylline/caffeine as a respiratory stimulant (see box below).

Primary level

- Stabilize symptomatic patient (ABCDE)
- Give loading dose of either Aminophylline or Caffeine:
    - Use aminophylline
        - Loading dose: 6mg/kgSTAT, then maintenance dose 2.5mg/kg BD
    - Alternatively, if available, use Caffeine
        - Loading Dose: 10 mg/kg of Caffeine Base
- Refer neonates with apnoea to the secondary level

Secondary level

- Stabilize symptomatic patient (ABCDE)
- Give loading dose of either aminophylline or caffeine
- Pulse oximetry or cardiac monitoring
- Start on CPAP
- Treat every preterm baby who has presented with apnoeas, irrespective of gestation or weight.
- Use aminophylline as a respiratory stimulant for babies <34/40 gestation
    - Loading dose: 6mg/kgSTAT, then maintenance dose 2.5mg/kg BD.
- Alternatively, if available, use Caffeine
    - Loading dose: 10 mg/kg of caffeine base
    - Maintenance dose: 2.5 mg/kg/dose. If indicated, can be increased up to 5 mg/kg/dose.
    - Higher doses may be considered but must be approved by a Consultant
- All babies presenting with apnoea must be assessed for possible infection and managed appropriately
- Rule out other underlying causes (eg IVH)
- Refer babies with recurrent apneas or apneas with instability to the tertiary level

Tertiary level

- Manage as in secondary above.
- For recurrent apneas
    - Repeat loading dose of the treatment and continue as per schedule.
    - Investigate possible underlying causes
    - Discuss with paediatric consultant

Follow up

- Neurodevelopmental follow up.
- Visual and hearing assessments.
- Growth monitoring

Neonatal Jaundice

Definition

Yellow discolouration of the skin and visible mucous membranes resulting from accumulation of bilirubin in the blood.

- Very common in newborns, especially the premature babies.

Types of Jaundice

Physiological jaundice:

Consider physiological jaundice if:

- Presentation after 24 hours of life
- Resolving within 14 days in term babies and 21 days in preterm babies
- Unconjugated bilirubinaemia
- Well baby with no associated abnormalities on examination

Pathological jaundice:

Consider pathological jaundice in the following:

- Presentation within 24 hours of birth
- Rapid increase in bilirubin levels (> 0.5 mg/dL/hr = > 9 mmol/L/hr)
- Presentation or persistence of jaundice beyond 14 days in term and 21 days in preterm babies
- Persistence of hyperbilirubinaemia despite treatment
- Ill-looking baby
- Associated anaemia, acidosis, hypoglycaemia, temperature dysregulation
- Associated hydrops
- Associated organomegaly and/or ascites
- Maternal blood group O or Rhesus negative.
- Conjugated bilirubinaemia
- Pale stools
- Dysmorphic or syndromic baby

Common causes of pathological jaundice:

- ABO or Rhesus incompatibility
- Infections, including TORCH infections such as syphilis.
- Enzyme defects such as G6PD deficiency.
- Big haematomas, particularly subgaleal haematoma

Jaundice presenting in the first 24 hours is PATHOLOGICAL and babies must be treated!!

Prevention/promotion

- Optimal antenatal care
- Increased community awareness
- Anti – D antibodies
- Optimal fluid and nutrition management

Investigations

Thorough examination to exclude other causes of pathological jaundice.

- Check baseline bilirubin level (TSB or TCB)
- FBC and differential count; reticulocytes if possible
- Blood culture, TORCH screen
- Blood grouping for mother and baby
- If the mother's blood group is O or Rhesus negative;
    - Coombs test
    - Peripheral smear

Management

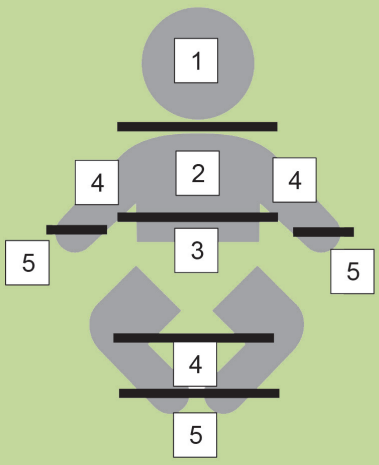
Primary Level

- Refer any baby with significant jaundice to the secondary level, after stabilization

Secondary /tertiary level

- Stabilize the patient (ABCDE)
- Check baseline bilirubin level (TSB or TCB)
    - If a bilirubinometer (TCB) or serum Bilirubin is not available, assign clinical severity grade to the jaundice, using the chart below:

Clinical grading of neonatal jaundice



Score	Area of body	Serum bilirubin levels
1	Face	4-6 mg/dl
2	Chest, upper abdomen	8-10 mg/dl
3	Lower abdomen, thighs	12-14 mg/dl
4	Arms, lower legs	15-18 mg/dl
5	Palms, soles	15-20 mg/dl

- If bilirubin levels are available, use the table for treatment thresholds. Note that the treatment thresholds are different for preterm, low birth weight and sick or unstable newborns.

	Phototherapy levels; healthy term baby	Phototherapy levels; Preterm, LBW, sick baby	Exchange transfusion levels; healthy term baby	Exchange transfusion levels; Preterm, LBW, sick baby
Day of life	µmol/L (mg/dl)	µmol/L (mg/dl)	µmol/L (mg/dl)	µmol/L (mg/dl)
Day 1	Treat any visible jaundice with phototherapy		17 (1.00)	14 (0.80)
Day 1	15 (0.85)	13 (0.75)	22 (1.28)	17 (0.95)
Day 3	18 (1.00)	16 (0.90)	24 (1.40)	18 (1.00)
Day 4 & after	20 (1.20)	17 (0.95)	25 (1.45)	20 (1.20)

- If the bilirubin is not high enough to warrant phototherapy, but is close to the threshold (within 3mg/dL), please check it again the following day.
- Start phototherapy. Once on phototherapy:
    - The baby's eyes should be covered with a gauze pad to protect them from the light.
    - Babies on phototherapy must be fully exposed, including removal of nappies.
    - Ensure the baby is feeding well - top up with EBM via cup or NGT if necessary.
    - Add 10% of the daily requirement to the fluids/ feeds the baby is getting to account for transpiration due to phototherapy.
    - The baby should be turned at least every 6 hours, but ideally every 2-3 hours to ensure the whole body is exposed to the blue light.
    - Babies under phototherapy should have their bilirubin level checked on a daily basis. Those with pathological jaundice due to severe haemolysis must have at least a TCB every 6 hours.
        - The bilirubinometer should be used on the chest and the forehead (which is not directly exposed to the phototherapy) and whichever value is highest used.
    - For a successful treatment, the bilirubin should be falling by at least 1mg/dL every 6 hours.
    - Phototherapy should be stopped when the value is more than 3mg/dl below the threshold shown above Monitor for ***complications of phototherapy:***
        - Diarrhoea
        - Dehydration
        - Hypothermia
        - Hyperthermia
        - Retinal damage
        - Eye infections
        - Bronze baby syndrome
    - Double phototherapy
    - Check bilirubin 6 hourly (TSB or TCB)
    - Transfuse for anaemia, based on the transfusion guidelines and the clinical picture.
- Exchange transfusion if meeting criteria, and where facilities are available.
    - **All patients who are in the exchange transfusion range should be referred to the tertiary level. Stabilization and phototherapy should continue, while waiting for transfer.**
- For all jaundiced babies, consider whether infection may be the cause.
    - Examine and investigate (blood culture, lumbar puncture) and treat appropriately.

Investigate for the cause of pathological jaundice as outlined in the investigations above.

Follow up

- Neurodevelopmental follow up.
- Visual and hearing assessments.
- Growth monitoring
- Palliative care

Acute Bilirubin Encephalopathy/Kernicterus

Definition and pathophysiology

- Results from neuronal damage due to bilirubin crossing over to the brain parenchyma at extremely high levels.
- Occurs in hyperbilirubinaemia (if bilirubin >350 µmol/l (or less in preterms or sick infants), more commonly if >500 µmol/L)

Clinical presentation

- Stage 1: sleepy, reduced suck, lethargy
- Stage 2: increased temperature, restless, lid retraction, odd mouth movements, seizures, high pitched cry, opisthotonus
- Stage 3: death or latent period
- Stage 4: cerebral palsy (esp. choreo-athethoid), deafness, reduced IQ

Management

- If the jaundice is not promptly and appropriately treated with adequate phototherapy light, permanent brain damage may occur
- In addition to phototherapy, exchange transfusions are required for serious jaundice
- Long-term neurodevelopmental follow up and palliative care will be required after discharge
- Arrange for screening for hearing and visual acuity

Follow up

- Neurodevelopmental follow up
- Visual and hearing assessments
- Growth monitoring
- Palliative care

Prolonged Jaundice

Definition

Diagnose prolonged jaundice in a baby whose jaundice persists beyond 14 days for a term baby, and 21 days for a preterm baby.

- Remember that sepsis must always be suspected in a newborn with prolonged or late onset jaundice

Causes of prolonged jaundice

Prehepatic (Haemolysis)	Hepatic Disease	Posthepatic (Obstructive)
• Sepsis • Enzyme defects (eg G6PD deficiency) • Hb abnormalities (eg Thalassaemia) • Membrane defects eg hereditary spherocytosis	• TORCH • Syphilis • Infective Hepatitis • Inborn errors of Metabolism	• Choledochal cyst • Biliary atresia • Allagille's syndrome • Bowel obstruction

Important points in history

- Family history of hereditary haemoglobinopathy, liver disease
- Previous need for transfusion (transfusion suggests risk for contracting hepatitis)
- Colour of stool and urine - normal colour of stools suggests unconjugatedjaundice and haemolysis, **tea-coloured urine and pale stools suggests obstructive causes of jaundice**

Important points on examination

A full physical examination is necessary. Particular signs may point to a diagnosis or may be important in different conditions:

- Assess growth and nutritional state - poor in chronic liver disease
- Pallor-suggests haemolysis if acute
- Bruising, bleeding, skin rashes, snuffles
- Hepatosplenomegly (syphilis, prolonged haemolysis)
- Liver tenderness - suggestive of acute hepatitis
- Abdominal masses - choledochal cyst
- Look for pale stools

Investigations

- Urine dipstick for bilirubin and urobilinogen - suggests prehepatic disease
- PCV/FBC
- Malaria parasites
- VDRL, TORCH screens
- Hepatitis B serology if hepatitis is considered
- Sickle cell test in older newborns or infants
- Blood film
- Thyroid test
- Liver function tests
    - **Conjugated bilirubin** in liver disease or biliary obstruction
    - **Unconjugated bilirubin** in haemolysis or hepatitis
    - Transaminases raised in hepatitis

- If bleeding tendency, a clotting screen should be done
- Abdominal ultrasound (shrunken liver in cirrhosis, large bright inflamed liver in hepatitis, tumours of liver, biliary atresia, choledochal cysts or gallstones)

Management

Primary/secondary level
- Refer any neonate with prolonged jaundice to the tertiary level

Tertiary level

Pre-hepatic (Haemolysis)
- Blood transfusion if anaemic; see guideline on anemia
- Treat underlying cause of haemolysis including infections
- IV fluids – hyperhydration
- Oxygen
- Screen and treat for presumed sepsis

Hepatic disease
- Blood sugar level - daily and more frequently if the child has a decreased conscious state - maintain RBS between 65-155mg/dL
- Vitamin K: IV if bleeding actively or persistent jaundice
- Vitamin A - if chronic liver disease is suspected
- Diet: Feed 2 hourly
- Fluid balance monitoring if encephalopathic- need approximately 2/3 maintenance fluid requirement. Monitor daily weight
- Antibiotics if febrile and jaundiced and MPS are negative
- Avoid Paracetamol

Post hepatic disease
- Monitor the colour of the stool
- Perform abdominal ultrasound
- Stabilize the patient as per guideline
- Consult the surgeons for surgical management for structural obstruction

Follow up
- Neurodevelopmental follow up
- Visual and hearing assessments
- Growth monitoring
- Palliative care

Neonatal Seizures

Definition
Paroxysmal alterations in neurologic function in a newborn (motor, behavioural, autonomic)

Epileptic seizure: Clinical seizure associated with EEG seizure activity
Non-epileptic seizure: Clinical seizures without EEG changes
EEG seizures: Abnormal EEG changes without clinical correlation

Causes/risk factors
- **Perinatal**
  - HIE (40-50%)
  - Intracranial haemorrhage (IVH, trauma, subarachnoid haemorrhage)
- Metabolic and endocrine causes
  - Hypoglycaemia, hypocalcemia, hypomagnesemia, hypo/hypernatraemia, pyridoxine deficiency, inborn errors of metabolism
- Infections
  - Sepsis, meningitis, encephalitis, TORCH, tetanus
- Congenital brain malformations
- Cerebro-vascular-malformation and disease
- Drugs and alcohol
- Familial seizures
- Syndromes: Sturge-Weber, benign familial, myoclonic epilepsy of the infant
- Idiopathic

Prevention
- Neonatal seizures can be prevented by early detection and management of underlying pathologies.

Clinical presentation
- Neonates commonly present with unusual and subtle seizures:
  - Ocular – sustained eye deviation, ocular fixation
  - Oral-facial-lingual movements – chewing, tongue-thrusting, lip-smacking etc.
  - Limb movements – cycling, paddling, boxing-jabs
  - Autonomic manifestations – tachycardia or bradycardia, apnoea
  - Tonic, clonic, myoclonic seizures
- EEG seizures may present sub-clinically and will only be picked up on EEG of a comatose patient.

Investigations
- Blood glucose, ABG
- FBC
- Blood culture
- Electrolytes (especially sodium, calcium, and magnesium, if available)
- CSF
- Consider cranial ultrasound
- EEG where available
- Metabolic panel screen if available

Differential diagnoses
- See under causes/risk factors

Management

Primary level

- Manage ABCDE
  - Administer oxygen
  - Check blood glucose – correct by IV dextrose bolus if < 45mg/dL (see hypoglycaemia management)
- Refer every newborn who presents with a seizure to the secondary or tertiary level for investigation and management.

Secondary level

- Stabilize patient (ABCDE)
- If fits are occurring more than twice an hour or lasting more than 3 minutes:
  - Phenobarbitone 20mg / kg IM Stat
  - If still fitting after 10 minutes repeat phenobarbitone
- Refer any neonate with persistent seizures or seizures with an underlying pathology

Tertiary level

- Stabilize as above
- If still no seizure control, give a loading dose of IV Phenytoin 20mg/kg OR Levetiracetam (Keppra) 20mg/kg PO or IV
- Screen for infection and start antibiotics
- Perform a lumbar puncture as soon as the baby is stable
- If seizures are difficult to control despite adequate doses of anticonvulsants give:
  - Calcium gluconate at 1mmol/kg or pyridoxine 100mg IV
- Consult neurologist/neonatologist

Follow up

- Neurodevelopmental follow up.
- Visual and hearing assessments.
- Growth monitoring

Approach to a Dysmorphic Neonate

Definition
Dysmorphic features: ranging from unusual appearance to major malformation

The definition of terms used in description of birth defects/dysmorphic features

Terminology	Meaning
Malformation	Morphologic abnormality that arises because of an abnormal developmental process. A primary error in morphogenesis e.g. cleft lip
Malformation sequence	Pattern of multiple defects resulting from a single primary malformation e.g. talipes and hydrocephalus can result from a lumbar neural tube defect
Malformation syndrome	Pattern of features, often with a unifying underlying cause, that arises from several different errors in morphogenesis e.g. trisomy 21
Deformation	Distortion by a physical force of an otherwise normal structure e.g. club foot
Disruption	Destruction of a tissue that was previously normal e.g. amniotic band sequence
Dysplasia	Abnormal cellular organisation within a tissue resulting in structural changes e.g. within cartilage and bone in skeletal dysplasias
Association	Group of anomalies that occur more frequently than would be expected by chance alone but that do not have a predictable pattern or unified etiology e.g. VACTERL association

Epidemiology: 1 in 40 neonates (2.5%)

Risk factors/causes
- Single gene disorders (including inborn errors of metabolism which may be progressive) e.g. Zellweger syndrome, congenital adrenal hyperplasia, Smith-Lemli-Opitz syndrome
- Chromosomal disorders (non-progressive) e.g. Down syndrome
- Microdeletion syndromes e.g. Prader-Willi syndrome
- Polygenic disorders e.g. club foot
- Environmental causes (teratogenesis) e.g. Rubella, congenital viral infection, infant of diabetic mother (IDM), fetal alcohol syndrome

Prevention/promotion
- Genetic causes are not preventable.
- Promote awareness of risk of consanguinity.
- Prevent congenital infections via maternal immunization and hygiene measures.

Clinical presentation
Suspect a genetic cause if:

- Congenital anomalies present: one or more major anomaly or more than two minor anomalies (see tables below)
    - Major anomaly: cause dysfunction or require surgical correction
    - Minor anomaly: neither cause significant dysfunction nor require surgical correction
- Poor growth: symmetric intrauterine growth restriction or postnatal growth failure
- Developmental delay or developmental regression
- Craniofacial dysmorphism
- Ambiguous genitalia

Common clinical signs in dysmorphic syndromes

Sign	Definition
Brachycephaly	A condition in which head shape is shortened from front to back along the sagittal plane; the skull is rounder than normal
Brachydactyly	A condition of having short digits
Brushfield spots	Speckled white rings about two thirds of the distance to the periphery of the iris of the eye
Camptodactyly	Permanent flexion of one or more fingers associated with missing inner phalangeal creases indicating lack of finger movement from before 8 wk of gestation
Clinodactyly	A medial or lateral curving of the fingers; usually refers to incurving of the 5th finger
Hypoplastic nail	An unusually small nail on a digit
Low-set ears	This designation is made when the helix meets the cranium at a level below a horizontal plane that is an extension of a line through both inner canthi
Melia	A suffix meaning “limb” (e.g., amelia—missing limb; brachymelia—short limb)
Ocular hypertelorism	Increased distance between the pupils of the two eyes
Plagiocephaly	A condition in which head shape is asymmetric in the sagittal or coronal plane; can result from asymmetry in suture closure or from asymmetry of brain growth
Posterior parietal hair whorl	A single whorl occurs to the right or left of midline and within 2 cm anterior to the posterior fontanel in 95% of cases. The whorl represents the focal point from which the posterior scalp skin was under growth tension during brain growth between the 10th and 16th wk of fetal development. Aberrant position of the whorl reflects an early defect in brain development.
Postaxial polydactyly	Extra finger or toe present on the lateral side of the hand or foot

Preaxial polydactyly	Extra finger or toe present on the medial side of the hand or foot
Prominent lateral palatine ridges	Relative overgrowth of the lateral palatine ridges secondary to a deficit of tongue thrust into the hard palate
Scaphocephaly	A condition in which the head is elongated from front to back in the sagittal plane; most normal skulls are scaphocephalic
Shawl scrotum	The scrotal skin joins around the superior aspect of the penis and represents a mild deficit in full migration of the labial-scrotal folds
Short palpebral fissures	Decreased horizontal distance of the eye based on measurement from the inner to the outer canthus
Syndactyly	Incomplete separation of the fingers. It most commonly occurs between the 3rd and 4th fingers and between the 2nd and 3rd toes.
Synophrys	Eyebrows that meet in the midline
Telecanthus	Lateral displacement of the inner canthi. The inner canthal distance is increased, but the inner pupillary distance is normal.
Widow's peak	V-shaped midline, downward projection of the scalp hair in the frontal region. It represents an upper forehead intersection of the bilateral fields of periocular hair growth suppression. It usually occurs because the fields are widely spaced, as in ocular hypertelorism.

Minor anomalies seen in various systems

System	Minor anomaly
Craniofacial	• Large fontanelle • Flat or low nasal bridge • Saddle nose, upturned nose • Mild micrognathia • Cutis aplasia of scalp
Eye	• Inner epicanthal folds • Telecanthus • Slanting of palpebral fissures • Hypertelorism • Brushfield spots
Ear	• Lack of helical fold • Posteriorly rotated pinna • Preauricular with or without auricular skin tags • Small pinna • Auricular (preauricular) pit or sinus • Folding of helix • Darwinian tubercle • Crushed (crinkled) ear • Asymmetric ear sizes • Low-set ears

Skin	• Dimpling over bones • Capillary hemangioma (face, posterior neck) • Mongolian spots (African Americans, Asians) • Sacral dimple • Pigmented nevi • Redundant skin • Cutis marmorata
Hand	• Simian creases • Bridged upper palmar creases • Clinodactyly of fifth digit • Hyperextensibility of thumbs • Single flexion crease of fifth digit (hypoplasia of middle phalanx) • Partial cutaneous syndactyly • Polydactyly • Short, broad thumb • Narrow, hyperconvex nails • Hypoplastic nails • Camptodactyly • Shortened fourth digit
Foot	• Partial syndactyly of second and third toes • Asymmetric toe length • Clinodactyly of second toe • Overlapping toes • Nail hypoplasia • Wide gap between hallux and second toe • Deep plantar crease between hallux and second toe
Others	• Mild calcaneovalgus • Hydrocele • Shawl scrotum • Hypospadias • Hypoplasia of labia majora

Evaluation / Investigations

Approach to a neonate with dysmorphism

- History including perinatal details and family history (consanguinity, previous pregnancy losses)
- Physical examination detailing the major and minor anomalies
    - Major anomaly: cause dysfunction or require surgical correction
    - Minor anomaly: neither cause significant dysfunction nor require surgical correction
- Growth recording and measurements
- Examination of previous records and photographs
- Making a diagnosis based on the above details
    - Ballpark diagnosis: an 'approximation' of the diagnosis based upon the clinical features
    - Diagnosis by Gestalt: identifying the syndrome by 'pattern recognition'
    - Syndrome search: searching a dysmorphology database using the key anomalies noted in the neonate
- Investigations to confirm the diagnosis and to evaluate the neonate for affected organ systems
    - Methods of genetic analyses

  - Karyotype
  - Fluorescence in situ hybridization (FISH)
  - DNA microarray
  - Comparative genomic hybridization (CGH)
  - Single nucleotide polymorphism (SNP) or oligonucleotide arrays
  - Molecular analysis
- Other diagnostic procedures
- Biochemical testing
- Metabolic investigations
- Rarely histology
- Imaging studies
  - Ultrasound
  - X-ray
  - CT
  - MRI

Differential diagnosis of common genetic syndromes

- A list of common dysmorphic syndromes encountered during the neonatal period and the lab test for confirming the diagnosis:

Condition	Presenting feature	Diagnostic test
Trisomy 21 Down syndrome	Brachycephaly, low set ears, flat nasal bridge, epicanthic folds, hypertelorism, macroglossia, brachydactyly, hypotonia, AVSD, single palmar crease, sandal gap, Hirschsprung disease	Karyotyping
Trisomy 18 Edward syndrome	Overlapping fingers, globular head, dysplastic ears, low birth weight, heart defects, short great toes, radial aplasia, rocker bottom feet, IUGR	Karyotyping
Trisomy 13 Patau syndrome	Holoprosencephaly, cleft palate, heart defect, polydactyly, renal abnormalities, microphthalmia, umbilical hernia	Karyotyping
Turner syndrome	Only female neonates Wide or weblike neck, low-set ears, broad chest with widely spaced nipples, high, narrow roof of the mouth (palate), arms that turn outward at the elbows, fingernails and toenails that are narrow and turned upward, swelling of the hands and feet, especially at birth, slightly smaller than average height at birth, slowed growth, cardiac defects, low hairline at the back of the head, receding or small lower jaw, short fingers and toes	Karyotyping, cardiac and abdominal echo
Noonan syndrome	Characteristic facial appearance: Broad forehead, drooping eyelids (ptosis), wider-than-usual distance between the eyes (ocular hypertelorism), short, broad nose, low-set ears that are rotated towards the back of the head, small jaw, short neck with excess skin folds, lower-than-usual hairline at the back of the head and neck Lymphoedema Cardiac defects, single kidney Short stature at later stage	Mutation analysis, cardiac echo

4p-Wolf-Hirshorn syndrome	Hypertelorism, prominent glabella (Greek helmet), cleft lip and palate, short philtrum, large ears	May be visible on standard karyotype. More reliably detected by FISH or MLPA
5p-Cri du Chat syndrome	Mewing cry, microcephaly, round face, prominent epicanthic folds, cleft palate, ear anomalies	Usually visible on routine karyotype. FISH will detect smaller deletions
22q11 deletion DiGeorge syndrome Velocardiofacial syndrome	Cardiac defects especially outflow tract, Cleft palate, micrognathia, prominent nose, overturned helix of ear, hypocalcaemia, absent thymus	FISH for 22q11 deletion, few have smaller deletions detectable on MLPA of 22q11
Prader-Willi syndrome	Neonatal hypotonia Bitemporal narrowing, Almond-shaped eyes, Tube feeding required	DNA for 15q11-13 methylation (15q11-13 FISH will miss infants with uniparental disomy (UPD) of chromosome 15)
Achondroplasia	Proximal limb shortening, relatively large head, trident hand, extra skin creases, depressed nasal bridge, lumbar kyphosis	Skeletal survey shows square ilia, translucent proximal femur, narrow sacrosciatic notch. Analysis of FGFR3 gene shows characteristic mutation
Williams-Beuren syndrome	Distinct facial appearance: broad fore-head, bitemporal narrowing, periorbital fullness, stellate and/or lacy iris pattern, short upturned nose with bulbous tip, long philtrum, wide mouth, full lips and mild micrognathia Cardiac anomalies (most frequently supravalvular aortic stenosis) Connective tissue abnormalities (e.g., joint laxity); later in life cognitive and developmental abnormalities	Mutation analysis, micro-deletion on chromosome 7q11.23, cardiac echo
Myotonic dystrophy	Hypotonia , Tented upper lip, Elevated diaphragm, Mother has myotonia	Examine mother DNA for expansion in myotonic dystrophy gene on chromosome 19
Beckwith-Wiedemann syndrome	Exomphalos, High birth weight, Large tongue, Facial naevus flammeus	DNA to assess methylation of 11p15 Parental DNA for UPD studies. Not all have 11p abnormality

Cornelia De Lange syndrome	Low birth weight, Synophrys, hirsutism, Beaked philtrum, Heart defects, Limb defects but may be subtle Diaphragmatic hernia	Primarily a clinical diagnosis. Some have mutations in NIPBL gene on chromosome 5 or other genes. Genetic abnormality not found in every patient
Neonatal Marfan syndrome	Long limbs, arachnodactyly, contractures, enophthalmos, dislocated lenses, wrinkly skin, heart murmur	Cardiac echo and follow-up as aortic dilatation may not be present at birth. Eye examination, FBN1 mutation analysis
Rubinstein-Taybi syndrome	Broad medially deviated thumbs and great toes, long columella, hirsutism, microcephaly, heart defects, glaucoma	Clinical diagnosis, FISH 16p13 deletion in 15-20%, some have mutations in CRBBP gene. Many have no genetic abnormality identified
Goldenhar syndrome (Hemifacial microsomia)	Findings usually unilateral. Mandibular hypoplasia, dysplastic or absent ear, pre-auricular tags, macrostomia, epibulbar dermoid. May be vertebral and cardiac defects	Clinical diagnosis. Heterogeneous condition with both genetic and environmental causes
12p tetrasomy Pallister Killian syndrome	High birth weight, macrocephaly, diaphragmatic hernia, coarse face, hypotonia, long philtrum, sparse hair over temples	Always in mosaic form. Unlikely to be detectable on blood chromosome analysis. Need skin biopsy or FISH cells from buccal mucosa
Stickler syndrome	Pierre Robin sequence with cleft palate and micrognathia. Flat nasal bridge, prominent eyes, joint laxity	Eye examination shows myopia and vitreous abnormalities (not often apparent at birth). Mild platyspondyly on spinal X-. Genetic testing complex May be mutation in Type 2 or Type 11 collagen genes

Management

- Depends on the underlying condition
- Wide range from medical and/or surgical interventions with the aim of curative care to purely palliative care
- Best handled at tertiary care level

Prognosis

- Depends on the underlying condition
- Range from normal life-span to early death

Principles of Postnatal Care and Post-Discharge Follow-Up

WHO Recommendations

Healthy mother, healthy newborns

- Care for healthy mothers and newborns in the health facility is recommended for at least 24 hours after vaginal birth.
- Prior to discharging mothers and newborns after birth from the health facility to the home, health workers should assess the following criteria to improve maternal and newborn outcomes:
    - The mother's and baby's physical well-being and the mother's emotional well-being;
    - The skills and confidence of the mother to care for herself and the skills and confidence of the parents and caregivers to care for the newborn; and
    - The home environment and other factors that may influence the ability to provide care for the mother and the newborn in the home, and care-seeking behaviour.
- A minimum of four postnatal care contacts is recommended.
    - If birth is in a health facility, healthy mothers and newborns should receive postnatal care in the facility for at least 24 hours after birth.
    - If birth is at home, the first postnatal contact should be as early as possible within 24 hours of birth.
    - At least three additional postnatal contacts are recommended for healthy mothers and newborns, between 48 and 72 hours, between 7 and 14 days, and during week six after birth.
- Home visits during the first week after birth by skilled health personnel or a trained community health worker are recommended for the postnatal care of healthy mothers and newborns.
- Where home visits are not feasible or not preferred, outpatient postnatal care contacts are recommended.

Preterm or low-birth-weight infants

- Families of preterm or low-birth-weight infants should be given extra support to care for their infants, starting in health-care facilities from birth, and continued during follow-up post-discharge
- The support may include education, counselling and discharge preparation by health workers, and peer support
- If preterm or low-birth-weight infants are born at home, immediate kangaroo mother care should be provided
- Extra home visits (in addition to routine home visits) by trained health workers (e.g. community health workers, nurses, midwives, or doctors) are recommended to support families to care for their preterm or low-birth-weight infant

Focus on

- Nutrition (breastfeeding)
- Weight gain
- Prevention of hypoglycaemia
- Thermal care
- Hygiene, prevention of infections
- Early detection of signs of infection
- Respiratory problems

Look for danger signs (if present indication for hospitalization)

- History of difficulty feeding
- Movement only when stimulated
- Lethargic
- Temperature < 35.5°C
- Temperature ≥ 37.5°C
- Prolonged capillary refill
- Respiratory rate ≥ 60/min
- Grunting
- Cyanosis
- Severe chest indrawing
- History of convulsions
- Stiff limbs
- Jaundice
- Infected umbilical stump

References

1. Risk factors for a newborn requiring resuscitation (Source: Predicting the need for resuscitation (https://www.nationalcprassociation.com/neonatal-resuscitation-study-guide/))

2. Ballard JL, Khoury JC, Wedig K, et al: New Ballard Score, expanded to include extremely premature infants J Pediatr 1991; 119:417-423. Reprinted from Dr Ballard and Mosby-Year Book, Inc.

3. PATH: A case study in establishing care for small and sick newborns in Malawi, PATH 2022)

4. National CPR Association Predicting the need for resuscitation (https://www.nationalcprassociation.com/neonatal-resuscitation-study-guide/)

5. Weiner GM, Zaichkin J: Textbook of Neonatal Resuscitation (NRP), 7th Ed (7th Edition), American Academy of Pediatrics; American Heart Association April 2016, DOI: https://doi.org/10.1542/9781610020251

6. 2017 International Consesus on Cardiovacular Resuscitation and Emergency Cardiovascular Care Science with Treatment recommendations summary.

7. American Heart Association 2020: Neonatal Resuscitation algorithm

8. 'Born too soon, decade of action on preterm birth', WHO 2023 .

9. NEST360°. Newborn Essential Solutions and Technologies-Education – Clinical Modules: Infection Prevention and Control. (June 2020). License: CC BY-NC-SA 4.0.

10. Kangaroo mother care: a transformative innovation in health care. Global position paper. Geneva: World Health Organization; 2023. Licence: CC BY-NC-SA 3.0 IGO.

11. Pocket book of hospital care for children: guidelines for the management of common childhood illnesses – 2nd ed. World Health Organisation 2013

12. Kangaroo mother care: a practical guide. Geneva: World Health Organization; 2003

13. Global position paper Kangaroo mother care a transformative innovation in health care. World Health Organization 2023

14. WHO recommendations for care of the preterm or low birth weight infant. Geneva: World Health Organization; 2022. Licence: CC BY-NC-SA 3.0 IGO.

15. WHO Immediate KMC Study Group, Arya S, Naburi H, Kawaza K, Newton S, Anyabolu CH et al. Immediate "kangaroo mother care" and survival of infants with low birth weight. N Engl J Med. 2021;384(21):2028–38. doi:10.1056/NEJMoa2026486.

16. Survive and thrive: transforming care for every small and sick newborn. Geneva: World Health Organization; 2019