Republic of Rwanda

Ministry of Health
P. O. Box 84 Kigali
www.moh.gov.rw

Neonatology

Clinical Treatment Guidelines

September 2012

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Acronyms

ABC	: Airway, Breathing and Circulation
ADH	: Antidiuretic Hormone
AST	: Aspartate AminoTransferase
ALT	: Alanine AminoTransferase
ARV	: AntiRetroViral
BCG	: Bacille Calmette -Guérin
BP	: Blood Pressure
BE	: Base Excess
BUN	: Blood Urea
BW	: Birth Weight
CNS	: Central Nervous System
CMV	: Cytomegalovirus
CPAP	: Continuous Positive Airway Pressure
CSF	: Cephalo Spinal Fluid
CRP	: C - Reactive Protein
CT	: Computed Tomography
CXR	: Chest X-ray
DAT	: Direct Antiglobulin Test
DIC	: Disseminated Intravascular Coagulopathy
DoL	: Day of Life
ECG	: Electrocardiography
EEG	: Electroencephalography
ETAT	: Emergency Triage Assessment and Treatment
FBC	: Full Blood Count
FISH	: Fluorescence In Situ Hybridization
G6PD	: Glucose 6 Phosphate Dehydrogenase
Hb	: Hemoglobin
Hct	: Hematocrit
HIE	: Hypoxic – Ischemic Encephalopathy
HIV	: Human Immuno Deficiency Virus
HR	: Heart Rate
INH	: Isoniazide
IM	: Intramuscular
IUGR	: Intra-Uterine Growth Retardation
IV	: Intravenous

IVF : Intravenous Fluid
KMC : Kangaroo Mother Care
LBW : Low Birth Weight
ELBW : Extremely Low Birth Weight
LR : Lactate Ringer
NFS : Numération Formule Sanguine
NICU : Neonatal Intensive Care Unit
NGT : Nasogastric Tube
NPO : Nil per os
NS : Normal Saline
PDA : Patent Ductus Arteriosus
PH : Potential Hydrogen
PMTCT : Preventing mother- to- Child transmission of HIV
PO : Per Os
PMA : Post menstrual age
RDS : Respiratory Distress Syndrome
Rh : Rhesus
RR : Respiratory Rate
TB : Tuberculosis
UTI : Urinary Tract Infection
VLBW : Very Low Birth Weight
VZV : Varicella-Zona Virus
WBC : White Blood Count
WHO : World Health Organization
GGT : Gamma Glutamyl Transpeptidase

Foreword

The guidelines and protocols presented in this document are designed to provide a useful resource for healthcare professionals involved in clinical case management in Rwanda. They were developed by taking into consideration services provided at different levels within the health system and the resources available, and are intended to standardize care at both the secondary and tertiary levels of service delivery across different socio-economic levels of our society.

The clinical conditions included in this manual were selected based on facility reports of high volume and high risk conditions treated in each specialty area. The guidelines were developed through extensive consultative work sessions, which included health experts and clinicians from different specialties. The working group brought together current evidence-based knowledge in an effort to provide the highest quality of healthcare to the public. It is my strong hope that the use of these guidelines will greatly contribute to improved the diagnosis, management, and treatment of patients across Rwanda. And it is my sincere expectation that service providers will adhere to these guidelines and protocols.

The Ministry of Health is grateful for the efforts of all those who contributed in various ways to the development, review, and validation of the Clinical Treatment Guidelines. We would like to thank our colleagues from District, Referral, and University Teaching Hospitals, and specialized departments within the Ministry of Health, our development partners, and private health practitioners. We also thank the Rwanda Professional Societies in their relevant areas of specialty for their contributions and for their technical review, which enriched the content of this document, as well as the World Health Organization (WHO) and the Belgium Technical Cooperation (BTC) for their support.

We would like to especially thank the United States Agency for International Development (USAID) for both their financial and technical support through the Management Sciences for Health (MSH) Integrated Health System Strengthening Project (IHSSP) and Systems for Improved Access to Pharmaceuticals and Services (SIAPS).

To end with, we wish to express our sincere gratitude to all those who continue to contribute to improving the quality of health care of the Rwanda population.

Dr Agnes Binagwaho
Minister of Health

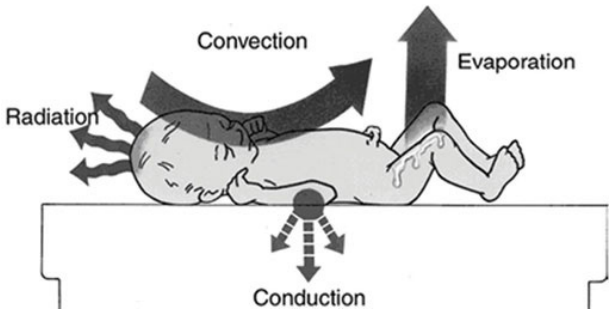
1. Neonatal Care

1.1. Routine Care of Newborn

Protection against hypothermia and prevention: Temperature regulation is fundamental immediately after birth. Studies have shown that hypothermia (<36.5C) in the first hour of life is associated with increased mortality at 2 years. Normal temperature: 36.5C-37.5C. The baby's temperature MUST be recorded within the first hour of life and monitored.

How newborn infants lose heat

- Evaporation: Heat loss when water evaporates from skin or breath
- Conduction: Direct heat loss to solid surfaces with which they are in contact
- Convection: Heat is lost to currents of air
- Radiation: Heat loss via electromagnetic waves from skin to surrounding surfaces



How to prevent hypothermia in the newborn infant

- At birth, when skin is wet, drying and wrapping in a warm towel
- Provide skin to skin contact
- Clothing the infant
- Raising the temperature of ambient air avoiding drafts

Early Breastfeeding: Feed the newborn immediately after birth (within 1 hour of birth). Refer to PMTCT chart for breast feeding of HIV+ve mothers

Umbilical cord care: Always wash hands with hand gel or clean water and soap before handling Umbilical Cord. Keep cord dry and exposed to air

Eye prophylaxis: Give tetracycline 1% eye drops within 1 hour of birth

Vitamin K administration: Single dose of Vitamin K to all newborns by intramuscular injection 1mg for birth weight >1500gm and 0.5mg for birth weight < 1500gm

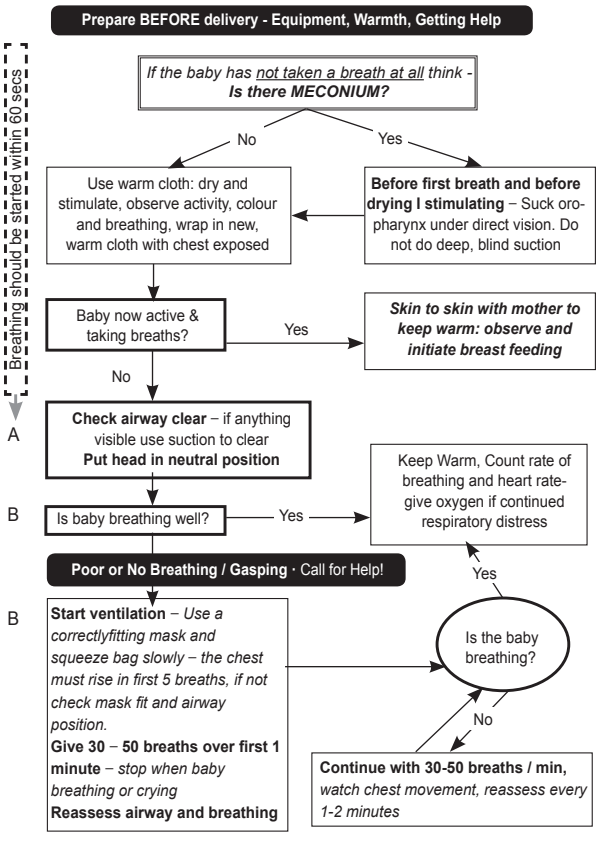
Review maternal history
Conduct Newborn physical examination
Identification and registration

1.2. Resuscitation of the Newborn

- Be prepared!
- Be at the delivery!
- Check the equipment and emergency medicines!
- Ask 3 questions to evaluate the infant
    - Is the baby breathing adequately and not just gasping?
    - Is the baby's heart rate (HR) above 100 beats per minute?
    - Is the baby centrally pink, i.e. no central cyanosis?
        - ➔ If the answer to all three questions is "yes", the baby does not need resuscitation.
        - ➔ If the answer to all three questions is "no" the baby needs resuscitation.
        - ➔ Assess the infant using the above 3 questions every 30 seconds during resuscitation
        - ➔ If the baby is improving, then the intervention e.g. bagging can be stopped
        - ➔ Only if the baby is not responding or getting worse, is further intervention needed e.g. chest compressions (see algorithm).
- Check that each step has been effectively applied before proceeding to the next step
- The algorithm follows the assumption that the previous step was unsuccessful and the newborn is deteriorating

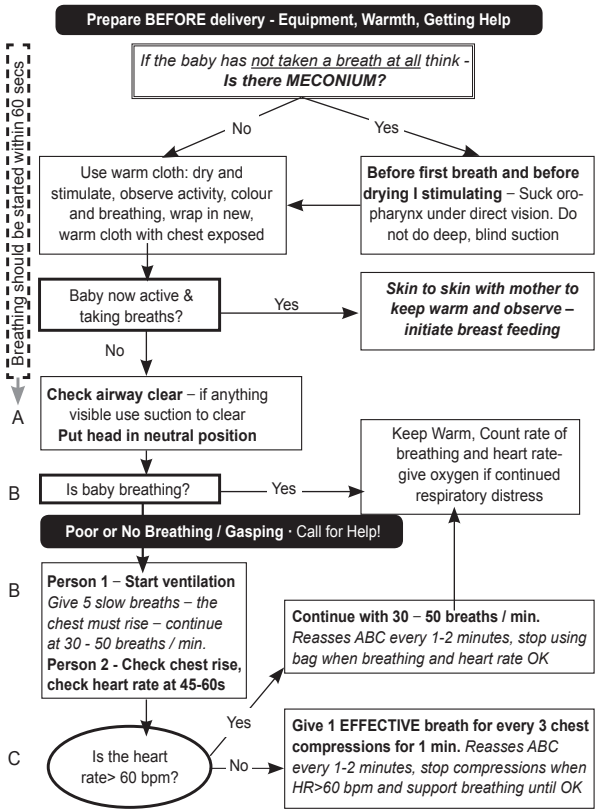
- Resuscitation should be in AIR. There is evidence that resuscitation with oxygen may be harmful (toxic) to the baby. Only use minimal oxygen, if the baby remains cyanosed, or a saturation monitor records saturation of O_2 less than 90% in air.
- An unsatisfactory response to resuscitation includes
    - A sustained slow heart rate, usually less than, or equal to, 60/minute or a progressive: Decrease in heart rate until cardiac arrest occurs
    - Episodes of cardiac arrest, with a progressively weaker response to chest: Compressions, positive pressure ventilation and medicines
    - A decreasing blood pressure, increasing acidosis, severe hypotonia with central: Cyanosis or intense pallor
    - Apnoea or weak, irregular and inefficient respiratory efforts
- Consider discontinuation of resuscitation if the unsatisfactory response to resuscitation persists for > 20 minutes and underlying conditions e.g. pneumothorax, diaphragmatic hernia has been excluded or > 10 minutes of unresponsive cardiac arrest (asystole) and/or > 20 minutes of unsustainable respiration.
- Newborns with a favourable response to resuscitation should be admitted to a neonatal high dependency or Intensive Care Unit, if available, for post resuscitation care.

Newborn Resuscitation - for SINGLE Health Worker - Be Prepared!



Reference taken from ETAT Manual (Rwanda) 2011

Newborn Resuscitation - for TWO trained Health Worker - Be Prepared!



Reference taken from ETAT Manual (Rwanda)

1.3. Infection Control

Assume that blood and body substances of all patients are potential sources of infection, regardless of diagnosis or presumed infectious status.

- Standard precautions include the following
  - Hand washing and antisepsis (hand hygiene)
  - Use of personal protective equipment (i.e. gloves) when handling blood and other body substances
  - Appropriate handling of patient care equipment and soiled linen
  - Prevention of needle stick/ sharp injuries
  - Environmental cleaning
  - Appropriate handling of waste

- Additional precautions
  - Additional precautions (transmission-based) are needed for diseases transmitted by air, droplets and contact
  - Precautions vary by disease
  - Patients with a viral illness should not be placed near patients with compromised immune system including neonates

- General rules of hospital hygiene
  - The following rules apply to ALL staff (including nurses and doctors) AND parents, child minders and visitors, or ANYBODY in contact with the baby.
    - ➔ Use only unit provided white coats, and leave outside when departing unit
    - ➔ Remove all jewelry (e.g. ring, bracelet, watches)
    - ➔ Roll long sleeves up to elbow
    - ➔ Disinfect stethoscope with alcohol wash before examining each baby
    - ➔ Make sure nails are cut short
    - ➔ Ensure ties are tucked into shirt, to avoid dangling onto patient

- Hand hygiene
  - YOU MUST WASH YOUR HANDS:
    - ➔ When entering the neonatal unit
    - ➔ Before clinical exam of the baby
    - ➔ After removing gloves / finishing examination
    - ➔ After contact with blood or other bodily fluids even if wearing gloves

- Before any aseptic procedure
- After touching any medical equipment including stethoscope
- After contact with the newborn environment (e.g. incubator, clothes)
- Before leaving the ward

1.4. Birth Injury

Definition: Birth injury is a neonatal condition caused by prolonged, obstructed labor and difficult instrumental deliveries. Birth injuries are avoided by cesarean section.

Types

- Injuries to the head
  - Caput: Edema, bruising of scalp. No treatment necessary. It resolves in a few days.
  - Chignon: Hematoma maximal on second day. May be associated with skull fracture. May calcify.
  - Cephalohematoma: Hematoma maximal on second day. May be associated with skull fracture. May calcify. Exacerbates jaundice. Resolves in days to months. Do not aspirate the cephalohematoma, even though it feels fluctuant.
  - Subgaleal (Subaponeuvrotic haemorrhage): Boggy appearance and pitting edema of scalp. Anterior displacement of the ears. May progess to hypovolemic shock. Transfusion of blood, fresh frozen plasma, Coagulation factors.
  - Skull fractures: Soft tissue edema and cephalohematoma. Fractures may be linear of depressed; later may be rarely require surgery
  - Forceps marks: Bruising and /or skin abrasion. Heals rapidly
  - Scalpel lacerations: Usually small. Depending on size and site. May need tapes to oppose edges, suturing or plastic surgical referral

- Injuries to the face
  - Facial palsy: Unilateral facial weakness on crying. Eye remains open. Resolves in 1-2 weeks.

- Asymmetric crying facies: in contrast to facial palsy, eye can close

- Injuries to the neck and shoulders
  - Fractured clavicle: oedema, bruising, crepitation at the site, decreased active movement of arm. Heals spontaneously
  - Brachial palsy: decreased shoulder abduction and external rotation, supination of wrist and finger extension (waiter's tip posture). To avoid contractures, perform passive range of motion ± splints. Surgical referral if not recovered by 6 weeks.
  - Klumpke (C8, T1 pasly): Claw hand deformity from weakness of hand muscles and wrist flexors. Horner syndrome in 30% (Triad of dilated pupil, ptosis). It is rare.

- Other injuries
  - Fracture of the humerus/femur: Deformity, reduced movement of limb, pain on movement. Orthopedic referral. Splint to reduce pain
  - Ruptured liver, spleen: Abdomen distension, mass, discoloration, tenderness, pallor and shock. Do abdominal ultrasound. Surgical management unless bleeding is contained.
  - Scrotum and labia majora trauma: Bruising, hematoma. It resolves.

1.5. Congenital Malformation

Causes

- Teratogenic: Environmental agents during pregnancy: – infections, drugs (particularly anticonvulsants), alcohol and radiation
- Sporadic or multifactorial: Many single birth defects occur as isolated cases with low recurrence risk. These may be polygenic or due to faults in developmental pathways
- Single-gene disorders: Possibly family history and previous pregnancy losses. Many multiple malformation syndromes follow autosomal recessive inheritance, but consider X-linked recessive disorders in males and new dominant mutations in isolated cases
- Chromosomal : Usually cause multiple congenital malformations and learning difficulties

Diagnosis

- History: Questions to ask
  - Parental age and health
  - Previous reproductive history
  - Family history of congenital anomalies
  - Consanguinity
  - Exposure to potential teratogens
  - Complications during pregnancy
  - Ultrasound screening and further investigations
  - Fetal movements

- Clinical signs: What to look for
  - Growth parameters: Intrauterine growth restriction, overgrowth, microcephaly
  - Movement and posture: Hypotonia, contractures, seizures
  - Minor anomalies: Features with little cosmetic or functional significance. The presence of two or more should prompt a search for major anomalies
  - Major birth defects: May represent an association (defects occurring together more often than by chance alone), e.g VACTERL (vertebral, anal atresia, cardiac, tracheo-esophageal fistula, renal and limb). May represent a sequence (one initial malformation resulting in the development of others, e.g. renal agenesis resulting in Potter sequence). May represent a syndrome (defects occurring together which have a common, specific etiology)
  - Dysmorphic features: Unusual or distinctive external appearance of the face, hands, feet, etc.

Investigations

- Clinical photographs: Provide a valuable record, especially if the phenotype changes with time
- Chromosome analysis: Order chromosome analysis (karyotype) in all babies with multiple malformations or dysmorphic features. Consider requesting FISH (fluorescence in situ hybridization) tests for specific disorders, such as Williams syndrome, if appropriate
- Biochemical analysis: Examples are calcium (for suspected Williams syndrome or DiGeorge syndrome) and creatine kinase (for suspected congenital muscular dystrophy)
- Skeletal survey: Suspected skeletal dysplasia, such as achondroplasia

- Echocardiography: Suspected congenital heart disease
- Renal ultrasound: If renal anomalies suspected, e.g. in some chromosomal disorders
- Brain CT/MRI/ultrasound scan: Suspected CNS malformation
- Molecular analysis: Specific disorders,e.g. cystic fibrosis, spinal muscular atrophytype 1

Management and counselling

- Management of the patient affected and genetic counselling are essential aspects of approaches to the dysmorphic patient. For example children with Down Syndrome have high incidence of hypothyroidism and children with achondroplasia have high incidence of cervicomedullary junction constriction.

1.6. Pain Management

Newborns experience pain: "If it would hurt you, it hurts them"

- Preterm infants have less ability to demonstrate symptoms of pain
- Repeated painful procedures have been proven to cause adverse, long term neurologic effects
- For minor procedures e.g. blood draw, IV placement, lumbar puncture
    - Give sugar water (1 teaspoon sugar in 20 ml clean water), breast feeding, comfort measures, holding, and swaddling
    - For major procedures (e.g. intubation, chest tube insertion)
    - Give *morphine* 0.02 mg/kg IV, may repeat x1.
    - May cause dose related respiratory depression.

- For palliative care
    - Give morphine 0.1 mg/kg IV, may repeat as needed.

Infants who have a devastating neurologic prognosis from congenital or acquired conditions require special consideration. The severity of the expected outcome must be explained to the family honestly and clearly.

1.7. Discharge and Follow up

Discharge criteria

The baby must meet the following criteria before being discharged

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

- Respiratory
  - There are no signs of respiratory distress
  - For premature or low birthweight babies, no apnoeas for 3 days without caffeine or *Aminophylline*

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

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

- Document the following parameters on discharge
  - Contact details for follow up
  - Weight

- Head circumference
- Final diagnosis
- Drugs prescribed
- Place of discharge (e.g. home)
- If baby died, cause of death

- Discharge Examination
  - All babies discharged must have had a full examination during their stay
  - Hips, testes and heart must be examined prior to discharge.
  - Weight and head circumference must be documented and plotted on growth charts.

Recommendations

- Babies with the following criteria should be followed up in 2 weeks at the outpatient clinic
  - Birthweight less than 2.0Kg
  - 32 weeks or less gestation at birth
  - Required alternative feeding methods > 2 weeks
  - Infants with congenital malformations or a syndrome e.g. Downs.
  - HIV positive mother/ are at risk of HIV infection
  - Required long term oxygen therapy
  - Required CPAP
  - Rhesus disease requiring an exchange transfusion
  - Severe birth asphyxia
  - Confirmed meningitis

2. Neonatal Infection

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

Causes/risk factors

- Maternal fever (temp >38°C) during labor or within 24 hours after delivery
- Maternal Urinary Tract Infection in current pregnancy or bacteruria
- Rupture of membranes > 18 hours before delivery
- Uterine tenderness or foul smelling amniotic fluid
- Obstetric diagnosis of chorioamnionitis
- Meconium Aspiration Syndrome
- Resuscitation at birth
- Invasive procedures
- Home delivery

Signs and symptoms

- Tachycardia, bradycardia, tachypnoea, lethargy, hypotonic, irritability– (always look at trends in the observation chart over last 24 hours)
- Abdominal distension (+/- skin + colour changes, e.g. shiny, darkened skin)
- Feeding problems –(e.g poor feeding, stopped feeding, increasing residuals, vomiting)
- Organomegaly
- Jaundice
- Signs of respiratory distress
- Petechiae haemorrghage, anaemia
- Diarrhoea
- Convulsions
- Temperature instability – including HYPOTHERMIA or HYPERTHERMIA
- Apnoeas, desaturations or Cyanosis
- Sclerema
- Bulging fontanelle

Complications

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

Investigations

- Blood, urine and cerebrospinal fluid cultures
- Blood count and differential count (WBC< 5000 or > 20000; Neutrophils > 70%)
- C-reactive protein
- Chest X-ray (if signs of respiratory distress)

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

Management

Non-pharmaceutical

- Admit to neonatal high dependency or Intensive Care Unit, if available
- Ensure adequate nutrition
  - Enteral feeding where possible, via oro/ nasogastric tube after ileus, obstruction, or other contraindications to enteral feeding have been excluded (e.g. shock)
  - If enteral feeding is not possible or is contra-indicated, commence IV fluids, e.g. neonatal maintenance solution (see chapter on neonatal nutrition)
- Insert naso/orogastric tube, open free drainage
- Oxygen to maintain saturations 90-95%

- CPAP if available and meets criteria (see separate criteria in unit)
- Monitor infants for the following:
  - Ensure a temperature of baby is 36.5-37.5oC
  - Blood glucose level greater than 2.6 mmol/L (45mg/dl)
  - Haematocrit of 40–45%
  - Vital signs within their normal physiological ranges (see appendix):
    - If sick/unstable – every hour
    - If stable and improving – every 3-4 hours

Pharmaceutical

- If sepsis is suspected, give *Ampicillin + Gentamicin*
- If meningitis is suspected, first-line therapy: *Ampicillin + Cefotaxime (preferred)* or *Ceftriaxone*
  - If the infant does not have adequate urine output, use a third generation *Cephalosporin* (*Cefotaxime or Ceftriaxone*) instead of *Gentamicin*

Table1: Antibiotic Dosing Chart for Newborns

Medication	Dose/Frequency			Comments
	Age < 14 days		Age> 14 days	
	≤ 35 weeks PMA* (if PMA not known use current weight ≤ 2.0 kg)	> 35 weeks PMA* (if PMA not known use current weight > 2.0 kg)		
Ampicillin or Cloxacillin	-If meningitis suspected :150 mg/kg IV every 12 hours -If meningitis ruled out: 50 mg/kg I every 12 hours		-50 mg/kg IV every 6 hours -100 mg/kg IV every 6 hours.	
Gentamicin	3 mg/kg IV once a day	5 mg/kg IV once a day	**> 1 month:** 7.5 mg/kg IV once a day	Use newborn dose through first month.
Cefotaxime	50 mg/kg IV every 12 hours	50 mg/kg IV every 8 hours	50 mg/ kg every 6 hours	Preferred over Ceftriaxone due to improved safety profile
Ceftriaxone	50 mg/kg IV every 12 hours for sepsis/ meningitis 50 mg/kg x1 IM for pus draining from eye For IM injection, dilute to 350 mg/mL. Max dose ½ mL = 175 mg			Contraindicated in setting of jaundice or within 48 hours of IV calcium administration
Metronidazole	7.5 mg/kg IV every 24 hours	7.5 mg/kg IV every 12 hours	7.5 mg/kg IV every 8 hours	Anaerobic coverage including treatment of necrotizing enterocolitis
Acyclovir	20 mg/kg IV every 12 hours	20 mg/kg IV every 8 hours		Treatment of herpes simplex infection: 14 days if localized, 21 days if disseminated
	20mg/kg PO every 6 hours if IV acyclovir not available			

Table 2: Duration of antibiotic therapy

Antibiotic Coverage Summary by Condition for infants < 1 month of age					
Condition	**Clinical Condition**	**Laboratory Results**	**Treatment Recommendation**	**Duration of Therapy**	**Comments**
Sepsis Evaluation: negative	Normal vital signs, well appearing	Normal WBC, differential, CRP, CXR	Ampicillin Gentamicin	48 hours	
Sepsis/ Pneumonia	Abnormal vital signs, ill appearing	Abnormal WBC, differential, CRP, CXR	Ampicillin Gentamicin	7 days	
Sepsis/ Pneumonia: Not improving	Abnormal vital signs, ill appearing, poor response to antibiotics after 48 hours	Abnormal WBC, differential, CRP, CXR	Ampicillin Add Cephalosporin Stop gentamicin	7 to 14 days	Cefotaxime preferred over ceftriaxone
Meningitis	Abnormal vital signs, ill appearing, abnormal neurological exam	Abnormal WBC, differential, CRP, CXR, CSF	Ampicillin Cephalosporin	14 days if gram positive 21 days if gram negative	Cefotaxime preferred over ceftriaxone *(see 3.7- meningitis protocol)*
Urinary Tract Infection	Abnormal vital signs, ill appearing	Urinalysis concerning for urinary tract infection	Ampicillin Gentamicin	7 days	Generally considered in infants ^{3} 7 days

Inotropic support in septic shock

- If correct Blood Pressure cuff available, mean Blood Pressure should not be less than the gestational age (weeks) of the infant plus 5–10 mmHg. (e.g. a 34 week gestation infant should have a mean Blood Pressure of 34mmHg)
- If Blood Pressure is < 60/40 mmHg in term infant, < 50/35 mmHg in pre-term infant
    - Give *Dopamine, IV,* 5–15 mcg/kg/minute as a continuous infusion
    - Continue with *Dopamine* as long as it is necessary to maintain the Blood Pressure

Recommendation

- Refer all patients to NICU with
    - septicaemia with complications
    - Septicaemia not responding to treatment

- *Cefotaxime*: To replace *Gentamicin* in the treatment of sepsis in the setting of renal dysfunction, or to treat presumed meningitis due to poor CNS penetration of gentamicin, preferred to Ceftriaxone, especially in setting of hyperbilirubinemia
- *Ceftriaxone*: Do not use in setting of hyperbilirubinemia because it displaces bilirubin from albumin, do not administer within 48 hours of IV calcium in infants < 28 days of age due to risk of lethal precipitation

2.1. Neonatal Meningitis (Bacterial)

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

Causes/Risk factors

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

Signs and symptoms

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

Complications

- Cerebral oedema
- Convulsions
- Raised intracranial pressure
- Hydrocephalus
- Vasculitis, with haemorrhage
- Subdural effusions
- Ventriculitis
- Brain abscess
- Ischaemia and infarctions of the brain
- Inappropriate antidiuretic hormone secretion (SIADH)
- Neurological sequelae
    - Blindness
    - Deafness
    - Mental retardation

Investigations

- Lumbar puncture
    - The CSF appears cloudy
    - Protein concentration is increased
    - Leucocyte count is increased with a predominance of polymorphonuclear leucocytes
    - Glucose concentration is low, < 2/3 of blood glucose
    - Gram stain, microscopy, culture and sensitivity of CSF.

- Blood cultures**:** For microscopy, culture and sensitivity

Non-pharmaceutical

- Admit to high dependency or Intensive Care Unit, if available
- Maintain infant temperature between 36.5 – 37.5: C
- Monitor neurological status including
  - Pupil reaction to light and size of pupils
  - Neurological exam (reflexes and tone)
  - Note any seizures
  - Head circumference (once per day during the acute illness, once per week when stable)
- Vital signs
- Blood glucose
- Haematocrit
- Fluid balance (hydration)
- Blood gases (if available)
- Ensure adequate nutrition
  - Enteral feeding where possible, use nasogastric tube, if necessary
  - If enteral feeding is not possible, IV fluids, e.g. neonatal maintenance solution (see chapter on neonatal nutrition and fluid management)
  - Limit total daily fluid intake, IV and oral, do not exceed the daily requirements for age to prevent fluid overload – monitor daily weight

Pharmaceutical

Note: *Do not delay Antibiotic Treatment: Start antibiotics immediately after lumbar puncture. If lumbar puncture has to be delayed, start the antibiotics*

- Empiric antibiotics
  - *Ampicillin* and *Cefotaxime* (For dosages, Refer to *Table1*: Antibiotic Dosing Chart for Newborns)
  - Review the empiric antibiotics prescribed, based on results of blood and CSF cultures or when the child does not improve within 72–96 hours
  - If unconfirmed but meningitis is suspected, continue empiric antibiotics for at least 14 days and review clinical response

- Antibiotic choice based on culture result
  - → Group B β-haemolytic streptococci
    - *Cefotaxime* for 14 days (For dosages, Refer to *Table1*: Antibiotic Dosing Chart for Newborns)
  - → Listeria monocytogenes
    - *Ampicillin* for 21 days and *Gentamicin* for only the first 7 days (For dosages, Refer to *Table1:* Antibiotic Dosing Chart for Newborns)
  - → Gram negative bacteria
    - *Cefotaxime* for 21 days (For dosages, Refer to *Table1*: Antibiotic Dosing Chart for Newborns)
- For patients with no response to empiric antibiotics after 5-7 days and a negative CSF culture, or patients intolerant of ampicillin and cephalosporins
  - → Consider anaerobic bacteria
    - *Metronidazole* (For dosages, Refer to *Table1*: Antibiotic Dosing Chart for Newborns)
  - → Methicillin resistant staphylococci, and treat with
    - *Vancomycin, IV*, 15 mg/kg loading dose followed by 10 mg/kg for 14 days;
    - ≤ 7 days 10 mg/kg, 12 hourly
    - 7 days 10 mg/kg, 8 hourly
  - → Sensitive staphylococci, and treat with
    - *Cloxacillin, IV,* 50–100 mg/kg/dose for 14 days
      - o ≤ 7 days 50–100 mg/kg, 12 hourly
      - o 7 days 50–100 mg/kg, 6 hourly
  - → Pseudomonas aeruginosa, and treat with
    - *Ceftazidime*, IV, 30 mg/kg/dose for 14-21 days
      - o ≤ 7 days 30 mg/kg/dose, 12 hourly
      - o 7 days 30 mg/kg/dose, 8 hourly
  - → For fever, give
    - *Paracetamol,* orally, 10 mg/kg/dose, 6 hourly when needed until fever subsides

- Convulsions, See Neonatal Seizures
- Raised intracranial pressure or cerebral oedema
  - ➔ Avoid fluid overload (monitor daily weight)
  - ➔ Limit total daily intake, IV and oral
  - ➔ Do not exceed the maintenance requirements for age

Recommendation

- Refer neonates with meningitis not responding to adequate treatment, with meningitis

2.2. Congenital Infection

Definition: Infections acquired in utero. Maternal infection can be asymptomatic.

- Route of infection: Transplacental
- Time of presentation**:** At birth or months/years later

Causes

- Viral: CMV, Rubella, Parvovirus, VZV, HIV
- Others: Toxoplasmose, syphilis, Malaria (rare), TB

Clincal features

- Intracerebral calcification
- Hydrocephalus
- Microcephalus
- Cataracts
- Microphtalmia
- Retinitis
- Deafness
- Heart defects (cardiomegaly, PDA)
- Pneumonitis
- Splenomegaly
- Hepatomegaly, Jaundice, Hepatitis
- Anemia, Neutropenia, thrombocytopenia
- Bone abnormalities
- Rash
- Intrauterine growth restriction

2.3. Newborn with HIV positive mothers

- Transmission of HIV from mother to baby
  - The transmission of HIV from mother to newborn must be prevented before, during and after delivery
  - Transmission occurs transplacentally, during passage through birth canal or during breastfeeding
  - During pregnancy
    - → Mothers should be screened for HIV
    - → All HIV+ve, mothers should receive post-test counseling and take ARVs according to national protocols
    - → Options regarding feeding of newborn should also be discussed

- During delivery
  - ARV prophylaxis: Refer to national document on Prevention of Mother to Child Transmission (PMTCT)
  - During expulsion, avoid episiotomy, instrumental delivery and do not "milk" the cord

- During post-natal period
  - ARV prophylaxis: Refer to national document on PMTCT

2.4. Newborn born of mothers with syphilis

- Mother positive syphilis serology during pregnancy and
  - Received treatment (2,4 million IU of *Benzathine-Penicillin* per week during 3 weeks and the treatment began 30 days or more before delivery). No additional measures are required
  - Not treated for syphilis or insufficiently treated, or if the treatment is not clear and the newborn does not present any clinical signs of syphilis, give the newborn one dose of 50.000 IU/kg of *IM Benzathine-Penicillin*

- Newborn with signs or symptoms of syphilis

Early signs include:
- Bullous rash (especially of palms and soles)
- Anaemia
- Hepatosplenomegaly
- Osteitis (presenting as pseudo-paralysis of limb)

- Coryza
- Jaundice
  - ➔ Hospitalize him for a treatment of 50000UI/kg/ per dose of IM or IV *Penicillin* 2 times a day for 10 days
  - ➔ Follow up at 4 weeks for growth and signs of congenital syphilis

2.5. Newborn born of mother with Hepatitis B

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

2.6. Newborn born of mothers with Tuberculosis

Do not give BCG Vaccination to the newborn for the following situation:

- Mother with active pulmonary tuberculosis who received at least 2 months of treatment before birth
- Mother is diagnosed with tuberculosis after delivery, start the baby on tuberculosis prophylaxis treatment
  - 5mg/kg oral *Isoniazide (INH)* once a day for 6 weeks
  - Re-evaluate the newborn at the age of 6 weeks (weight gain, PPD, chest X-ray if possible)
  - If there are no signs of disease progression (no symptoms or clinical signs), complete 6 months of INH prophylaxis and DO NOT GIVE BCG until 2 weeks after ending treatment.
  - If BCG was given, repeat BCG 2 weeks after end of INH prophylaxis.

- Signs of TB in the newborn
  - Start full anti-tuberculosis treatment according to national guidelines.

2.7. Newborns with minor infection

- Cutaneous infections: pustules and vesicles
  - Clean lesion with antiseptic.
  - Apply *Violet gentian 0.5%* solution or if not available, eosin 4 times a day.
  - If the pustules are numerous and there are no signs of generalized infection (no danger signs), start *Cloxacillin 25 mg*/kg/dose 2 times a day orally for 5 days.
  - If there are danger signs or if the pustules are very important, hospitalize the newborn and treat with antibiotics against staphylococcus aureus.

- Candidiasis (buttocks)
  - Nappy candidiasis will appear as a red nappy rash often involving the skin creases and may have satellite lesions.
  - Apply *Gentian violet 0,5% or 2%* aqueous eosin, let dry, and then apply *Nystatin cream* 2 times a day for 14 days minimum. Continue antiseptics until lesions are dry.

- Thrush (oral candidiasis)
  - Apply *Gentian violet 0,5%* or *Nystatin oral* solution in the mouth 4 times a day. Continue treatment for 14 days minimum.
  - Apply *Gentian Violet 0,5%* or *Nystatin cream* after each feed on the mother's breasts until the end of the treatment

- Neonatal conjunctivitis
  - Characterized by redness of conjunctivas or purulent eye secretions in the newborn.
  - The eyes must be washed with physiologic serum or boiled water (boiled, then let to cool down) with a sterile gauze.
  - Apply antibiotic ointment (for example *Tetracycline 1%* eye ointment) 4 times a day until resolved.
  - If Gonococcal conjunctivitis is suspected (conjunctivitis appearing at birth or very shortly thereafter) also give a single dose of *IM Ceftriaxone 50 mg*/kg in addition to local treatment.
  - If a Chlamydial conjunctivitis is suspected, give *Erythromycin 30 mg*/kg/day orally, twice a day for 14 days in addition to local treatment.

3. Neonatal Complications

3.1. Neonatal Hypoglycemia

Definition: Neonatal hypoglycemia is low blood sugar (glucose) in the first few days after birth

- Moderate Hypoglycemia: Glucose is 1.4 – 2.5 mmol/L (25 - 45 mg/dL)
- Severe Hypoglycemia: Glucose is < 1.4 mmol/L (25 mg/dL)

Causes/Risk factors

- Prematurity/Low Birth Weight /large baby
- Infant of diabetic mother
- Sepsis
- Postmaturity
- Hypothermia/ hyperthermia
- Feeding difficulties
- Respiratory distress
- Birth asphyxia
- Rhesus iso-immunisation
- Hyperinsulinism

Signs and symptoms

- Lethargy
- Poor feeding
- Hypotonia
- Respiratory distress
- Apnoea
- Jitteriness
- Convulsions
- Irritability
- Metabolic acidosis
- Coma
- Cardiac failure

Investigations

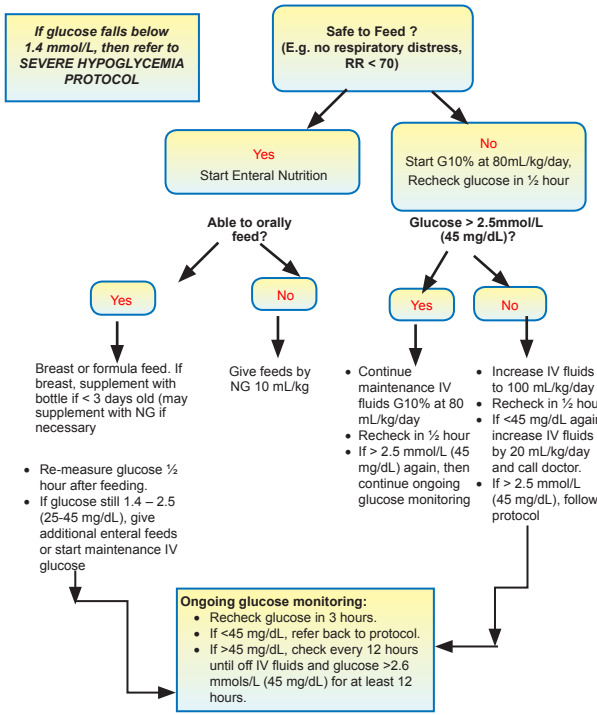
- Blood tests for monitoring blood glucose (heel prick) < 2.6 mmol/L
- Newborn screening for metabolic disorders

Management

Non-pharmaceutical

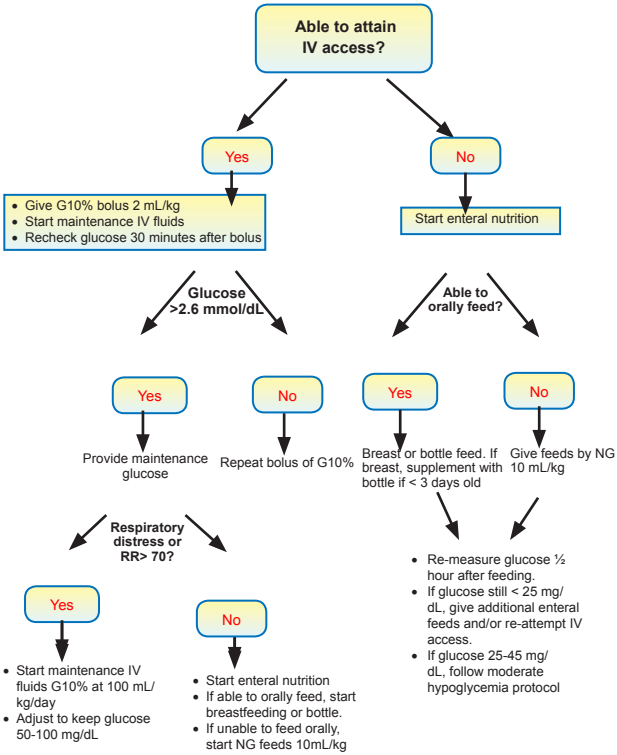
- Determine and treat the underlying cause
- Enteral feeding, oral or via oro/nasogastric tube, after exclusion of vomiting, ileus or obstruction

MODERATE HYPOGLYCEMIA: Glucose 1.4- 2.5 mmols/L (25-45mg/dL)



Source: Neonatal protocols Rwanda. 2011

Severe Hypoglycemia Protocol: Glucose < 1.4 mmol/L (25 mg/dL)



Note:

- *Glucose conversion: 1mmol/L = 18 mg/dL*
- *If unable to measure blood sugar for high risk but asymptomatic newborn, follow moderate hypoglycemia protocol*
  - *High risk: Required resuscitation, concern for sepsis, premature (<35 weeks) or LBW (<2kg), poor feeding*
  - *If unable to measure blood sugar for infant with symptoms of hypoglycemia, follow severe hypoglycemia protocol*
  - *Symptoms of hypoglycemia: Jittery, lethargic, seizures*
    If breastmilk not available, use artificial milk. If neither breast nor artificial milk is available, G10% IV fluid may be given enterally

3.2. Hypocalcaemia

Definition: Hypocalcaemia is when blood level of calcium are less than 80mg/L (2mmol/L)

Causes

- Maternal factors
  - Diabetes
  - Toxaemia
  - Severe dietary calcium deficiency
- Intrapartum factors
  - Asphyxia
  - Prematurity
  - Maternal magnesium administration
- Postnatal factors
  - Hypoxia
  - Shock
  - Asphyxia
  - Poor intake
  - Sepsis
  - Exchange transfusion
  - Respiratory metabolic acidosis

Note: *Neonatal hypocalcaemia usually resolves in 2 to 3 days*

Three days after birth, other causes may be:
- High phosphate diet
- Mg deficiency
- Renal disease
- Hypoparathyroidism

Diagnosis

- Serum calcium < 2.2 mmol/L, or
- Ionised calcium < 1.2 mmol, equivalent to <3.8 mEq/L, or
- Ionized calcium < 4.0 mg/dL

Management

- Symptomatic hypocalcaemia
  - *Calcium gluconate 10%*, IV/oral, 1–2 mL/kg 6–8 hourly, 1 mL of calcium gluconate 10% = 100 mg calcium gluconate = 9 mg elemental calcium = 0.45 mEq/mL

- Correct hypomagnesaemia, acute hypocalcaemia with seizures
  - ➔ *Calcium gluconate 10%, IV*, 1–1.5 mL/kg over 5–10 minutes, administer slowly at a rate of 1 mL/minute. Rapid infusion causes bradycardia/arrthythmia
  - ➔ Repeat in 15 minutes
  - ➔ Electrocardiographic monitoring is advised
  - ➔ Monitor the heart rate

Recommendation

- Refer child with persisting or recurrent unexplained hypocalcaemia to a specialist consultation

3.3. Respiratory distress syndrome

Definition: Newborn experiencing difficulty with breathing

Respiratory distress syndrome (hyaline membrane disease / surfactant deficiency is a specific pathology of premature infants which is due to surfactant deficiency in the lungs, causing alveolar collapse, poor gas exchange and respiratory distress.

Causes

- Pulmonary
- Extra pulmonary

Pulmonary Causes	Extrapulmonary Causes
- Hyaline membrane disease (surfactant deficiency) - Meconium aspiration - Pneumonia - Pneumothorax - Wet lung syndrome (Transient Tachypnea of the newborn (TTN) - Pulmonary haemorrhage - Hypoplastic lungs - Diaphragmatic hernia	- Sepsis - Cardiac failure irrespective of cause - Pulmonary hypertension - Hypothermia/hyperthermia - Hypoglycaemia - Anaemia - Polycythaemia - Hypovolaemic shock - Perinatal hypoxia

Signs of breathing problems

- The baby's respiratory rate is more than 60 breaths per minute
- The baby's respiratory rate is less than 30 breaths per minute
- The baby has central cyanosis (blue tongue and lips)
- The baby has chest indrawing
- The baby is grunting on expiration
- The baby has apnoea (spontaneous stopping of breathing for more than 20 seconds)

Investigations

- Chest X-ray
- Oxygen saturations measure (aim saturations at 90-95% in infants if using oxygen)
- FBC, CRP, Hemoculture if infection is suspected
- Echocardiography (to exclude cardiac causes of respiratory distress)
- Blood gas (if available)

Management

General Measures

- **Immediately resuscitate the baby using a bag and mask if:**
  - **The baby is not breathing at all, even when stimulated**
  - **Is gasping**
  - **Or has a respiratory rate of less than 20 cycles/minute**

- Establish the classification of breathing problem

Respiratory Rate (breaths per minute)	Grunting or Chest Indrawing	Classification
More than 90	Present	Severe
More than 90	Absent	Moderate
60 to 90	Present	Moderate
60 to 90	Absent	Mild

- Nurse the Baby in a neutral thermal environment (incubator or infant crib with overhead heater) and aim for the baby's temperature to be 36.5-37.4C. Hypothermia will worsen respiratory distress

- Admit to neonatal high care/intensive care facility, if available but stabilize infant first
- Monitor respiratory rate, oxygen saturations, pulse rate, and blood pressure (if available).
- Maintain saturations of haemoglobin at 90–95%.
- Monitor the concentration or flow of oxygen being provided (if any)
- Monitor for Apnoea
  - ➔ Stimulate the baby to breathe by rubbing the baby's back for 10 seconds
  - ➔ If the baby does not begin to breathe immediately, resuscitate the baby using a bag and mask
- Measure blood glucose and treat if less than 2.6mmol/l (45mg/dl)
- If the baby has breathing >60/min and is cyanosed (even with oxygen), and has **NO** grunting or indrawing, suspect a congenital heart abnormality

Specific Management

- Severe breathing difficulty
  - ➔ If saturations are less than 90%, give oxygen if available to maintain saturations 90-95%
    - Give CPAP if available and meets criteria (see under CPAP criteria)
    - Insert a gastric tube to empty the stomach of air and secretions
    - Commence IV fluids
    - Treat for sepsis
    - Monitor and record the baby's respiratory rate, presence of chest indrawing or grunting on expiration, and episodes of apnoea every three hours until the baby no longer requires oxygen and then for an additional 24 hours
    - When the baby begins to show signs of improvement: give expressed breast milk by gastric tube
    - When oxygen is no longer needed, allow the baby to begin breastfeeding
  - ➔ If the baby cannot be breastfed,
    - Give expressed breast milk using an alternative feeding method

- If the baby's breathing difficulty worsens or the baby has central cyanosis
  - Give oxygen at a high flow rate
- If breathing difficulty is so severe that the baby has central cyanosis even in 100% oxygen,
  - Organize transfer and urgently refer the baby to a tertiary hospital or specialized centre capable of assisted ventilation, if possible.
  - Observe the baby for 24 hours after discontinuing antibiotics.
- If the baby's tongue and lips have remained pink without oxygen for at least two days, the baby has no difficulty breathing and is feeding well, and there are no other problems requiring hospitalization – discharge the baby

- Moderate breathing difficulty
  - Give oxygen if saturations <90%.
  - Give CPAP if available and meets criteria (see under CPAP criteria)
  - Establish an IV line and give only IV fluid at maintenance volume according to the baby's age for the first 12 hours
  - Monitor and record the baby's respiratory rate, presence of chest indrawing or grunting on expiration, and episodes of apnoea every three hours until the baby no longer requires oxygen and then for an additional 24 hours
  - If the baby's breathing difficulty does not improve or worsens after two hours, manage for severe breathing difficulty
  - Monitor the baby's response to oxygen
  - When the baby begins to show signs of improvement give expressed breast milk by gastric tube
  - When oxygen is no longer needed, allow the baby to begin breastfeeding
  - If the baby cannot be breastfed, give expressed breast milk using an alternative feeding method

- Mild breathing difficulty
  - Give expressed breast milk by gastric tube or alternative method e.g. cup feed

- Monitor and record the baby's respiratory rate, presence of chest indrawing or grunting on expiration, and episodes of apnoea every three hours until the baby no longer requires oxygen and then for an additional 24 hours
- Only provide oxygen if saturations are less than 90% and maintain saturations 90-95%
- Monitor the baby's response to oxygen
- When oxygen is no longer needed, allow the baby to begin breastfeeding
- If the baby cannot be breastfed, continue giving expressed breast milk using an alternative feeding method
- If the baby does NOT have the typical pattern of RDS,
  - look for signs of sepsis and treat if found
- If the baby's tongue and lips have remained pink without oxygen for at least one day, the baby has no difficulty breathing and is feeding well, and there are no other problems requiring hospitalization - discharge the baby

- Feeding and fluids with breathing difficulty
  - Refer to chapter 6 for feeding a sick term or preterm baby

Other specific causes of respiratory distress

- Anaemia
  - Hct < 40 % and Hb <13 g/dL
  - Give red cells, packed, IV, 10mL/kg over 1–2 hours
- Polycythaemia
  - Treat with isovolaemic dilutional exchange transfusion using sodium chloride 0.9%
  - If the venous haematocrit is Hct > 65%: Hb >22 g/dL and the baby is symptomatic.
    - Formula taking
    - Desired Hct = 50
    - Volume to be exchanged (mL) = [Baby's Hct – desired Hct (i.e. 50) x body mass (kg)] x 90 ÷ Baby's Hct
- Respiratory Distress Syndrome (Hyaline membrane disease / Surfactant deficiency)
  - Refer to specific management of breathing difficulty according to classification

- Ensure baby is maintained at correct temperature (36.5-37.4C)
- If baby is stable, obtain CXR and look for:
  - Air bronchiograms
  - Hyperexpanded chest
  - Ground glass appearance of lung fields
  - Treat baby for presumed sepsis with Ampicillin and Gentamicin (See chapter on sepsis management)
  - Co-manage other problems associated with prematurity
  - Baby may likely require CPAP see the following
  - If Infection, bronchopneumonia, is present or suspected
    - Give antibiotics based on antibiogram and/ or blood culture results

- Breathing difficulty due to congenital heart abnormality
  - The diagnosis of a heart abnormality is made by exclusion of other diagnoses or by echo when baby is stable (if an expert and machine is available)
  - Give oxygen at a high flow rate. In cyanotic heart disease, there will be no response to maximum oxygen
  - Give expressed breast milk by gastric tube
  - If the baby cannot tolerate feeding, establish an IV line and give IV fluid at maintenance volume according to the baby's age
  - Organize transfer and refer the baby to a tertiary hospital or specialized centre for further evaluation, if possible

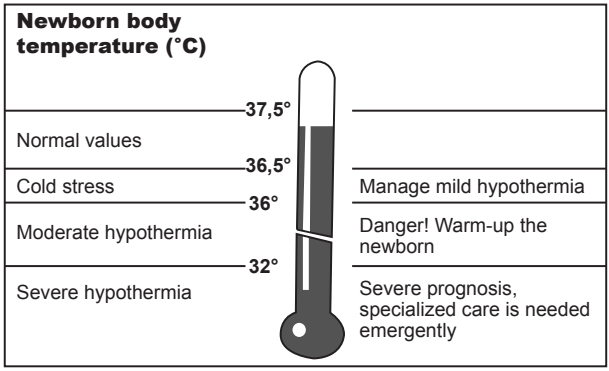
- Continuous positive airways pressure (CPAP)
  - Newborn babies with breathing difficulty, in particular Low Birth Weight and premature babies with Respiratory Distress Syndrome may require CPAP
  - Premature lungs have surfactant deficiency. Surfactant keeps the airways (alveoli) open to allow oxygen from the air to exchange across the alveolar membrane and the effective removal of waste CO2. Surfactant production is impaired further with hypothermia, sepsis and other underlying medical conditions

- Too much oxygen is very toxic to the developing brain, eyes, lungs and other organs. Many studies have shown that oxygen therapy in Low Birth Weight, premature and also asphyxiated babies may result in
  - Brain damage (and poor neurodevelopmental outcome)
  - Blindness (retinopathy of prematurity)
  - Chronic lung disease
  - Providing a continuous pressure with CPAP allows the baby to receive PEEP (Peak End Expiratory Pressure). This is back pressure that as the baby expires, will allow the surfactant deficient lungs to remain open and prevent the airways collapsing. By keeping the airways open, the amount of supplemental oxygen can be reduced and often not given at all.
    - o *CPAP Criteria (*Follow the diagram below to assess whether the baby may benefit from CPAP)
    - o Monitoring as per chart above should be recorded on the provided CPAP sheets
    - o Continue to check
      - ◊ Baby's temperature
      - ◊ Ensure nasal prongs are firmly in the nostrils
      - ◊ Nasal Trauma
  - Sudden deterioration on CPAP maybe due to pneumothorax or machine error (check if circuit is ok and that there are no leaks or detachments)
  - Check that the water level in the humidifier is up to the line and check if bubble chamber's overflow compartment needs emptying.

- Every baby with CPAP should have a CPAP data sheet completed. Please complete in as much detail as possible. If a baby needs to stop CPAP, please document the reason why (e.g. machine required for a sicker baby, baby not tolerating CPAP, complications etc)
- If you have stopped CPAP and you feel the baby meets the criteria later, CPAP maybe started again, please record a new data sheet
- Ensure baby's temperature is within normal range as this will greatly affect outcome

3.4. Hypothermia

Definition: Temperature less than 36.5°



Risk factors

- Low Birth Weight and/or premature newborns
- Septic newborns
- Newborn with asphyxia at birth
- All newborns who do not receive heat loss prevention measures

Signs and symptoms

- Lethargy and Refusal to breastfeed
- Dyspnea and Apnea
- Cyanosis and Pallor
- Shock and Sclerema
- Hemorrhage and Hypoglycemia

Complications

- Increase in oxygen consumption
- Increase in glucose utilization and decrease of glycogen reserves
- Increase in brown fat metabolism
- Increase in metabolism leads to growth impairment, lethargy, hypotonia and feeding difficulties
- Decrease of surfactant production which can lead to respiratory distress
- Difficulties with extra-uterine adaptation because of hypoxia
- Thermal shock which can lead to death

Management

- Immediately after birth or arrival to hospital
  - Dry infant and keep under warming light
  - Obtain temperature within first hour of life
  - Normal temperature range 36.5-37.5°C

3.5. Neonatal Jaundice

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

Types

- Physiological Jaundice
  - Does not appear before 24 hours after birth
  - Rarely lasts more than 10 days in a full term infant and 14 days in a pre-term infant
  - Only the unconjugated bilirubin fraction is increased
  - Total peak serum bilirubin concentration is usually below 275 micromol/L in a term infant
  - Total bilirubin concentration does not rise by more than 85 micromol/L/24 hours
  - The baby thrives and shows no signs of illness or anaemia treatment is unnecessary

- Pathological Jaundice
  - Appears within the first 24 hours of birth but may also appear at any other time after birth
  - Persists for longer than 10 days in a full term infant or 14 days in a pre-term infant
  - The unconjugated and/or conjugated fractions of bilirubin are increased
  - The conjugated bilirubin level exceeds 10% of the total bilirubin value, or the conjugated bilirubin fraction is 30 micromol/L or more
  - Total bilirubin concentration rises by more than 85 micromol/L/24 hours
  - The total serum bilirubin level is above physiological level
  - There are signs and symptoms of illness in the baby
  - Stools are pale in conjugated hyperbilirubinaemia (obstructive jaundice)

Causes of Unconjugated hyperbilirubinaemia

Excessive haemolysis	Defective conjugation
- ABO incompatability - Rhesus disease - Enclosed haemorrhages - Polycythaemia - Infections - Spherocytosis - G6PD deficiency	- Prematurity Infection - Hypoxia - Hypoglycaemia - Hypothyroidism - Breast milk jaundice

Signs and symptoms

- Yellow color in the eyes and on skin on physical examination
- Changes in muscle tone, seizures, or altered cry characteristics
- Hepatosplenomegaly
- Petechiae
- Hemolytic anemia
- Signs of Sepsis

Investigations

- Measurement of Bilirubin level
- Blood type and Rh determination in mother and infant
- Direct antiglobulin test (DAT) in the infant (direct Coombs test)
- Hemoglobin and hematocrit values
- Ultrasonography

Management

Non-pharmaceutical

- Treat the underlying cause
  - ➔ Monitor the infant's body temperature
  - ➔ Maintain adequate nutrition and hydration
  - ➔ Correct factors known to increase the risk of brain damage in babies with jaundice e.g.
    - Hypoxia
    - Prematurity
    - Hypoglycaemia
    - Hypothermia
    - Acidosis
    - Hypoalbuminaemia and haemolysis

Guidelines for Initiating Phototherapy

Body mass	Unconjugated bilirubin (micromol/L)
1 000 g or less	85–100
> 1 000–1 500 g	> 100–150
> 1 500–2 000 g	> 150–200
> 2 000–2 500 g	> 200–250
> 2 500–3 000 g	> 250–275
> 3 000 g with jaundice caused by haemolysis or an identifiable serious disease process, e.g. sepsis)	> 275
> 3 000g without any identifiable cause for the jaundice	300
After exchange transfusion irrespective of body mass and unconjugated bilirubin level	

- Determine phototherapy when the unconjugated bilirubin level is lower than the recommended phototherapy initiating level, and the cause of the jaundice has been
- Determine and adequately address the skin colour of a baby receiving phototherapy does not reflect the degree of jaundice (bilirubin blood level) or the efficacy of the phototherapy
- Undress the baby and cover the eyes with gauze pad
- Position the phototherapy unit (fluorescent light bulbs of 400-500nm wavelength) not higher than 45 cm above the baby, a rebound increase in bilirubin may follow termination of phototherapy
- Monitor bilirubin levels ± 6 hourly after phototherapy has been stopped
- Exchange transfusion is indicated when the risk of bilirubin encephalopathy andkernicterus is significant

Diagnosis

At birth	History of Rh incompatibility Cord unconjugated bilirubin level > 85 micromol/L Cord haemoglobin level 10 g/dL or lower	
Within 24 hours	A rise in the serum unconjugated biliruin level exceeding 20 micromol/L/hour despite phototherapy	
After 24 hours	**Body mass**	**Unconjugated bilirubin** (micromol/L)
	1 000 g or less	200
	>1 000–1 500 g	250
	>1 500–2 500 g	300
	>2 500–3 000 g	340
	> 3 000 g with jaundice caused by haemolysis or an indentifiable serious disease process, e.g. sepsis	340
	> 3 000 g without any identifiable cause of jaundice	425

Pharmaceutical management

- As soon as the diagnosis is confirmed
  - ➔ Give Gammaglobulin, IV, 500 mg/kg over 1 hour, for ABO incompatibility, repeat once after 6–8 hours
  - ➔ Mothers of babies with Rh incompatibility as soon as possible after birth but within 72 hours of birth
  - ➔ Give anti D immunoglobulin, IM, 100 mcg

3.6. Conjugated Hyperbilirubinaemia

Causes

- Hepatocellular disease bile duct obstruction
- Hepatitis
- Total parenteral nutrition
- Syphilis
- Other congenital infections
- Galactosaemia
- Bile duct hypoplasia/atresia
- Choledochal cyst
- Cystic fibrosis

Signs and symptoms

- Cholestasis usually present in the second week of life or later
- The baby has a green yellow skin discolouration, dark bile stained urine and pale alcoholic stool
- Hepatomegaly is commonly present
- Infant often fails to thrive
- Neonatal hepatitis
- Prolonged total parenteral nutrition and biliary atresia or hypoplasia

Management

Non -pharmaceutical

- Treat the underlying cause
- Dietary modifications to counteract the malabsorption of fat and fat soluble vitamins (A,D,K) that may occur in patients with a prolonged conjugated hyperbilirubinaemia
- Avoid lactose containing feeds, i.e. breast milk and lactose containing formula, when galactosaemia is suspected

Pharmaceutical

- Fat soluble vitamins A, D, E and K

Surgical

- Conditions amenable to surgery e.g. biliary artresia
- Hepatoporto-enterostomy for biliary atresia done before 60 days of age for optimal outcome

3.7. Prolonged Neonatal Jaundice

Definition: Jaundice for more than 10 days in a term infant and 14 days in a preterm infant (Static or rising bilirubin).

Causes

- Breast milk Jaundice
- Hypothyroidism
- Hepatitis
- Galactosaemia, and
- Infections, e.g. UTI's

Note:

- *Breast milk jaundice may be confirmed by substituting breastfeeding with formula feeds for 24–48 hours*
- *The bilirubin level will always drop to a lower level and increase again when breastfeeding is resumed*
- *Breast milk jaundice is an unconjugated hyperbilirubinaemia and the infant is always well and thriving*

Investigations

- Hepatitis may be confirmed by abnormal liver function tests, i.e. raised values of:
  - AST
  - ALT
  - Alkaline phosphatase
  - Bilirubin, mainly the conjugated fraction
  - γ-GT

Management

Non - pharmaceutical

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

Pharmaceutical

- Fat soluble vitamins, A, D and K

Recommendations

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

3.8. Perinatal Hypoxia/Hypoxic-Ischemic Encephalopathy

Definition: Hypoxic-ischemic encephalopathy is characterized by clinical and laboratory evidence of acute or subacute brain injury due to asphyxia (i.e, hypoxia, Acidosis). Asphyxia is not a diagnosis derived from a poor score alone. It is the result of compromised gas exchange resulting in cardio-respiratory depression.

Causes

- Inadequate pre-, peri- intra- and/or post-partum oxygen delivery and blood flow ischaemia

Risk factors

- Failure of gas exchange across the placenta
- Interruption of umbilical blood flow
- Inadequate maternal placental perfusion, maternal hypotension/ hypertension
- Compromised fetus (anemia, IUGR)
- Failure of cardio respiratory adaptation at birth
- Decreased blood flow from the placenta to the fetus
- Impaired gas exchange across placenta or fetal tissues
- Increased fetal oxygen requirement

Signs and symptoms

Characteristic on stage of disease

Modified Sarnat Stage *				
STAGE		**Stage l**	**Stage 2**	**Stage 3**
Level of Consciousness		Hyperalert	Lethargic or obtunded	Stupor or Coma
Activity		Normal	Decreased	Absent
Neuromuscular Control				
	Muscle Tone	Normal	Mi1d hypotonia	Flaccid
	Posture	Mild distal flexion	Strong distal flexion	Intermittent decerebration (extension)
	Stretch Reflexes	Overactive	Overactive	Decreased or absent
Complex/Primitive Reflexes				
	Suck	Weak	Weak or absent	Absent
	Moro (startle)	Strong; low threshold	weak; incomp1ete; high threshold	Absent
	Tonic Neck	Slight	Strong	Absent
Autonomic Function				
	Pupils	Mydriasis	Miosis	Variable; often unequal; poor light reflex; fixed; dilated
	Heart Rate	Tachycardia	Bradycardia	Variable
Seizures		None	Common; focal or mu1tifocal	Uncommon (excluding decerebration)

* Sarnat H .B . , Sarnat M.S. : Neonatal encephalopathy following fetal distress. Arch Neuro l. 33:698-705 1976.
** STAGE 0 = Normal

- In mild hypoxic-ischemic encephalopathy
  - Muscle tone may be slightly increased and deep tendon reflexes may be brisk during the first few days.
  - Transient behavioral abnormalities, such as poor feeding, irritability, or excessive crying or sleepiness, may be observed.
  - The neurologic examination findings normalize by 3-4 days of life

- In moderately severe hypoxic-ischemic encephalopathy
  - Lethargy, with significant hypotonia and diminished deep tendon reflexes
  - The grasping, Moro, and sucking reflexes may be sluggish or absent

- Occasional periods of apnea
- Seizures within the first 24 hours of life
- Full recovery within 1-2 weeks associated with a better long-term outcome
- An initial period of well-being or mild hypoxic-ischemic encephalopathy followed by sudden deterioration, suggesting ongoing brain cell dysfunction, injury, and death; during this period, seizure intensity might increase

- In severe hypoxic-ischemic encephalopathy
  - Typical stupor or coma
  - Not responding to any physical stimulus
  - Irregular breathing
  - Generalized hypotonia and depressed deep tendon reflexes
  - Neonatal reflexes (eg, sucking, swallowing, grasping, Moro) are absent
  - Disturbances of ocular motion, such as a skewed deviation of the eyes, nystagmus, bobbing, and loss of "doll's eye" (ie, conjugate) movements
  - Dilated pupils, fixed, or poorly reactive to light
  - Seizures occur early and often, initially resistant to conventional treatments
  - Subsided seizures with isoelectric EEG
  - Wakefulness deterioration, with fontanelle bulge (increasing cerebral edema)
  - Irregularities of heart rate and Blood Pressure (BP)
  - Death from cardiorespiratory failure

Diagnosis

- History of
  - Fetal distress and/or meconium stained amniotic fluid
  - Profound metabolic acidosis (pH <7.0, BE >12mmol/L)
  - Persistence of an Apgar score of 0-3 for longer than 5 minutes
  - Neonatal neurological sequelae (e.g., seizures, coma, hypotonia
  - Multiple organ involvement (e.g., kidney, lungs, liver, heart, intestines)
  - A significant hypoxic event immediately before or during labour or delivery

Investigations

- Serum electrolyte levels
- Renal function studies
- Cardiac and liver enzymes
- Coagulation system evaluation
- Arterial Blood Gases
- Brain MRI
- Cranial ultrasonography
- Head CT scanning

Complications

- Cardiovascular (heart rate and rhythm disturbances, cardiac failure and hypotension)
- Pulmonary (respiratory distress/respiratory failure, pulmonary hypertension and pulmonary haemorrhage)
- Renal (renal failure, acute tubular/cortical necrosis and urinary retention)
- Gastrointestinal tract (Ileus and necrotizing enterocolitis)
- Central nervous system (increased intracranial pressure, cerebral oedema, encephalopathy, seizures, inappropriate antidiuretic hormone (ADH) secretion, hypotonia and apnoea)
- Metabolic (hypoglycaemia, hyperglycaemia, hypocalcaemia, hypomagnesaemia and metabolic acidosis)
- Hypothermia/hyperthermia
- Disseminated intravascular coagulation

Management

Non-pharmaceutical

- Resuscitate
- Admit to neonatal high care or intensive care unit (if available)
- Maintain body temperature at 36.5-37.5^0
- Sat O2 88–92% (normal range)
- Maintain
  - Blood glucose at 2.6–6mmol/L
  - Haematocrit at ≥ 40% – packed red cells, IV, 10mL/kg
- Give IV Fluids
  - Restrict fluids with D 10% to 50–60 mL/kg in the first 24–48 hours
- Give Nutrition
  - No enteral feeds for at least the first 12–24 hours
  - Enteral milk feeds only after ileus has been excluded

Pharmaceutical

- If infection is suspected or confirmed
  - → (see table 2 under sepsis for empiric antibiotics for sepsis/meningitis)

- If hypotension
  - → Give Sodium Chloride 0.9% IV, 20 mL/kg over 1 hour + dopamine, IV, 5–15 mcg/kg/minute. Alternatively give Dobutamine (if available), IV, 5–15 mcg/kg/minute until Blood Pressure is stable

- If Convulsions
  - → Give Phenobarbital
    - Loading dose: 20 mg/kg IV slow push. May repeat 10 mg/kg after 20-30 minutes if seizures continue
    - Maintenance dose: 3-5 mg/kg/day IV if seizures persist.

      Or

  - → Phenytoin IV
    - Loading dose: 15 mg/kg diluted in 3 ml Sodium Chloride 0.9% given over 30 minutes by slow IV infusion
    - Maintenance dose : IV/oral, 5–10 mg/kg/24 hours as a single dose or 2 divided doses
    - Flush IV line with sodium chloride 0.9% before and after administration of the phenytoin

- If Cardiac failure
  - → Restrict fluids
  - → Give furosemide IV/oral/nasogastric tube, 1 mg/kg/24 hours as a single daily dose

- If Hypocalcaemia (with Serum total calcium < 1.7mmol/L or ionized calcium < 0.7 mmol.L)
  - → Give calcium gluconate 10%, slow IV, 1–2 mL/kg over 15 minutes under ECG control

- If Hypomagnesaemia (with Serum magnesium < 0.7 mmol/L)
  - → Give magnesium sulphate 50%, IV, 0.2 mL/kg as a single dose

- If Hypoglycaemia (with Blood Glucose < 2.6 mmol/L)
  - ➔ Give dextrose, IV as bolus, 250–500 mg/kg
    - Do not repeat (Dilute dextrose 50% solution before use to 10% strength 0.5–1 mL of dextrose 50% = 250–500 mg **OR** 2.5 mL of dextrose 10% = 250 mg)

- If inappropriate ADH: Cerebral oedema/raised intracranial pressure
  - ➔ Moderate fluid restriction of 50–60 mL/kg/24hours for the first 24–48 hours.
  - ➔ Raise head of cot by 10–15 cm
  - ➔ Moderate hyperventilation to lower PaCO2 to 30–35 mmHg, if ventilation facilities are available
  - ➔ Steroids are not considered to be of value

Recommendations

- Monitor neurological status, fluid balance, vital signs, temperature, blood glucose acid-base status, blood gases, electrolytes, SaO2, minerals, blood pressure(where avaible) and renal function
- Newborns with stage 3 Hypoxic Ischaemic Encephalopathy should not be ventilated
- Refer survived child for neurological assessment for 3 months
- Phenytoin must not be given in glucose/dextrose- containing solutions
- To minimize risk of precipitation administer phenytoin in 0.9% Sodium Chloride solution
- Do not administer phenytoin intramuscularly

3.9. Necrotizing Enterocolitis

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

Risk factors

- Pathogenesis is unknown, but several risk factors have been identified
  - Prematurity - the main risk factor
  - Feeding
  - Rapid increase in enteral feeds
  - Formula feeds >breast milk
  - Hypertonic formula
  - Infection
  - Hypoxia–ischemia to the bowel

Clinical features

- Onset is at 1–2 weeks but may be up to several weeks of age, with:
  - Bilious aspirates/vomiting
  - Feeding intolerance
  - Bloody stool
  - Abdominal distension and tenderness, which may progress to perforation
  - Features of sepsis:
    - → Temperature instability
    - → Jaundice
    - → Apnea and bradycardia
    - → Lethargy
    - → Hypo-perfusion, shock

Investigations

- Lab
  - Raised acute-phase reactant (C-reactive protein, CRP or procalcitonin)
  - Thrombocytopenia
  - Neutropenia, neutrophilia
  - Anemia
  - Blood culture positive
  - Coagulation abnormalities
  - Metabolic acidosis
  - Hypoxia, hypercapnia
  - Hyponatremia, hyperkalemia
  - Increased blood urea
  - Hyperbilirubinemia

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

Complications

- Peritonitis/perforation
  - Abdominal tenderness
  - Guarding
  - Tense, discolored abdominal wall
  - Abdominal wall edema
  - Absent bowel sounds
  - Abdominal mass

Management

Non Pharmaceutical

Table: Management of necrotizing enterocolitis.

Treatment	Rationale/goals
- Secure airway and breathing	- Maintain adequate oxygenation and ventilation - Abdominal distension may compromise breathing
- NPO (nil by mouth) - Place large-bore naso/orogastric tube	- Intestinal decompression, bowel rest
- Circulation • establish vascular access • give intravascular volume replacement (saline, blood, fresh frozen plasma) • correct metabolic acidosis	- Infusion of fluids - Treat hypoperfusion / hypovolemic shock - Improve organ and tissue perfusion
- Treat coagulopathy (fresh frozen plasma, platelets, cryoprecipitate)	- Avoid bleeding complications
- Monitor regularly – clinical, radiographic and laboratory investigations	- Necrotizing enterocolitis can worsen very quickly

Pharmaceutical management

- Broad-spectrum antibiotics
  - ➔ Gram-positive, negative and anaerobic coverage (Metronidazole)

Surgical Management

- Indication: Bowel perforation or failure to resolve on medical treatment
- Option
  - ➔ Laparotomy
  - ➔ Resection of non-viable bowel and anastomosis or ileostomy or colostomy

3.10. Anemia in a Newborn

Definition: Infants are born with a physiologic polycythemia due to relative hypoxia in utero. Normal haemoglobin of a newborn is between 15 –18, and normal hematocrit is 45 – 55 for neonate (conversion: haemoglobin x3= hematocrit)

Causes

- Anaemia and Jaundice
- Hemolysis
    - Immune (Rhesus or ABO incompatibility or other red cell antibodies)
    - Enzyme (G6PD deficiency, pyruvate kinase deficiency)
    - Red blood cell membrane defects (spherocytosis)
    - Acquired (Infection, Disseminated Intravascular Coagulopathy)

- Anemia without jaundice
- Blood loss
    - Fetal (Fetomaternal, twin-twin transfusion)
    - Obstetrical (Placental abruption, placenta praevia, cord accidents)
    - Neonatal (Cephalohematoma, subgaleal hemorrhage, intracranial hemorrhage, bleeding into abdominal organs)
    - Iatrogenic (Blood sampling, accidental loss from an arterial line)

- Diminished red blood cell production
    - Infection: Diamond Blackfan
    - Congenital: e.g. parvovirus

Clinical features of anemia

History	Examination
- History – blood loss - Family history – anemia, jaundice, splenomegaly from hemolytic disease - Obstetric history – antepartum hemorrhage - Maternal blood type – rhesus or other red cell antibodies, potential for ABO incompatibility (mother O, infant A or B) - Ethnic origin – hemoglobinopathies and G6PD deficiency more common in certain ethnic groups	- Pallor - Jaundice from hemolysis - pnea and bradycardia - Tachycardia - Heart murmur – systolic - Flow murmur - Respiratory distress, - Heart failure - Hepatomegaly and/or - Splenomegaly, hydrops - Inadequate weight gain from poor feeding

Investigations

- Complete Blood Count
- Reticulocyte count
- Direct antiglobulin (DAT, Comb's test)
- Bilirubin level
- Blood smear
- Cranial ultrasound

Management

Blood transfusion

- Indications for red blood cell transfusion
  - → Significant cardiorespiratory distress
  - → Blood loss more rapid than ability for infant to generate red blood cells (e.g. rapid bleeding, severe hemolysis)
  - → Severe anemia (hemoglobin <7) with poor reticulocytosis or impaired infant growth (e.g. average of <10 gm/day) despite adequate nutrition

- Transfusion Procedure
  - → Typical transfusion is 10ml/kg given over 3 to 4 hours
  - → May need second transfusion (preferably from same donor) if anemia not adequately corrected

- Volume of transfusion
  - To calculate volume based on observed and desired hematocrit, estimated blood volume of 80 ml/kg
    Calculation: (Desired hematocrit – observed hematocrit) x weight x 80 ml
    Hematocrit of blood to be given (typically 60-90%)

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

Prevention: Infants at risk of iron deficiency should receive supplemental oral iron (2-4 mg of elemental iron/kg/day) once they are tolerating full enteral feeds. At risk infants include prematures and those with substantial blood loss via bleeding or phlebotomy.

3.11. Patent Ductus Arteriosis (PDA) in a Newborn

Definition: This is the persistence of the normal fetal vessel that joins the pulmonary artery to the aorta extra-uterine

Causes

- Congenital
- Prematurity
- Pulmonary hypertension
- Hypoxia
- Sepsis
- Fluid overload
- Lung disease
- Anaemia
- Congenital cardiac abnormalities

Signs and symptoms

- Depends on size of PDA
- Systolic or continuous murmur at left sub clavicular area
- Hyperactive precordium with easily palpable bounding peripheral pulses

Investigation

- Echocardiography

Complications

- Cardiac failure
- Systemic hypotension
- Pulmonary haemorrhage

Management

Non-Pharmaceutical

- If preterm Infants
  - Identify and treat underlying risk factors
  - Restrict fluid intake to 80–120 mL/kg/24 hours
  - Maintain haematocrit at ≥ 40% and Hb ≥ 13 g/dL
  - Monitor cardiac function, renal function and urinary output
  - Provide adequate nutrition
  - Nurse in neutral thermal environment

Pharmaceutical

- If Cardiac failure, give diuretics
  - *Furosemide, IV*/oral, 1 mg/kg/24 hours + Short term *Digoxin, IV*/oral, 0.005 mg/kg/dose 12 hourly
  - Closure of PDA in preterm infant less than 14 days of age with oral ibuprofen
  - First dose: 10 mg/kg followed by 2 additional doses after 24 hours
  - Additional doses: 5 mg/kg each 12–24 hours apart.

Note: *Contraindications to ibuprofen therapy include thrombocytopenia (<50 000/mm3), bleeding disorders, impaired renal function, and jaundice approaching exchange transfusion levels*

Surgical

- If medicine treatment is contraindicated or failed

Recommendations

- Refer patients to specialist:
  - Complications, e.g. cardiac failure, pulmonary hemorrhage
  - PDA which remained patent despite adequate treatment
  - Term babies with symptomatic or persistent PDA

4. Low Birth Weight/ Prematurity

4.1. Prematurity/Low Birth Weight

Definition: Neonate born at >22 weeks and <37weeks of gestation

- Newborn who weigh <2.5kg are low birth weight (LBW)
- <1.5 kg are very low birth weight (VLBW)
- 500 gm to <1.0kg are extremely low birth weight (ELBW)

Causes/Risk factors

- Unknown
- Precocious foetal endocrine activation
- Uterine over distension
- Decidual bleeding
- Intrauterine inflammation/infection
- Diabetes
- Heart disease
- Infection (such as a Urinary Tract Infection or infection of the amniotic membrane)
- Kidney disease
- Different pregnancy-related problems which increase the risk of preterm labour
    - An "insufficient" or weakened cervix, also called cervical incompetence
    - Birth defects of the uterus
    - History of preterm delivery
    - Poor nutrition right before or during pregnancy
    - Preeclampsia: The development of high blood pressure and protein in the urine after the 20th week of pregnancy
    - Premature rupture of the membranes
    - Placenta previa

Signs and symptoms

- Common signs of prematurity
  - Body hair (lanugo)
  - Abnormal breathing patterns (shallow, irregular pauses in breathing called apnea)
  - Enlarged clitoris (female infant)
  - Problems breathing due to immature lungs (neonatal respiratory distress syndrome) or pneumonia
  - Lower muscle tone and less activity than full-term infants
  - Problems feeding due to difficulty sucking or coordinating swallowing and breathing
  - Less body fat
  - Small scrotum, smooth without ridges, and undescended testicles (male infant)
  - Soft, flexible ear cartilage
  - Thin, smooth, shiny skin, which is often transparent (can see veins under skin)

BALLARD score

Neuromuscular Maturity

Score	-1	0	1	2	3	4	5
Posture							
Square window (wrist)	 > 90°	 90°	 80°	 45°	 30°	 0°	
Arm recoil		 180°	 140-180°	 110-140°	 90-110°	 < 90°	
Popliteal angle	 180°	 160°	 140°	 120°	 100°	 90°	 < 90°
Scarf sign							
Heal to ear							

Physical Maturity

Skin	Sticky, friable, transparent	Gelatinous, red, transparent	Smooth, pink; visible veins	Superficial peeling and/or rash; few veins	Cracking, pale areas; few 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 anterior 2/3	Creases over entire sole	
Breast	Imperceptible	Barely peceptible	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	Slightly curved pinna; solt; slow recoil	Well curved pinna solt but ready recoil	Formed and 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,	Clitoris prominent small labia minora,	Clitoris prominent enlarging minora,	Majora and minora equally prominent	Majora large, minora small	Majora cover, clitoris and minora	

Maturity Rating

Skin	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

BALLARD score *(Maturational assessment of gestational age. Ballard JL et al. New Ballard Score, expanded to include extremely premature infants. J Pediatr 1991; 119:417)*

Investigations

- Glycemia
- NFS
- Blood gases, Electrolytes (if available)
- Blood tests to check glucose, calcium, and bilirubin levels
- Chest x-ray
- Continuous cardiorespiratory monitoring (monitoring of breathing and heart rate)
- Other Investigations based on specific diseases/complications

Complications

- Hypothermia
- Hypoglycemia
- Hypocalcemia
- Respiratory problems: Respiratory distress syndrome, apnea, aspiration
- Feeding difficulty
- Infections
- Jaundice of prematurity
- Anemia (in premature babies) or polycythemia (in hypotrophic babies)

- Gastro-intestinal problems: Necrotizing enterocolitis
- Neurologic problems (cerebral hemorrhage, in particular intraventricular hemorrhage, periventricular leucomalacia)

Management of complications

- Fluid And Nutrition Management
  - Infants admitted to neonatal care who are stable from a cardio-respiratory standpoint and have a BW of ≥2 kg can be offered ad lib PO feeds.
- Fluid Guideline for Infants
  - Infants require higher daily fluid amounts and dextrose concentrations than older children due to high caloric and fluid requirements
  - Low birth weight (LBW) infants have high fluid requirement due to their large body surface area.
  - "Weight for calculations" is the birth weight (BW) until current weight is >BW.
  - Infants with BW < 1.5 kg and those with cardio-respiratory instability including those at risk for brain injury should not receive enteral feedings on Day 0 (day of birth). Instead, they should be given G10% at the appropriate volume based on Total IV Fluid chart

Total IV Fluid, mL/kg/day for infants who are NPO			
	< 1.5 kg	> 1.5 kg	Brain injury
Day 0	90	80	60
Day 1	100	90	60
Day 2+	120	100	80

- Newborns (DOL 0) should always be started on G10%, never G5%.
- On day of life 0 and 1, infants do not need supplemental electrolytes due to higher baseline total body sodium content and decreased renal function
- By day of life 2, infants require maintenance Na+ at 2- 3 mmol/kg/day and K+ at 2 mmol/kg/day.
- Usually this is in the form of milk if feedings are started. Therefore, infants can remain on G10% as they titrate off Intra Venous Fluids as they are increasing their enteral volume.

- If feeding is not established by day of life 2, infant is requires prolonged IV fluids and electrolytes (ions). If concern for hyperkalemia or alkalosis, IV fluid should be *G10%* ¼ NS.
- Infants should not receive high amounts of sodium (do not use ½ NS)
- Infants require increased total fluid administration if they have increased losses
  - Infants receiving phototherapy should be given an additional 20 mL/kg/day of total fluids to account for increased insensible losses due to evaporation
  - Other reasons for increased losses include fever, vomiting, diarrhea

- Recipes for IV fluids
  - *G10%*: Use for all infants on admission and as increasing enteral feeding and decreasing IV fluids:
    - Use premixed *G10%* if available. Otherwise, combine 1 part G50% + 9 parts G5%.
      - For example: combine 10 mL G50% + 90 mL G5% = 100 mL G10%
    - Small volume bolus of G10% to treat hypoglycemia: combine 1 part G50% and 4 parts sterile water

  - G10% ¼ + LR : Use for infants on prolonged IV fluids who have not established feeding after 2 days
    - First prepare a *G14*% solution by combining 1 part *G50% + 4 parts G5%*.
      - For example, combine 20 mL G50% + 80 mL G5% = 100 mL G14%
    - Using this G14% solution, combine 3 parts G14% + 1 part Ringer's Lactate (LR)
      - For example: Combine 75 mL G14% + 25 mL Lactated Ringer's = 100mL G10% ¼ LR
    - Normal saline may be substituted for LR if concern for hyperkalemia or alkalosis or LR not available

- Enteral fluid guidelines
  - When infants are stable they can start receiving enteral feeds. LBW infants should start feeding on day of life 1 if they are otherwise well:
    - Most infants <1.5 kg will have an immature suck reflex, therefore they usually need to start with Naso-Gastric tube feeds.

- If infant is >1.5 kg, has mature suck and demonstrates interest in feeding, start with oral feeds (breastfeeding, bottle or syringe). If unable to take full volume enterally, give remainder of volume by naso-gastric tube.
- Naso-gastric feeds should be given by gravity, not pushed through syringe.
- If temperature < 35°C, enteral feedings should not be given until infant has been rewarmed

- In contrast to IV fluids, enteral fluids are not entirely absorbed into the vascular space. Therefore infants need higher fluid volume if being enterally fed than if on IV fluids.
  - Follow the "Recommended IV and Enteral Feeding Rates for Infants in Neonatal Care" below to increase the total fluids daily by increasing the enteral feeding rate if tolerated (no vomiting or distension) and decreasing IV fluid rate.
  - Total fluids = IV fluids + Enteral fluids
  - When infant reaches 100 ml/kg/ day by enteral feeds, discontinue IV fluids.
  - If infant with BW < 1.5kg tolerates full enteral feeds (150mL/kg/day) then consider enhanced calorie feeding to give 24 calorie/ounce.

Newborn Feeding / Fluid requirements	Age	Total Daily Fluid / Milk Vol.
- **Well baby** - immediate milk feeding - **Table A**. For first feed give 7.5 mls and increase by this amount each feed until full daily volume reached - **Day 1 - Sick baby or Weight <1.5kg** start with 24hrs iv 10% D - **Table B** - **From Day 2** unless baby very unwell start NGT feeds - Begin with 5mls each 3hrly feed if <1.5kg; 7.5mls 3hrly if ≥1.5kg <2kg; and 10mls 3hrly if ≥ 2kg. Increase feed by the same amount **every day** and reduce iv fluids to keep with in the total daily volume until IVF stopped - **Table C** - For IVF **from Day 2** use 2 parts 10% dextrose to 1 part HS Darrow's (eg. 200mls 10% 0 + 100m[s HSD) if not able to calcu late or give added Na+ (2-3mmol/kg/ day) and K+ (1-2mmol/kg/day) to glucose solution. - Please ensure sterility of iv fluids when mixing / adding - Always use EBM for NGT feeds unless contra-indicated - If signs of poor perfusion or fluid overload please ask for senior opinion on whether to ive a bolus, step-u or ste -down dail fl uids.	Day 1	60 mls/kg/day
	Day 2	80 mls/kg/day
	Day 3	100 mls/kg/day
	Day 4	120 mls/kg/day
	Day 5	140 mls/kg/day
	Day 6	160 mls/kg/day
	Day 7	180 mls/kg/day

Source: Basic Pediatric Protocols (ETAT document_ Rwanda) 2011

A. Nasogastric 3 hrly feed amounts for well babies on full volume feeds on Day 1 and afterwards

Weight (kg)	1.5 to 1.6	1.7 to 1.8	1.9 to 2.0	2.1 to 2.2	2.3 to 2.4	2.5 to 2.6	2.7 to 2.8	2.9 to 3.0	3.1 to 3.2	3.3 to 3.4	3.5 to 3.6	3.7 to 3.8	3.9 to 4.0
Day 1	12	14	15	17	18	20	21	23	24	26	27	29	30
Day 2	15	18	20	22	24	26	28	30	32	34	36	38	40
Day 3	19	23	25	28	30	33	35	38	40	43	45	48	50
Day 4	24	27	30	33	36	39	42	45	48	51	54	57	60
Day 5	28	32	35	39	42	46	49	53	56	60	63	67	70
Day 6	32	36	40	44	48	52	56	60	64	68	72	76	80
Day 7	36	41	45	50	54	59	63	68	72	77	81	86	90

Source: Basic Pediatric Protocols (ETAT document_ Rwanda) 2011

B. IV fluid rates in mls I hr for sick newborns who cannot be fed on FULL volume Iv fluids

Weight (kg)	1.0 -1.1	1.2 - 1.3	1.4 - 1.5	1.6- 1.7	1.8 - 1.9	2.0 - 2.1	2.2 - 2.3	2.4 - 2.5	2.6 - 2.7	2.8 - 2.9	3.0 - 3.1	3.2 - 3.3	3.4 - 3.5	3.6 - 3.7	3.8 - 3.9
Day 1	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10
Day 2	4	4	5	6	6	7	8	8	9	10	10	11	12	12	13
Day 3	5	5	6	7	8	9	10	10	11	12	13	14	15	15	16
Day 4	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Day 5	6	8	9	10	11	12	13	15	16	17	18	19	20	22	23
Day 6	7	9	10	11	13	14	15	17	18	19	21	22	23	25	26
Day 7+	8	10	11	13	14	16	17	19	20	22	23	25	26	28	29

Source: Basic Pediatric Protocols (ETAT document_ Rwanda) 2011

C. Standard regimen for introducing NGT feeds in a VLBW or sick newborn after 24hrs IV fluids

Weight (kg)	1.0 - 1.1		1.2 - 1.3		1.4 - 1.5		1.6 - 1.7		1.8 - 1.9		2.0 - 2.1		2.2 - 2.3		2.4 - 2.5	
	IVF mls per hr	NGT 3hrly feed	IVF mls per hr	NGT 3hrly feed	IVF mls per hr	NGT 3hr1y feed	IVF mls per hr	NGT 3hrly feed	IVF mls per hr	NGT 3hrly feed	IVF mls per hr	NGT 3hrly feed	IVF mls per hr	NGT 3hrly feed	IVF mls per hr	NGT 3hrly feed
Day 1	3	0	3	0	4	0	4	0	5	0	5	0	6	0	6	0
Day 2	2	5	3	5	3	5	3	8	4	8	4	10	4	10	5	10
Day 3	1	10	2	10	3	10	2	15	3	15	2	20	3	20	4	20
Day 4	1	15	2	15	3	15	1	22	2	22	0	30	2	30	3	30
Day 5	0	18	1	20	2	20	0	30	1	30	0	36	0	39	1	40
Day 6	0	21	0	25	2	25	0	34	0	38	0	42	0	45	0	50
Dav 7+	0	24	0	30	0	33	0	38	0	42	0	48	0	51	0	56

Source: Basic Pediatric Protocols (ETAT document_ Rwanda) 2011

4.2. Apnea And Bradycardia For LBW (<1500 Kg) or Premature Infants (<33 Weeks Gestation)

Definitions

- Apnea: Pause in breathing for > 20 seconds
- Bradycardia: Abnormally slow HR; <100 beats/minute in the preterm infant

Causes

- Central apnoea
  - Prematurity
  - Intra-ventricular haemorrhage
  - Hypoxia
  - Patent ductus arteriosus
  - Sepsis
  - Hypoglycaemia
  - Acidosis
  - Hyper-magnesaemia
  - Meningitis
  - Sedatives
  - Temperature disturbances
  - Atypical convulsions
  - Rough handling

- Obstructive apnoea
  - Choanal atresia
  - Gastro-oesophageal reflux
  - Micrognathia
  - Macro glossia
  - Secretions (milk, meconium, blood, mucus) lodged in the upper airway

- Reflex apnoea or vagally mediated apnoea
  - Endotracheal intubation
  - Passage of a nasogastric tube
  - Gastro-oesophageal reflux
  - Overfeeding
  - Suction of the pharynx or stomach

- Mixed apnoea
  - Apnoea caused by a combination of the above causes

Management

Non-pharmaceutical

- Small Baby
  - → Small babies are prone to episodes of apnoea, which are more frequent in very small babies (less than 1.5 kg at birth or born before 32 weeks gestation) but they become less frequent as the baby grows.
    - Teach the mother to observe the baby closely for further episodes of apnoea. If the baby stops breathing, have the mother stimulate the baby to breathe by rubbing the baby's back for 10 seconds. If the baby does not begin to breathe immediately, resuscitate the baby using a bag and mask
    - Review the general principles of feeding and fluid management of small babies
    - Encourage the use of kangaroo mother care if possible. Babies cared for in this way have fewer apnoeic episodes, and the mother is able to observe the baby closely
    - If the apnoeic episodes become more frequent, treat for sepsis

- Term Baby
  - → If a term baby has had only a single episode of apnoea
    - Observe the baby closely for further episodes of apnoea for 24 hours, and teach the mother how to do so. If the baby does not have another apnoeic episode in 24 hours, is feeding well, and has no other problems requiring hospitalization, discharge the baby

  - → If apnoea recurs
    - Manage for multiple episodes of apnoea

  - → If a term baby has had multiple episodes of apnoea
    - Treat for sepsis

- For all forms of neonatal apnoea
  - Identify and treat the underlying cause
  - Maintain the temperature at 36.5–37.5°C
  - Maintain oxygen Saturation at 90–95%
  - Maintain haematocrit at 40%

Note: *A baby with Apnoeas may benefit from stimulation with Nasal CPAP. See criteria under CPAP*

Pharmaceutical treatment

- Start respiratory stimulant (caffeine or aminophylline) when birth weight <1.5 kg or GA <33 weeks

  - *Caffeine:*
    - Loading dose: 20 mg/kg NG/PO on day 1 then,
    - Maintenance dose 10 mg/kg/day NG/PO

    OR

  - Aminophylline
    - Loading dose: 10mg/kg IV x1 on day 1 then
    - Maintenance dose
      - o < 7 days of age: 2.5 mg/kg/dose IV or NG/PO every 12 hours
      - o > 7 days of age: 4 mg/kg/dose IV or NG/PO every 12 hours

4.3. Kangaroo Mother Care (KMC) for Low Birth Weight (LBW) Infants

- Encourage all mothers with LBW babies to KMC
- KMC transfers heat from mother to baby by conduction
- Advantages: Prevents hypothermia, enables frequent breast feeding, and allows earlier hospital discharge
- Method
  - Skin to skin on chest of family member
  - Face should not be covered
  - Can be intermittent or continuous
  - Good hand hygiene to prevent infection

- Criteria
  - Stable newborn
  - Mild respiratory distress in nasal cannula acceptable

- Contraindications
  - Moderate to severe respiratory distress
  - Hemodynamic instability
  - Systemic signs of sepsis

- Vital signs per doctor's orders
  - If hypothermic at initiation of KMC, measure temperature one hour after starting KMC to ensure normothermia

- Discharge criteria
  - KMC method well tolerated by infant and mother
  - Temperature (and remainder of vital signs) stable for at least 3 days
  - Breast feeding and gaining birth weight plus gaining weight well (10-15 gm/day for 3 days)

- Follow up: All infants with BW <2 kg should have Rendez-Vous (Appointment) to assess temperature and weight gain within the week after discharge
- Readmission criteria
  - Unable to continue KMC for an infant <2 kg
  - <10 gm/day weight gain
  - Presence of any danger sign

4.4. Incubator guidelines for Low Birth Weight Infants

Initial Incubator Management

- Ensure that the incubator is functioning properly, has been cleaned, and is correctly connected to power source with voltage transformer if needed
- Place naked infant in the incubator if meets one of the following criteria:
  - ➔ Unable to keep temperature >36.5°C using warming lights, KMC, or bundling (because of VLBW or another reason)
  - ➔ Too unstable to remain in KMC (because of respiratory distress or another reason)
  - ➔ Poor weight gain

- Set the incubator ambient air temperature according to the following WHO recommendations:

Recommended Incubator Ambient Air Temperature		
Weight of infant	**36 °C**	**35 °C**
<1.5 kg	If infant is 0-10 days old	If infant is > 10 days old
1.5 to 2.0 kg		Regardless of age

Source: *WHO. Hospital Care for Children. Pocket Book, 2005*

- After placing infant in incubator, check axillaries temperature every hour until > 36.5°C.
- If unable to reach temperature > 36.5°C, then increase the ambient air temperature of the incubator by 1°C increments every hour until the infant temperature reaches >36.5°C. Goal temperature is 36.5–37.5°C.

Ongoing Incubator Management

- Any infant placed in the incubator must have manual maxillary temperature checked every 3 hours.
- If infant's temperature is < 36.5°C, increase incubator temperature by 1°C and check temperature after 1 hour.
- If infant's temperature is >37.5°C, decrease incubator temperature by 1°C and check temperature after 1 hour.
- Once infant is clinically stable, wrap in blanket and hat and turn incubator temperature down by 2°C and recheck temperature in 1 hour. Adjust incubator temperature as above.
- If the infant temperature reaches >38°C or there is any concern that the incubator is not functioning properly, remove the infant from the incubator immediately.

5. Appendix

Chart 1

Infant feeding guide: Term Baby

Term baby daily fluid/milk requirements

Age	Total daily fluid/milk volume
Day 0	60 ml/kg/day
Day 1	80 ml/kg/day
Day 2	100 ml/kg/day
Day 3	120 ml/kg/day
Day 4	140 ml/kg/day
Day 5	160 ml/kg/day
Day 6	180 ml/kg/day

Always use birth weight to calculate fluid requirements until baby weighs more than birth weight

Weigh baby 2-3 times per week

For IVF from Day 1 use 2 parts 10% dextrose to 1 part Ringers Lactate e.g.200ml 10% D + 100ml RL. If not able to give, use 10%D with Na+2-3 mmol/kg/day and K+ 1-2mmol/kg/day
Ensure sterility of iv fluids when mixing adding

Titrate iv fluids with milk feeds to keep total volume for appropriate day of life

IV fluid rate (ml/hr) for Sick Term newborns who cannot be fed

Weight (kg)	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9	3.0-3.1	3.2-3.3	3.4-3.5	3.6-3.7	3.8-3.9
Day 0	5	6	6	7	7	8	8	9	9	10
Day 1	7	8	8	9	10	10	11	12	12	13
Day 2	9	10	10	11	11	13	14	15	15	16
Day 3	11	12	13	14	14	16	17	18	19	20

If clinically stable after 24 hours of iv fluids:
Consider starting feeds at 5 mls every 3 hours or try breast feed
After 24 hours, if tolerated give 10 mls every 3 hours or try breast feed
Increase milk volume as tolerated

Chart 2

Infant feeding guide: Preterm babies

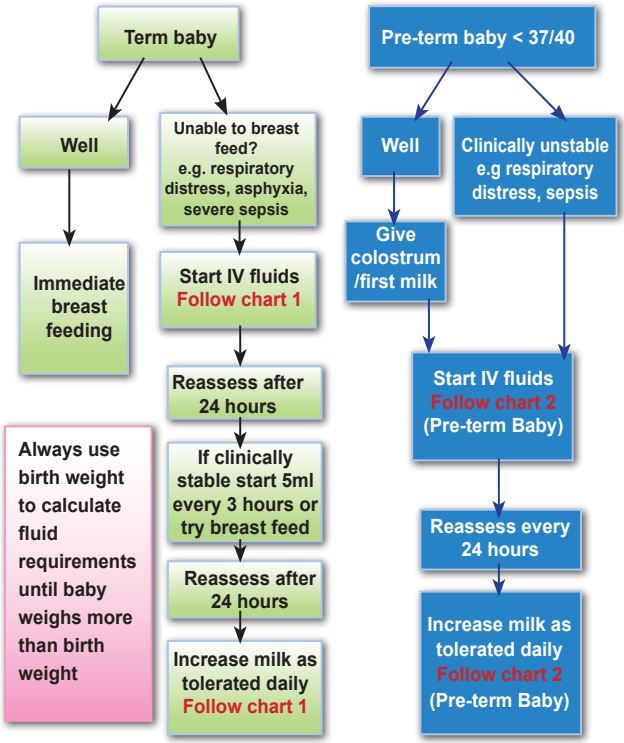
Birth Weight < 1.0 kg (ELBW) (Estimated as 0.9 kg for calculation)						
DOL	IV Fluid	Total Fluid: IV+PO ml/kg/day	IV		Enteral	
			ml/kg/24hrs	ml/24 hrs	ml/kg/24hrs	ml/3hrs
0	G10%	80	80	70	0	0
1	G10%	100	90	80	10	1
2	G10%	120	90	80	30	3
3	G10%	140	90	80	50	5
4	G10%	150	80	70	70	8
5	G10%	150	55	50	95	11
6	G10%	150	30	30	120	14
7	G10%	150	0	0	150	17 (full)

Birth Weight 1.0 – 1.5 kg (VLBW) (Estimated as 1.25 kg for calculation)						
DOL	IV Fluid	Total Fluid: IV+PO ml/kg/day	IV		Enteral	
			ml/kg/24hrs	ml/24 hrs	ml/kg/24hrs	ml/3hrs
0	G10%	80	80	100	0	0
1	G10%	100	80	100	20	3
2	G10%	120	80	100	40	6
3	G10%	140	70	90	70	11
4	G10%	150	40	50	110	17
5	G10%	150	0	0	150	25 (full)

Birth Weight 1.5 – 2.0 kg (VLBW) (Estimated as 1.75 kg for calculation)						
DOL	IV Fluid	Total Fluid: IV+PO ml/kg/day	IV		Enteral	
			ml/kg/24hrs	ml/24 hrs	ml/kg/24hrs	ml/3hrs
0	G10%	**80**	80	140	0	0
1	G10%	**100**	70	120	30	7
2	G10%	**120**	60	100	60	14
3	G10%	**140**	40	70	100	22
4	G10%	**150**	0	0	150	33 (full)

Birth Weight > 2.0 kg unable to feed by enteral route (Estimated as 2.5 kg for calculation)						
DOL	IV Fluid	Total Fluid: IV+PO ml/kg/day	IV		Enteral	
			ml/kg/24hrs	ml/24 hrs	ml/kg/24hrs	ml/3hrs
0	G10%	**80**	80	200	0	0
1	G10%	**100**	70	175	30	10
2	G10%	**120**	60	150	60	20
3	G10%	**140**	40	100	100	30
4	G10%	**150**	0	0	150	45 (full)

Infant feeding guide Algorithm



HEMOGLOBINE AND HEMATOCRITE: Values for Term and Pre-term infants

Age	Hemoglobine (g/dL)		Hematocrit (%)	
	Mean	-2 SD	Mean	-2SD
26-30 weeks Gestation	11.0		41.5	34.9
28 weeks	14.5		45.0	
32 weeks	15. 0		47.0	
Term gestation (cord blood)	16.5	13.5	51.0	42
24 to 72 hours	18.5	14.5	56.0	45
1 week	17.5	13.5	54.0	42

Adapted from Nathan, Orkin, Ginsburg, & Look (2003), and Brunettie& Cohen (2005)

	Platelets
Infant Size	**Mean value+/-SD (per micro/L)**
Very low birth weight (VLBW,<1500 gram)	275000+/-60.000
Premature (LBW, 2500 grams)	290000+/-70000
Term	310000+/-68000

From Christinen (2000)

Blood Gas values in young infants

	Arterial	Capillary
pH	7.30 - 7.45	7.30 - 7.45
PCO_2	35-45 mmHg	35- 50 mmHg
PO_2 (on room air)	50 - 80 mmHg	35- 45mmHg (Not useful for assessing oxygenation)
Bicarbonate (HCO_3-)	19 - 26 mEq/L	19 - 26 mEq/L
Base excess	-4 to +4	-4 to +4

Adapted from Jackson &Chuo (2004), and Parry& Zimmer (2004)

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