Republic of Rwanda
MINISTRY OF HEALTH

NATIONAL NEONATAL CARE PROTOCOL

2nd Edition | SEPTEMBER 2014

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Forward

Despite numerous advances in decreasing the toll of childhood mortality, neonatal mortality remains one of the largest contributors to under-five mortality in the developing world. Neonatal health and survival remain a major challenge in the Sub-Saharan Africa.

In September 2000, world leaders gathered for the United Nations Millennium Summit where they agreed upon ten goals for improving lives around the world. One of these Millennium Development Goals is to reduce the deaths of children under five years old by two-thirds before 2015. This goal is only attainable if we address the unique set of risks faced by newborn infants.

In a setting such as Rwanda, there is a unique opportunity to develop and implement best practices in care for those in the earliest stage of life. The Ministry of Health has strongly prioritized decreasing maternal and neonatal mortality, and this impetus has led to the creation of this protocol and equipment manual.

The following guidelines offer critical updates to the first national standardization of neonatal care in Rwanda. This second edition includes new sections on respiratory distress incorporating the use of continuous positive airway pressure (CPAP), and cardiovascular complications. This protocol is also intended to harmonize the many existing protocols affecting newborn care, and is intended for use at the referral and district hospital level.

The knowledge and guidance found within these protocols offers those caring for newborns important resources and methods for reducing mortality and morbidity in the first month of life.

There remains much to be done in improving the quality of care provided to newborns and their mothers in order to achieve the needed reduction in infant morbidity and mortality and improvement in overall neonatal health. May this publication and the accompanying equipment manual contribute to improving awareness and knowledge around neonatal care for all those in the health sector, and to improving the lives of Rwanda's population.

Dr Agnès BINAGWAHO
Rwanda Minister of Health

Acknowledgements

The Ministry of Health is grateful to all organizations and individuals who contributed to the development of this 2014 second edition of national guidelines for neonatal care in Rwanda. The guidelines are aimed at district and referral hospital level care in specialized neonatal units. Additional intensive-care unit level care may be available at referral hospitals (such as ventilator management), which are not included in this protocol and require specialist management.

These guidelines would not have been updated without the generous support of all who are involved in the domain of providing neonatal care in Rwanda.

We offer our sincere gratitude and appreciation for the guidance and feedback from the following people and organizations for leading and coordinating the effort to develop these protocols.

To Dr. Victor Mivumbi, neonatal focal point, and to Dr. Fidèle Ngabo, Director of Maternal and Child Health at the Rwanda Ministry of Health for their leadership in coordinating this effort to update the protocols.

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Our appreciation also goes towards all persons, who, from near or far, contributed to the realization of these guidelines.

Abbreviations

BW	Birth Weight
CPAP	Continuous Positive Airway Pressure
CRP	C-reactive protein
CXR	Chest X-Ray
DIC	Disseminated Intravascular Coagulopathy
DOL	Day of Life
ELBW	Extremely Low Birth Weight
FBC	Full Blood Count (equivalent to Complete Blood Count)
HR	Heart Rate
HSV	Herpes Simplex Virus
IV	Intravenous
IVH	Intraventricular Hemorrhage
KMC	Kangaroo Mother Care
LBW	Low Birth Weight
LMP	Last Menstrual Period
IUGR	Intrauterine growth restriction
LR	Lactated Ringers Solution
LBW	Low Birth Weight
NC	Nasal Cannula
NG	Nasogastric
NGT	Nasogastric Tube
NPO	Nothing by Mouth / Nil Per
NS	Normal Saline
NVP	Nevirapine
PHH	Posthemorrhagic Hydrocephalus
PDA	Patent Ductus Arteriosus
PO	By Mouth / Per Os
RR	Respiratory Rate
SBI	Serious Bacterial Infection
VLBW	Very Low Birth Weight
ELBW	Extremely Low Birth Weight
WBC	White Blood Cell Count
WHO	World Health Organization

CHAPTER 1

Routine Care Of The Well Newborn

Before Delivery

- Be prepared for potential resuscitation
- Prevent Hypothermia
  - Close windows, curtains, and doors to avoid drafts
  - Prepare radiant warmer (if available) and warm towels
  - Raise the temperature of ambient air if possible

Immediately After Delivery

- Place the infant on the mother's chest to provide skin-to-skin contact
- Dry the newborn with a warm towel on mother's chest: Kangaroo Mother Care (KMC)
- Suction and/or stimulate if needed
- Assess need for resuscitation (See Chapter 3, Neonatal Resuscitation)
- Cut cord 1–3 minutes after delivery while providing essential newborn care on mother's abdomen
  - Early cord clamping (< 1 minute after delivery) is only recommended if the newborn is not breathing and must be moved for immediate resuscitation
- Assign **Apgar score** to describe the newborn's condition during the first few minutes of life

Apgar Score	0	1	2
Heart rate	Absent	< 100 beats/min	> 100 beats/min
Respiration	Absent	Slow, irregular	Good, crying
Muscle tone	Limp	Some flexion of extremities	Active motion
Reflex/irritability (response to stimulation)	No response	Grimace	Cough
Color	Blue or pale	Body pink, extremities blue	Pink

After Delivery

1. THERMOREGULATION

- Continue KMC with a hat, if available. When KMC not being offered, newborn should be wrapped in blanket or clothed.

2. BREASTFEEDING

- Breastfeed the newborn as soon as possible after birth (within an hour)
  - Refer to EMTCT chart for HIV + mothers

3. UMBILICAL CORD CARE

- Always wash hands with hand gel or clean water and soap before handling umbilical cord
- If available, use 7.1% chlorhexidine digluconate (delivering 4% chlorhexidine) daily until the cord separates
  - Chlorhexidine has a risk of skin irritation especially in preterm newborns
  - Use care to apply Chlorhexidine solution directly to umbilical cord and not on surrounding skin, do not cover with a dressing
  - Consider the risk of significant skin irritation vs benefit of infection prevention in the < 1 kg newborn
- If Chlorhexadine is not available or skin irritation occurs, keep cord dry and open to air

4. VITAMIN K

- Administer to all newborns to prevent hemorrhagic disease of the newborn
- If newborn was born at hospital, confirm that Vitamin K was given by maternity
- If newborn was born at health center or home and no record of having received it, give Vitamin K x 1 (1 mg IM for full term and 0.5 mg IM for preterm infants/infants < 1.5 kg)

5. ANTIBIOTIC EYE OINTMENT

- Administer Tetracycline 1% eye ointment to all newborns to prevent eye infections
- If newborn was born at hospital, confirm that eye ointment was given in maternity
- If newborn was born at health center or home and no record of having received eye ointment, give on admission

6. BATHING

- Newborns are at increased risk of hypothermia during and immediately after being bathed
- Ideally avoid bathing for the first 24 hours
- Minimize length of bath, dry newborn promptly and thoroughly. Some newborns (especially preterm and low birth weight) need to have portions of body washed while rest remains covered to prevent hypothermia

7. HISTORY AND PHYSICAL EXAMINATION

- Verify identification, place name band, and re-check prior to any medication administration
- Review maternal history and conduct newborn physical examination

8. INFECTION PREVENTION AND 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 waste, patient care equipment and soiled linen
- Prevention of needle stick and sharps injuries
- Environmental cleaning

Additional precautions

- Needed for diseases transmitted by air, droplets and contact
- Exact precautions vary by disease
- Patients with a viral illness should not be placed near patients with compromised immune system including neonates

Hand hygiene

Hand hygiene is the simplest and most cost effective way to prevent the transmission of infection.

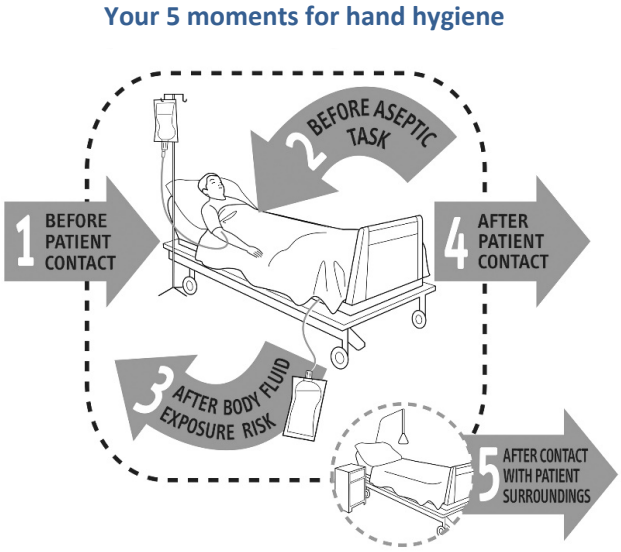
Two methods of hand hygiene:

1. Hand-rub with waterless antiseptic solution
    a. Alcohol hand-rubs are appropriate for rapid hand decontamination between patient contacts
    b. If alcohol hand-rub not available: Mix alcohol and glycerin solution: 2ml of glycerin + 100 ml of alcohol 70–90%; clean hands with 3 to 5 ml of solution
    c. Not a substitute for hand washing if hands are soiled
2. Hand wash with clean water and soap
    a. Dry hands with clean towel after washing or air dry
    b. Common towels must not be used as they facilitate transmission of infection

When to perform hand hygiene

- Unit staff and parents:
    - Prior to entry to neonatal care
- Unit Staff:
    - Before touching a patient
    - Before a clean/ aseptic procedure

- After handling any blood, body fluid or contaminated items
- After touching a patient
- After touching patient surroundings



World Health Organization, 2014.

Equipment cleaning

- Equipment that can be dedicated to a single patient should remain at the bedside
  - Stethoscope, thermometer if feasible
- Equipment that is shared must be cleaned between patients
  - Glucose monitor, oxygen saturation monitor, scale
- All surfaces in patient care areas should be cleaned daily including countertops and tables, medication cart
  - 0.5% Chlorine or 70% alcohol solution should be used to clean surfaces and equipment
  - Allow to dry before use on another patient
  - Chlorhexidine is intended for skin preparation or hand cleaning; not intended for cleaning surfaces

Personal attire

- Staff of neonatal unit: Leave white coats outside unit and replace with unit specific coats
- Parents: Wear washable multi-use gown over regular clothes

CHAPTER 2

Assessment and Stabilization of the High Risk Newborn

Before Delivery

- Consider any risk factors that make neonatal resuscitation likely:
  - Preterm (GA < 35 weeks)
  - Meconium-stained amniotic fluid
  - Concerns for maternal infection
  - Other obstetric concerns at delivery (prolonged labor, placental abruption, shoulder dystocia, fetal distress, hemorrhage)
- Prepare resuscitation area, materials, equipment (see chapter 3)

Immediate Assessment On Admission

- All newborns should be assessed and have temperature, vital signs and weight documented by a nurse within 30 minutes of admission.
- All newborns should be examined and have orders written by a doctor as soon as possible after admission

1. PREGNANCY DATING

Definitions

- *Gestational Age*: time from last menstrual period (LMP) to birth
- *Chronologic Age*: age since birth
- *Post Menstrual Age (PMA):* gestational age + chronologic age
- *Term gestation:* > 37 weeks
- *Preterm:* < 37 weeks gestation
- *Very preterm:* < 33 weeks gestation
- *Low Birth Weight (LBW)*: birth weight < 2.5 kg
- *Very Low Birth Weight (VLBW):* birth weight < 1.5 kg
- *Extremely Low Birth Weight (ELBW)*: birth weight < 1 kg

In this protocol, we often refer to "LBW infants < 2 kg" as they are a subset of LBW who are most at risk for specific conditions.

- The newborn's due date can be calculated from the date of the last menstrual period (LMP) by subtracting 3 months and adding one week (e.g. an LMP of October 21st = due date of July 28th)

- Determine the gestational age for all LBW newborns
  - Use LMP if known
  - Perform Ballard score (appendix A) if LMP not known
  - If both LMP and Ballard known, use LMP unless differs from Ballard by > 2 weeks

2. THERMOREGULATION (SEE CHAPTER 4)

- Measure axillary temperature immediately on admission. Normal: 36.5–37.5 °C
- If hypothermic (temp < 36.0 °C), begin Kangaroo Mother Care (KMC), or use an external heat source (radiant warmer, warming lamp or incubator) if available **(See accompanying Equipment Manual for details)**
- Avoid hyperthermia, especially if risk of birth asphyxia, as it exacerbates brain injury

3. RESPIRATORY (SEE CHAPTER 5)

ASSESSMENT

- Assess for grunting, flaring, retractions, tachypnea, cyanosis
- Measure O_2 saturation immediately on admission. Goal O_2 saturation: > 90%
  - If O_2 saturation monitor not available, check tongue color for cyanosis

Treatment

Respiratory support should be started immediately after identification of need

- Nasal Cannula oxygen (NC O_2) by oxygen concentrator or tank
- Continuous Positive Airway Pressure (CPAP)
- Treat all newborns < 1.5 kg and < 33 weeks gestation with caffeine or aminophylline

4. CARDIOVASCULAR (SEE CHAPTER 6)

- If capillary refill > 3 seconds, history of suspected blood loss or sepsis, or peripheral pulses weak, give 10 mL/kg IV bolus of normal saline over 30 minutes.
- May repeat fluid bolus for a total of 3 times. Measure hemoglobin to assess need for blood transfusion.
  - If able to accurately measure neonatal blood pressure, mean blood pressure less than gestational age in weeks represents hypotension and should also be treated with IV fluid bolus

5. FLUIDS AND NUTRITION (SEE CHAPTER 7.2)

- Most newborns with BW < 1.5 kg, those with cardiorespiratory instability, asphyxia, or respiratory distress should be started on IV fluids and should not receive enteral feedings. Newborns who require IV fluids on day of birth should be started on G10% at 80 mL/kg/day for preterm infants (< 1.5 kg) and 60 ml/kg/day for term infants (> 1.5 kg) and those at risk for cerebral edema (ex. birth asphyxia)

6. HYPOGLYCEMIA (SEE CHAPTER 7.4)

- Measure glucose for all newborns admitted to neonatal unit if possible
  - For infants at highest risk obtain blood glucose within 1 hour of life: infant of diabetic mother, large for gestational age, low birth weight/preterm, septic, hypothermic, ill-appearing
- Goal glucose is > 45 mg/dL (2.5 mmol/L)
- If unable to measure blood sugar, assess for hypoglycemia based on symptoms (jitteriness, lethargy, inability to breastfeed, seizures)
- If hypoglycemic, treat per hypoglycemia protocol

7. HYPERBILIRUBINEMIA (SEE CHAPTER 8)

- Measure serum bilirubin for newborns with visible jaundice on day of birth and those with visible jaundice involving more than face and chest. Inspect palms and soles
- Treat with phototherapy per hyperbilirubinemia protocol
  - If no serum bilirubin available, start phototherapy if jaundiced below the chest

8. PERINATAL BACTERIAL INFECTION (SEE CHAPTER 9.1)

Assessment

Risk of bacterial infection is assessed on the basis of:

- Perinatal risk factors (labor and delivery)
- Physical exam: cardiorespiratory/temperature instability, lethargy, full fontanelle
- Laboratory Investigations
  - FBC: concerning if WBC < 5,000 or > 20,000, granulocyte > 70%
  - CRP: concerning if positive (> 1 mg/dL) at 24 hours of life
  - Chest X ray: consider if newborn has respiratory distress
  - Blood culture if available

Treatment

- Administer antibiotics as soon as possible (after blood culture if available) if there is any concern for sepsis
  - Start with Ampicillin and Gentamicin

9. PREVENTION OF VERTICAL HIV TRANSMISSION (SEE CHAPTER 9.2)

Assessment

- Send maternal HIV serological test if not done. If newborn is HIV exposed, confirm what EMTCT therapy the mother received.

Treatment

- Give the newborn antiretroviral prophylaxis per national protocol

10. HYPOXIC ISCHEMIC ENCEPHALOPATHY (SEE CHAPTER 11.1)

Assessment

- At risk for HIE if:
  - Resuscitation needed
  - 5 minute Apgar < 5 or no cry by five minutes of life
  - Abnormal neurological examination

Treatment

- Supportive care
  - Start supplemental O2 if saturation < 90%
  - NPO if respiratory distress, seizures or Sarnat stage = 3
    - IVF, G10% at 60 mL/kg/day
  - Monitor and normalize glucose and electrolytes
  - Monitor and treat seizures
  - Maintain euthermia
    - Patients with HIE are at risk for thermal instability; avoid hyperthermia, use caution with external heat source

11. SEIZURES (SEE CHAPTER 11.2)

Assessment

- Closely monitor for seizures
  - Compared to older patients, neonatal seizures can be subtle, sometimes manifested only by mild rhythmic movements, lip or tongue smacking or eye deviation
- Determine etiology (consider HIE, hypoglycemia, meningitis)

Treatment

- Phenobarbital : Administer over at least 10 minutes due to risk of apnea
  - Monitor for respiratory depression/apnea due to seizures and anticonvulsants
- Phenytoin (Fosphenytoin preferable if available) if second agent needed
- Treat underlying etiology such as hypoglycemia, electrolyte imbalance or infection immediately

12. GUIDELINES FOR TRANSFER TO ANOTHER FACILITY

- Stabilize patient to the best of your ability prior to and during transport
  - *Thermoregulation:* provide KMC by parent or other family member during transport
  - *Respiratory Support:* Provide oxygen during transport if respiratory distress or hypoxia
  - *Fluids and Nutrition:* Check blood sugar and treat hypoglycemia prior to transport. If infant requires IV fluids, administer NS 10 ml/kg fluid bolus prior to transport and discontinue during ambulance transport to avoid fluid administration error.
  - *Infectious Disease:* If infant has suspected infection, give first dose of antibiotics prior to transport

- Communication
  - Discuss clinical course and reasons for transfer with receiving facility prior to transfer
  - Record relevant antepartum, delivery, postnatal history and pre-transfer treatment in transfer note
- Equipment and Personnel
  - A nurse should accompany infant and continue close monitoring during transport
  - A parent or caregiver should accompany infant during transport whenever possible
  - The ambulance should have emergency equipment per standards at all times, including ambubag with correct size mask, oxygen, nasal cannula, pulse oximeter, IV fluids and catheter, and emergency medications such as adrenaline

CHAPTER 3

Neonatal Resuscitation

Be prepared for every delivery

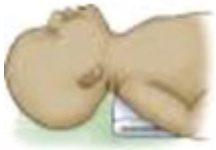
- Always have resuscitation equipment checked and ready
- *Every* delivery needs at least 1 person:
  - whose only responsibility is the newborn
  - who is available and capable of performing a full resuscitation
- When significant resuscitation is anticipated, have additional personnel present
- Learn relevant maternal history including dating of pregnancy
  - Preterm newborns (GA < 35 weeks) are at increased risk of needing resuscitation
  - Meconium-stained amniotic fluid
  - Concerns for maternal infection
  - Other obstetric concerns at delivery (prolonged labor, placental abruption, shoulder dystocia, fetal distress, hemorrhage)

EQUIPMENT AT DELIVERY

- Clean, warm towels/clothes
- Self-inflating bag and mask, term newborn and preterm newborn sizes
- Suction device
- Tie for umbilical cord
- Nasogastric tube
- Oxygen (if available)
- Clock or timer (with seconds hand)
- IV infusion equipment
- Medications and fluids: Adrenaline, G10% and normal saline

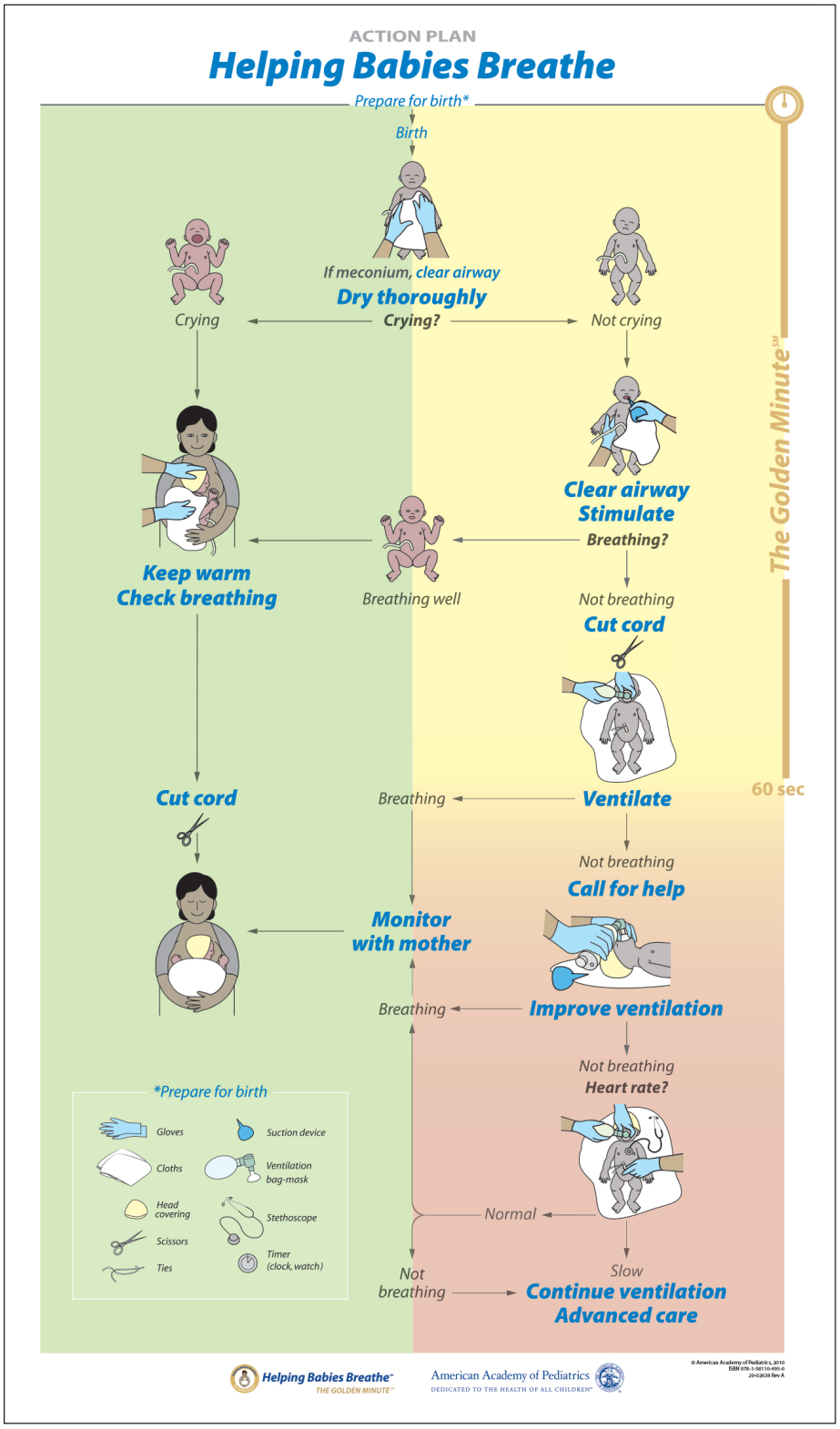
Order of Priority for resuscitation

A: Airway (clear airway and put head in neutral position as below)

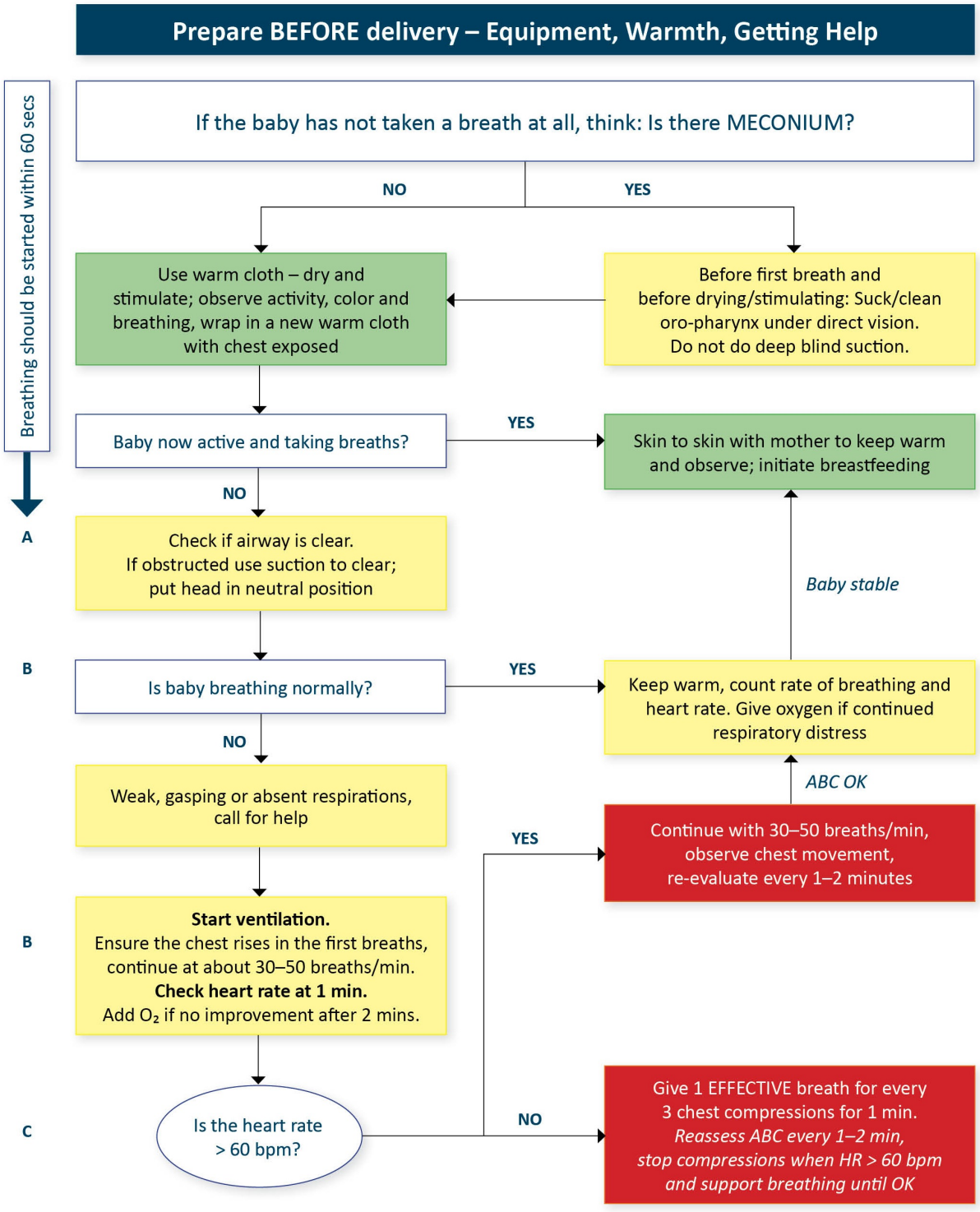


B: Breathing (stimulate and provide positive-pressure ventilation)
C: Circulation (administer chest compressions)
D: Drugs (administer adrenaline and/or volume)

For resuscitations in the health center setting, use Helping Babies Breath (HBB) algorithm:



For resuscitation in the hospital setting, use WHO algorithm (Adapted from Rwanda ETAT 2014):



Drugs for neonatal resuscitation

Drugs	Concentration	Route/Dosage
Adrenaline	1:10,000	IV: 0.1–0.3 ml/kg
Volume expander	Normal saline (NS 0.9%); Whole blood	IV: 10 ml/kg

The majority of newborns will respond to standard resuscitation (algorithm above). However, if HR persists < 60 beats per minute and trained staff and equipment available, adrenaline may be administered per the chart below. If a newborn has adequate respiratory effort, and transitions to a pink color (check mucous membranes), then no further resuscitation is necessary.

Adrenaline (1mg/ml→0.1mg/ml)			
Adrenaline (1mg/ml or 1:1,000) is a high-dose solution This must be diluted to standard-dose (0.1mg/ml or 1:10,000) before using it			
IV/IO: bradycardia, asystole			
⊖ Prepare	**⊜ Calculate**		**⊛ Give**
YOU MUST DILUTE adrenaline 1 mg/ml solution to 0.1 mg/ml BEFORE using it: Mix 0.1 ml of adrenaline with 0.9 ml of sterile water/saline. Then give the written volume.	**Weight (kg)**	**Dose (mg) (0.1 mg/ml)**	**Volume (ml)**
		0.01 mg/kg	**0.1 ml/kg of the diluted solution**
	1 kg	0.01 mg	0.1 ml of the diluted solution
	2 kg	0.02 mg	0.2 ml of the diluted solution
	3 kg	0.03 mg	0.3 ml of the diluted solution
	4 kg	0.04 mg	0.4 ml of the diluted solution
	5 kg	0.05 mg	0.5 ml of the diluted solution
	6 kg	0.06 mg	0.6 ml of the diluted solution
	7 kg	0.07 mg	0.7 ml of the diluted solution
	8 kg	0.08 mg	0.8 ml of the diluted solution
	9 kg	0.09 mg	0.9 ml of the diluted solution
	10 kg	0.10 mg	1 ml of the diluted solution
	11 kg	0.11 mg	1.1 ml of the diluted solution
	12 kg	0.12 mg	1.2 ml of the diluted solution
	13 kg	0.13 mg	1.3 ml of the diluted solution
	14 kg	0.14 mg	1.4 ml of the diluted solution
	15 kg	0.15 mg	1.5 ml of the diluted solution

CHAPTER 4

Thermoregulation

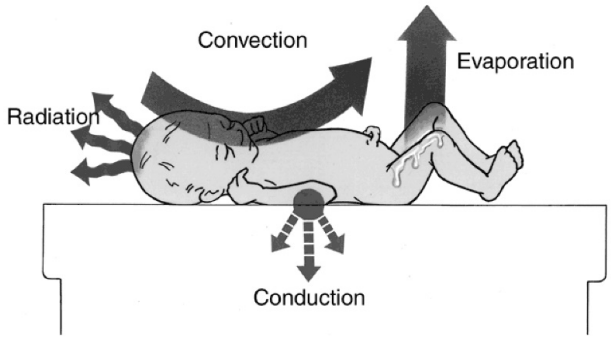
4.1 Principles of Thermoregulation

- Normal temperature range 36.5–37.5°C
- Temperature regulation is critical immediately after birth. Hypothermia can cause increased oxygen and energy consumption resulting in hypoxia, metabolic acidosis, hypoglycemia, apnea, bleeding, neonatal cold injury, failure to gain weight and even mortality.

HOW NEWBORNS LOSE HEAT

All practices aimed at maintaining normothermia are based on these 4 mechanisms of heat loss:

- **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 loss to currents of air
- **Radiation:** heat loss via electromagnetic waves from skin to surrounding surfaces



THERMOREGULATION ROUTINE CARE

- Temperature should be monitored every 3 hours in the neonatal unit
- Full term babies should be kept wrapped in dry cloth, wear a hat, and with face visible
- Preterm and LBW babies should be kept in Kangaroo Mother Care (KMC) (see below)
- Close windows/curtains to prevent drafts

4.2 Kangaroo mother care (KMC) for low birth weight (LBW) newborns

- Encourage all mothers with stable LBW newborns to KMC
- KMC transfers heat from mother to newborn by conduction
- Advantages: Prevents hypothermia, enables frequent breastfeeding and allows earlier hospital discharge

METHOD

- Skin to skin on chest of responsible adult
- Face should positioned to the side and should not be covered
- Can be intermittent or continuous
- Good hand hygiene to prevent infection
- If newborns receiving phototherapy develop hypothermia, consider alternating with KMC

CRITERIA

- Stable newborn
- Acceptable medical condition/equipment
  - Mild respiratory distress
  - Receiving nasal cannula oxygen or CPAP (interface with patient secure)
  - Nasogastric tube and IV cannula

CONTRAINDICATIONS

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

MONITORING

- If hypothermic at initiation of KMC, measure temperature one hour after starting KMC to ensure normothermia.

HOSPITAL DISCHARGE

- Infants may be discharged to home while still requiring KMC for thermoregulation if
  - Temperature (and remainder of vital signs) stable
  - Method well tolerated by newborn and mother

FOLLOW UP

- All LBW newborns < 2 kg should have follow-up appointment to assess temperature and weight gain within the week after discharge.
- Readmission criteria
  - Unable to continue KMC for a newborn < 2 kg
  - < 10 grams/kg/day weight gain
  - Presence of any danger signs

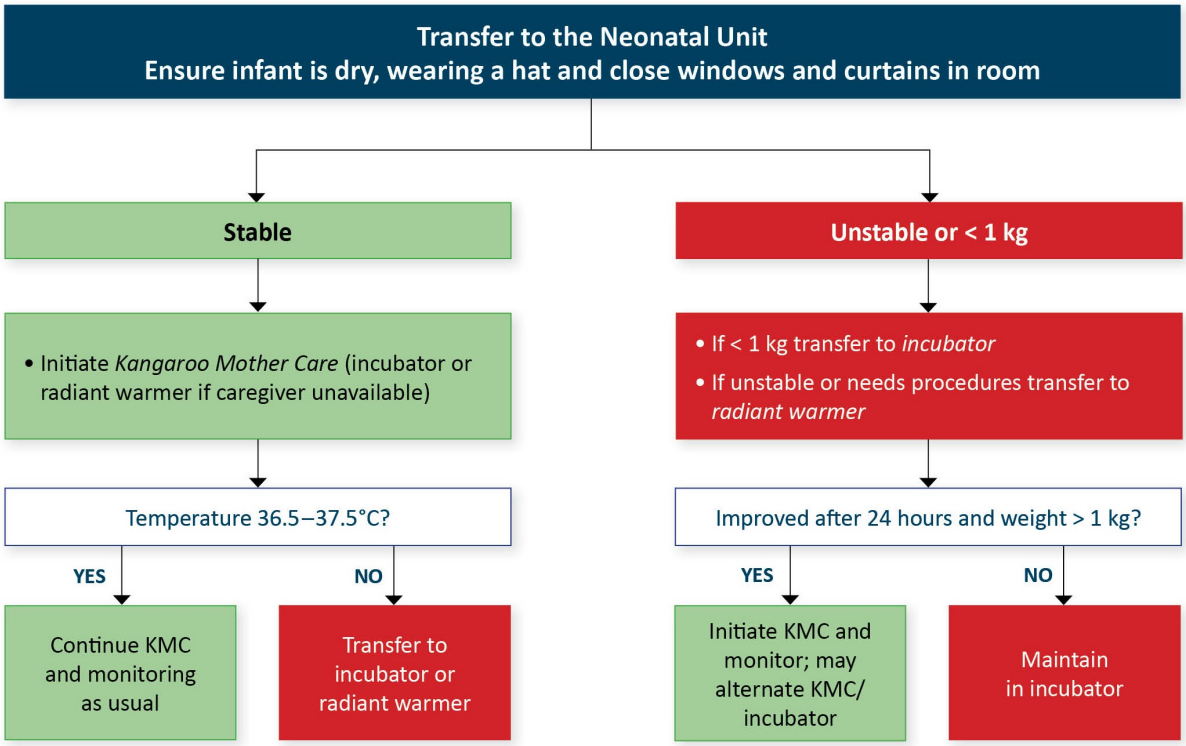
4.3 Management of Newborns with Hypothermia

See “Hypothermia Management of Newborns” algorithm below.

4.4 External Heat Sources (see accompanying Equipment Manual for detailed instruction manual)

Caution should be used with use of external heat sources in newborns due to risk of hyperthermia and burns with improper use or defective equipment. Newborns should be monitored closely when external sources of heat are in use. Review instructions for using the specific type of radiant warmer or incubator prior to use.

Hypothermia Management of Newborns (Temperature < 36°C)



Definition of Successful KMC

- Infant able to maintain temperature 36.5 – 37.5°C
- Exam stable
- After first week of life steady weight gain, > 15 grams/kg/day

Special Considerations for Very Low Birth Weight Infants < 1.5 kg

- Increased risk for hypothermia; immediate intervention essential
- Unstable infants < 1.5 kg should remain in incubator until exam stable and weight gain steady
- Once goals achieved begin transition to KMC. May increase KMC frequency and duration daily as tolerated.

For Severe Hypothermia (Temperature < 35°C)

- Use radiant warmer for immediate rewarming
- Hold enteral feeds until temperature > 35°C; initiate IV fluid if prolonged
- Recheck temperature every hour until > 36.5°C

CHAPTER 5

Respiratory

5.1 Respiratory Disorders in Newborns

ASSESSMENT

- Abnormal Respiratory Rate (RR):
  - Tachypnea: RR > 60 breaths/minute
  - Bradypnea: RR < 30 breaths/minute
  - Apnea: cessation of breathing for > 15 seconds
- Increased Work of Breathing
  - Grunting on expiration
  - Flaring of nostrils
  - Retractions (chest indrawing)
- Hypoxia
  - Central cyanosis: blue tongue and lips
  - O2 saturation < 90%

MILD RESPIRATORY DISTRESS

- PEx: minimal grunting, flaring and retractions
- VS: RR in 50–70, Oxygen saturation > 90%

MODERATE TO SEVERE RESPIRATORY DISTRESS

- PEx: moderate to severe grunting, flaring, retractions
- VS: RR > 70 or < 30, oxygen saturation < 90%

INVESTIGATION

- FBC, CRP, blood culture if available and infection is suspected
- Blood gas if available
- Chest X-ray
- Echocardiography if congenital cardiac disease suspected

DIAGNOSIS

Typical presentation of most common respiratory conditions:

- Pneumonia
  - Birth History: Perinatal risk factors for sepsis

  - Laboratory evaluation suggestive of sepsis
  - Chest X ray may be focal but often nonspecific in newborns
  - Moderate to Severe respiratory distress that lasts for > 48 hours
- Respiratory Distress Syndrome (RDS)
  - Birth History: Preterm delivery at < 35 weeks gestation
  - Laboratory evaluation not suggestive of sepsis (unless RDS with pneumonia)
  - Chest X ray poorly expanded (prior to positive pressure such as CPAP) diffusely hazy lung fields with overlying air bronchograms
- Transient Tachypnea of the Newborn (TTN)
  - Birth History: usually term, short labor, rapid delivery, C-section, no perinatal risk factors for sepsis
  - Laboratory evaluation not concerning for sepsis
  - Chest X ray with fluid in fissure on right side
  - Mild respiratory distress that resolves spontaneously over hours to 1–2 days
- Meconium Aspiration Syndrome (MAS)
  - Birth History: Meconium stained amniotic fluid, often term or post term delivery
  - Laboratory evaluation may be suggestive of sepsis; often associated with pneumonia
  - Chest X ray with hyperinflated lungs, diffuse patchy infiltrates
  - Moderate to severe respiratory distress, associated with spontaneous pneumothorax
- Pneumothorax (PTX)
  - Birth History: Received bag mask ventilation at birth, meconium stained amniotic fluid if associated with MAS, can also occur spontaneously
  - Laboratory evaluation not concerning for sepsis (unless PTX associated with pneumonia/MAS)
  - Chest X ray with unilateral hyperlucency representing PTX. Cardiac shadow shifted away from PTX if component of tension.
  - Mild to severe respiratory distress depending on size of PTX. Smaller PTXs resolve spontaneously over days. Babies with PTX that interferes with cardiac function (low blood pressure, poor perfusion, tachycardia) have tension PTX. This requires immediate needle aspiration by an experienced provider.

MANAGEMENT/TREATMENT

General Measures

- Immediately resuscitate the newborn using a bag and mask if:
  - Not breathing at all, even when stimulated
  - Gasping respirations
  - Heart rate < 100 beats/minutes
- Stabilize and admit to neonatal unit if available

- Monitor Vital signs with focus on respiratory rate and oxygen saturation
  - Normal RR 30–60
    - Preterm newborns are at risk for apnea and bradycardia of prematurity, treat with methylxanthine (caffeine or aminophylline) therapy, respond to episodes with stimulation. If persists, consider CPAP.
  - Goal oxygen saturation
    - Room air: 90–100%
    - Supplemental Oxygen: 90–95%
- NPO, IVF, follow blood glucose
  - Treat if < 45mg/dl (2.6 mmol/l)
- Treat for sepsis/pneumonia with antibiotics

Newborn with tachypnea and cyanosis (despite oxygen), but no or minimally increased work of breathing; consider congenital heart disease.

Treatment options for respiratory distress are either nasal cannula oxygen (NC O_2) or Continuous Positive Airway Pressure (CPAP) depending on newborn's gestational age, birth weight and degree of respiratory distress:

- For very preterm (< 33 weeks gestation) and LBW < 2 kg
  - Start CPAP if *any* respiratory distress
- For newborns ≥ 2 kg or ≥ 33 weeks gestation
  - If mild respiratory distress and O2 sat < 90%, start NC O_2
  - If moderate to severe respiratory distress, start CPAP +/- oxygen

OXYGEN DELIVERY METHODS

- Nasal Cannula
  - Long term oxygen therapy, flow 0.5L–2L/min
  - Ensure appropriate prong size
  - Lowest concentration of oxygen delivered to patient
- Face Mask
  - Can deliver higher flow oxygen (5–6 L/min)
  - Optimal for nasal obstruction
  - Higher concentration of oxygen delivered than nasal cannula
- Oxygen hood/face mask with reservoir (10–15 L/min)
  - Highest concentration of oxygen delivered to patient
- CPAP: Continuous Positive Airway Pressure

OXYGEN SOURCES

Use minimal amount of oxygen necessary, causes long term problems with lungs and retinopathy of prematurity leading to loss of vision in preterms.

- Oxygen concentrator
  - Variable oxygen concentration 45–80%
  - 0.5 to 5 liters/minute flow
  - Does not run out of oxygen
  - Requires electricity
- Oxygen tank
  - 100% oxygen concentration
  - ≥ 1 L/min flow
  - Use with caution in preterm due to risk retinopathy of prematurity if over oxygenated (O2 sat > 95%)
  - Can run out of oxygen
  - Does not require electricity

5.2 Continuous Positive Airway Pressure (CPAP)

BACKGROUND

- CPAP may be useful respiratory support for any newborn with moderate to severe respiratory distress, but it is especially useful for preterm and low birth weight newborns that can benefit even if they have only mild respiratory distress.
- **Bubble** CPAP is a form of CPAP in which the pressure delivered to the lungs is generated by pressure (measured in cm H20), from the depth of the expiratory limb of the CPAP circuit in a water chamber. This protocol applies to bubble CPAP.
- CPAP offers the following benefits:
  - Keeps the respiratory tract and lungs open
  - Promotes comfortable breathing
  - Improves oxygen levels and decreases apnea in preterm newborns

INDICATIONS FOR CPAP (SEE "TREATMENT OF NEWBORN WITH RESPIRATORY DISTRESS" BELOW)

- Term newborn with a moderate to severe respiratory distress
- Very preterm (< 33 weeks gestation) or LBW newborns < 2 kg with *any* respiratory distress
- Significant apnea and bradycardia of prematurity

The etiology of respiratory symptoms and the natural history of that diagnosis guide the value of CPAP with it particularly benefitting preterm/< 2kg newborns with surfactant deficiency. The respiratory assessment to determine need for CPAP is based on the history and physical examination, including vital signs (VS), and presence/degree of grunting, flaring and retractions. Once the overall assessment is completed, the degree of respiratory distress should be determined to be "mild" or "moderate to severe."

MILD SIGNS

- Physical exam: grunting, flaring and retractions
- RR 50–70, Oxygen saturation > 90%

Recommended respiratory support for mild signs:

- Term/ Near term newborns: Standard oxygen therapy via nasal cannula, oxygen hood or mask
- Very preterm (< 33 weeks)/LBW < 2 kg): CPAP

MODERATE TO SEVERE SIGNS

- Physical exam: grunting, flaring, retractions and RR > 70 or < 30, oxygen saturation < 90%

Recommended respiratory support for moderate to severe signs:

- All Newborns: CPAP

5.3 Apnea and Bradycardia of Prematurity

Very preterm newborns (< 33 weeks gestation) and VLBW (BW < 1.5 kg) are susceptible to apnea and bradycardia of prematurity due to immaturity of their cardio-respiratory drive. Pharmacological therapy with a methylxanthine stimulant (caffeine or aminophylline) decreases apnea and bradycardia of prematurity and is a crucial intervention to improve the outcome of preterm newborns.

DEFINITION

- *Apnea*: Cessation of breathing that lasts for at least 15 seconds or is accompanied by bradycardia or oxygen desaturation(cyanosis)
- *Bradycardia*: Abnormally slow HR; < 100 beats/minute in the preterm newborn

SIGNIFICANCE

- A slowing of RR or HR causes decreased oxygen and blood supply to vital organs potentially causing repetitive hypoxic ischemic end organ injury, including brain injury
- Usually due to immaturity of cardio-respiratory drive
- If new onset or worsened frequency/severity, may indicate other problems such as infection, hypothermia or seizures

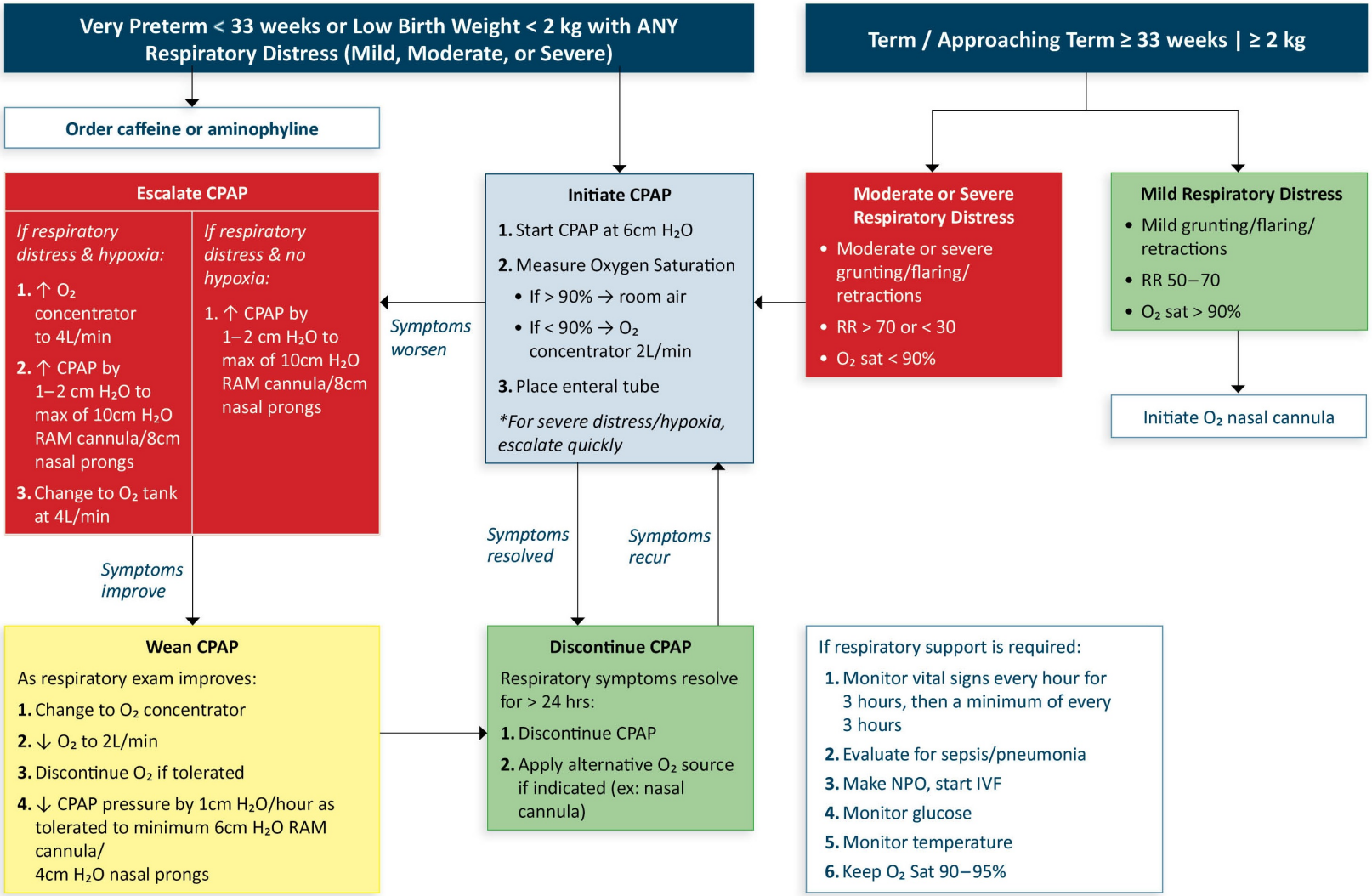
ASSESSMENT

- Monitor with cardiovascular and/or O2 saturation monitor if available
- If not available, assess by physical exam for color change: pallor, cyanosis or mottling. In mild cases of apnea/bradycardia, there may be no associated physical examination findings.
- If new onset apnea and bradycardia, or worsened frequency or severity:
  - Conduct thorough physical exam looking for signs/symptoms of sepsis (hypotension, poor perfusion, pallor, respiratory distress, abdominal distention, lethargy)
  - Consider FBC and CXR
  - Consider starting antibiotics based on above evaluation

TREATMENT

- All newborns with birth weight < 1.5 kg or GA < 33 weeks should be started on a methylxanthine stimulant (caffeine or aminophylline) on admission or DOL 1
- If newborn is too immature or ill to PO feed and is prescribed enteral methylxanthine, it should be given NG, not PO
- Caffeine
  - Loading dose: 20 mg/kg caffeine citrate NG/PO x1 on day of initiation
  - Maintenance dose (subsequent day and onward): 10 mg/kg/day caffeine citrate NG/PO, given as once daily dose in morning
  - Caffeine is currently only available for enteral administration in Rwanda. May give by enteral route even if newborn is still on IV fluids
- Aminophylline
  - Loading dose: 10 mg/kg IV x1 on day of initiation
  - Maintenance dose (subsequent day and onward):
    - < 7 days of age: 2.5 mg/kg/dose IV or NG/PO Q12 hrs
    - ≥ 7 days of age: 4 mg/kg/dose IV or NG/PO Q12 hrs
  - Contraindication: Severe vomiting, convulsions
  - Give aminophylline IV if newborn is still receiving IV fluids, then give NG/PO
- If newborn develops tachycardia, vomiting, and agitation these may be signs of toxicity. Evaluate for all potential causes of tachycardia and vomiting such as sepsis, necrotizing enterocolitis, and dehydration. If cannot find another cause of the patient's symptoms consider holding one dose of caffeine or aminophylline and then reassess. If the patient has improvement of the tachycardia/vomiting within 12 hours, resume caffeine or aminophylline but decrease the dose by 10%.
- Discontinue caffeine or aminophylline at 33 weeks post-menstrual age or 3 days prior to anticipated discharge to home if there are no signs or symptoms of apnea or bradycardia. After discontinuation, it takes 1 day for the serum level to fall below the therapeutic range. The newborn must then be observed closely for an additional 2 days to monitor for recurrence of apnea and bradycardia. *Note: Newborns should NOT be discharged to home on caffeine or aminophylline because it is difficult to safely discontinue the medication in the outpatient setting.*

Treatment of Newborn with Respiratory Distress



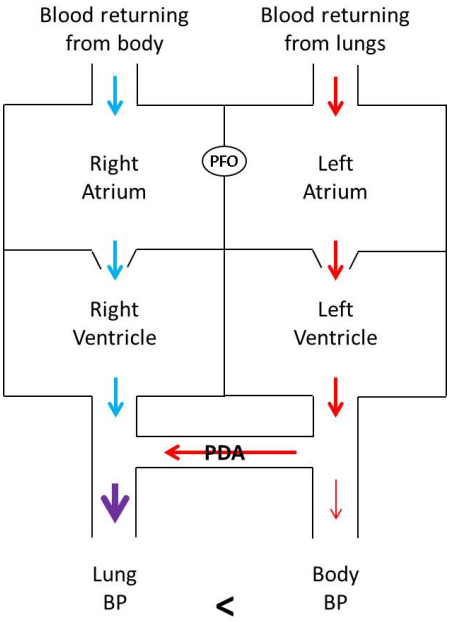
CHAPTER 6

Cardiovascular

6.1 Patent Ductus Arteriosus (PDA)

DEFINITION

- *Patent Ductus Arteriosus*: Post-natal persistence of the normal fetal vessel that joins the pulmonary artery to the aorta



ASSESSMENT

- Most commonly seen in preterm newborns, increased risk in setting of hypoxia
- Also seen as congenital defect in newborns of any gestational age, often associated with more complex congenital heart disease
- Signs and symptoms (as seen in preterm newborns, when blood is typically shunted from left to right through the PDA)
  - Systolic or continuous murmur at left sternal border, hyperactive precordium
  - Pulmonary overcirculation
    - Tachypnea
    - Increased work of breathing
    - Pulmonary hemorrhage
- Systemic hypotension with wide pulse pressure, bounding pulses, palpable palmar pulse

- Investigation (diagnosis may be made clinically)
  - Chest X ray: pulmonary edema and cardiomegaly
  - Echocardiography

NON-PHARMACEUTICAL MANAGEMENT

- Support increased respiratory needs
- Fluid restrict to about 80% of maintenance fluids

Infants with clinically significant PDA are at risk for necrotizing enterocolitis due to decreased mesenteric perfusion. Monitor closely, consider replacing enteral feeds with IVF for 2–3 days to mimimize risk of NEC.

PHARMACEUTICAL MANAGEMENT

- If preterm newborn, may attempt to close PDA with enteral ibuprofen
  - Dose: 10 mg/kg/dose x 1 dose, followed 24 hours later by 5 mg/kg/dose every 24 hours for 2 doses
    - If liquid preparation available, this is preferable over crushing pill form
    - Contraindicated in setting of thrombocytopenia (< 50,000/mm3), bleeding disorders, impaired renal function, and hyperbilirubinemia approaching exchange transfusion levels
    - Course may be repeated x 1. May not be effective in babies > 1 month old.
    - Rare risk of intestinal perforation with ibuprofen treatment
- If PDA with cardiac failure, consider risk/benefit of diuretics
  - Furosemide: 1 mg/kg/day, IV or enteral
  - If medical treatment is contraindicated or has failed, consider surgical closure

CHAPTER 7

Fluids, Electrolytes & Nutrition

7.1 Feeding Guidelines for Well Newborns: Breastfeeding

- Newborns admitted to the neonatal care unit who are stable from cardio-respiratory standpoint and have a BW of > 1.5 kg can be offered breastfeeding on demand

BREASTFEEDING

General Points

- Newborns usually feed at least 8 times a day, every 2–3 hours throughout the day and night
- Both breasts should be offered at each feeding, alternating which breast is offered first
- Breastfeeding is the best method to feed a newborn and will provide all the nutrients needed for growth
- Formula should be reserved to supplement when mothers milk supply is inadequate despite all attempts to increase production
- Lactation Support: Breast milk is made on a supply and demand basis: milk must be removed from the breast in order for it to make more milk
  - Counsel adequate maternal nutrition, hydration and rest, frequent feedings and proper positioning
  - Mothers of newborns who cannot breast feed due to illness, prematurity or any other reason should be advised to begin expressing breast milk early and often (at least every three hours day and night) to encourage milk supply and avoid breast engorgement
  - If the newborn is going to be fed by NG tube, the milk should be saved for this purpose

COMPLICATIONS OF BREASTFEEDING

Sore Nipples

Mild tenderness usually during first week of breastfeeding

- Assure good latch with proper positioning. Try to vary positioning to avoid repeated pressure to same area of sore nipple.
- Breastfeed on less painful side first
- After feeding, rub breast milk onto nipples. Let them air dry.
- Topical moisturizer can be applied to nipples to help healing but should be wiped off before next feeding
- Consider topical antibiotics for infection if nipples are sore, cracked, red, and irritated or crusted, or no improvement in pain with above measures in 2–3 days

Breast Engorgement

- Breast erythema, firmness, tenderness or flattened nipples from buildup of breast milk due to missed feedings or inadequate milk removal
- Treatment
  - Apply cold cloths to breasts between feedings. Gently massage breasts before and during feeding.
  - Hand express milk remaining in breasts after feeding or if missed feeding
  - If the newborn cannot latch on due to flattened nipples, hand express to soften area around nipples
  - Breastfeed or hand express at least every 2 hours until the engorgement is better

Blocked Milk Ducts

- Tender breast with hard reddish lump in otherwise well mother due to obstructed milk duct
- Treatment
  - Continue breastfeeding; the newborn may help dislodge the plug
  - Use warm, moist cloths on breasts before and during feedings
  - Breastfeed on the plugged side every 2 to 3 hours
  - Change positioning so that the newborn's chin points towards the plug
  - Massage the plug with downward motion toward the nipple while breast feeding
  - Plugged ducts should go away within 24 to 48 hours

Mastitis

- Hot, painful and swollen breast in mother with systemic signs of illness due to inflammation and possible infection of milk ducts, typically of one breast
- Treatment
  - Continue to breastfeed; it is safe for the newborn
  - If it is too painful to breastfeed, hand express milk. Resume breastfeeding as soon as able.
  - Apply warm moist cloths to breasts before and during feeding
  - Drain breasts every 2 to 3 hours by breastfeeding or hand expressing
  - Drink plenty of fluids and eat well
  - Paracetamol if indicated for fever or pain
  - Antibiotics if fever or symptoms persist > 12–24 hours

7.2 Feeding and Fluid Guideline for Ill Newborns

- The smaller and younger the newborn, the more fluid and calories needed
- "Weight for calculations" is the weight used for calculation of fluid volume and medications.
  - The birth weight (BW) should be used as the "weight for calculation" until current weight is > BW
  - The current weight should be used as the "weight for calculation" when it is above the birth weight

- Newborns with BW < 1.5 kg or unstable: give only IV fluid on Day 0
- Base volume of IV fluid on chart below.

Total IV Fluid, mL/kg/day for newborns who are NPO			
Days	**< 1.5 kg**	**Term/≥ 1.5 kg**	**Brain injury**
Day 0	80	60	60
Day 1	100	80	60
Day 2+	120	100	80

Note: Day of birth is "Day 0"

- Newborns (DOL 0) should always be started on G10%, never G5%. If a newborn is persistently hyperglycemic on G10% despite minimizing volume of infusion while supporting hydration, change to G5% ¼ RL and monitor glucose closely.
  - This situation occurs most frequently in the ELBW (< 1 kg) newborn
  - G5% ¼ RL is used because G5% is hypotonic
- In the first 24 hours of life, newborns do not need supplemental electrolytes due to higher baseline total body sodium content and decreased renal function. Therefore their IV fluids should be G10%.
- After 24 hours of life, newborns require maintenance Na+ at 3 mEq/kg/day and K+ at 2 mEq/kg/day
  - Usually this is in the form of milk if feedings are started. Therefore, newborns can remain on G10% as they wean off IVF and increase their enteral volume.
  - If feeding is not established by 24 hours of age, newborns requiring prolonged IV fluids need electrolytes (ions). This should generally be given as G10% ¼ RL. If concern for hyperkalemia or alkalosis, IV fluid should be G10% ¼ NS.
- Newborns should not receive high amounts of sodium (do not use ½ NS) for typical maintenance IV fluid
- Newborns require increased total fluid administration if they have increased losses
  - Newborns receiving phototherapy and not feeding well may 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 and diarrhea
- ***See IV fluid recipes in Appendix D***

ENTERAL FEEDING GUIDELINES

- When newborns are stable they can start receiving enteral feeds. LBW newborns should start feeding on day of life 1 if they are otherwise well.
  1. Most newborns < 1.5 kg will have an immature suck reflex; therefore they usually need to start with NG tube feeds
  2. If newborn 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 NGT.
  3. NG feeds should be given by gravity, not pushed through syringe

4. If temperature < 35°C, enteral feedings should not be given until newborn has been rewarmed
    - If it takes longer than three hours to warm a newborn to ≥ 35 °C, maintenance IVF should be started to avoid hypoglycemia

- When advancing enteral and weaning IV volume, the term "Total fluids" = IV fluids + Enteral fluids
- In contrast to IV fluids, enteral fluids are not entirely absorbed into the vascular space. Therefore newborns need higher fluid volume if being enterally fed than if on IV fluids.
- ***Follow the "Recommended IV and Enteral Feeding Rates for Newborns in Neonatal Unit" in Appendix E to increase the total fluids daily by increasing the enteral feeding rate if tolerated (no vomiting or distension) and decreasing IV fluid rate.***

WEIGHT GAIN

- Background
    - Breast milk has approximately 20 kilocalories per 30 mL. Calorie content in breast milk varies throughout the feeding with the hind milk (milk at end of feeding) having the highest caloric concentration.
    - Standard artificial milk (formula) has 20 kilocalories per 30 mL
    - Special Considerations for Preterm Infants:
        - They may require extra calories compared to term infants due to their growth needs
        - Therefore, they may benefit from feeding longer on one breast to obtain hind milk and thus increase caloric intake. Mothers should then hand express milk from other breast.
        - Adequate caloric provision is especially important to support the rapid brain growth of preterm infants; enhanced caloric milk may improve neurologic outcomes by improving short-term growth.
- When newborn achieves full volume feeds, adjust the 150 mL/kg/day volume weekly based on weight gain.
- If not gaining adequately, ideally 15 gm/kg/day, there are two options for increasing caloric provision:
    1. Increase total enteral volume by 10 mL/kg/day every other day as tolerated. Most newborns will tolerate 160 mL/kg/day, and some will tolerate higher volumes.
    2. Increase caloric density of milk. Adding additional formula powder to breast milk will increase the caloric density. Increase caloric density by 4 kcal/oz with formula powder. If well tolerated and still with inadequate weight gain, increase by an additional 2 kcal/oz with oil (total change of 6 kcal/oz). ***See recipes in Appendix F.***
        - NOTE: The choice between increasing volume or caloric density depends on availability of formula powder, newborn's tolerance and clinician preference. Both may be increased alternately. Likely maximal caloric intake would be 26 kcal/oz milk at 170 or 180 mL/kg/day. This should be sufficient for adequate growth of extremely preterm infants.
- Discontinuation of enhanced calorie feeds:
    - When infant approaches readiness for discharge to home, all enhanced calories should be removed and newborn should be solely breastfed to ensure adequate weight gain

- To allow for a three-day weight gain trial of breastfeeding, the additional calories can be discontinued at the same time the methylxanthine stimulant is stopped

7.3 Feeding Intolerance and Necrotizing Enterocolitis (NEC)

- Feeding Intolerance
  - If newborn has feeding intolerance (mild abdominal distension, gastric residuals that are greater than the volume of previous feeding, or vomiting) stop feedings (start IV fluids), slow the advancement of feeds or consider smaller feeds at increased frequency (such as every 2 hours)
    - Note: CPAP usually causes mild abdominal distension. This does not usually prevent standard feeding advancement.
- Suspected NEC
  - If the newborn has bloody stool, marked abdominal distension, visible loops of bowel, discoloration of the abdominal wall, especially if accompanied by signs and symptoms of sepsis, consider the diagnosis of necrotizing enterocolitis (NEC). Air in the bowel wall (pneumatosis) on abdominal X ray is diagnostic.

MANAGEMENT OF NEC

- Stop all enteral feedings, leave NG tube open to air to decompress stomach
- Start IV fluids G10% ¼ RL or G12.5 ¼ LR at 150 mL/kg/day to maximize caloric intake. ***(See IV fluid recipes in Appendix D)***
- Due to fluid losses into the bowel, newborns may need higher IV fluid volume or normal saline boluses
- Broad spectrum antibiotics: ampicillin, gentamicin, metronidazole OR cefotaxime + metronidazole
- Duration of bowel rest and antibiotic therapy: 7 to 14 days. Recommended course: 10 days unless amino acid infusion available.
- Newborns may need medication for pain control
  - Paracetamol: 10 mg/kg PR q 6 hours for up to three days, then only PRN
  - Morphine (0.02 to 0.05 mg/kg IV q 4 hours) can be helpful, but monitor for potential respiratory depression, hypotension and decreased bowel motility
- After course of bowel rest and broad-spectrum antibiotics, slowly reintroduce enteral feeds, watching closely for intolerance, malabsorption and obstruction due to scar tissue (strictures)

7.4 Hypoglycemia

DEFINITION

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

CAUSES/RISK FACTORS

- Prematurity/Low Birth Weight
- Large for Gestational Age Newborn/Newborn of diabetic mother/Hyperinsulinism
- Birth asphyxia
- Feeding difficulties
- Sepsis/Respiratory distress
- Hypothermia

SIGNS AND SYMPTOMS

- Jitteriness, tremors, irritability
- Stupor, lethargy, hypotonia, poor feeding
- Respiratory depression
- Convulsions
- Hypothermia
- Coma

INVESTIGATIONS

- Blood tests for monitoring blood glucose (heel sample)

MANAGEMENT

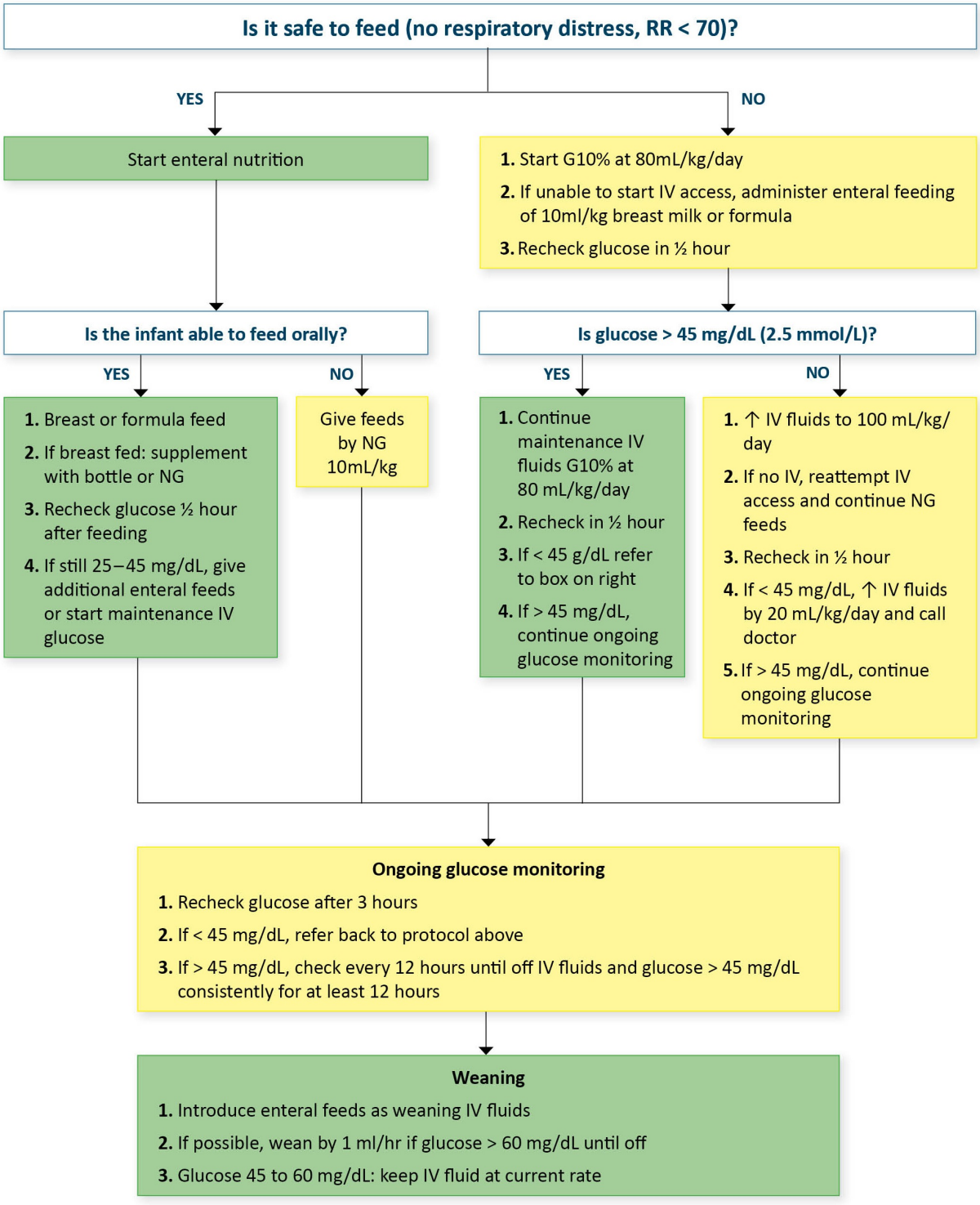
See Moderate and Severe hypoglycemia algorithms below.

Notes:

- Glucose conversion: 1 mmol/L = 18 mg/dL
- If unable to measure blood glucose for high risk but asymptomatic newborn, follow moderate hypoglycemia protocol
  - High risk: Required resuscitation, concern for sepsis, < 35 weeks gestation or birth weight < 2 kg, 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 breast milk not available, use formula. If neither breast nor formula is available, G10% IV fluid may be given enterally

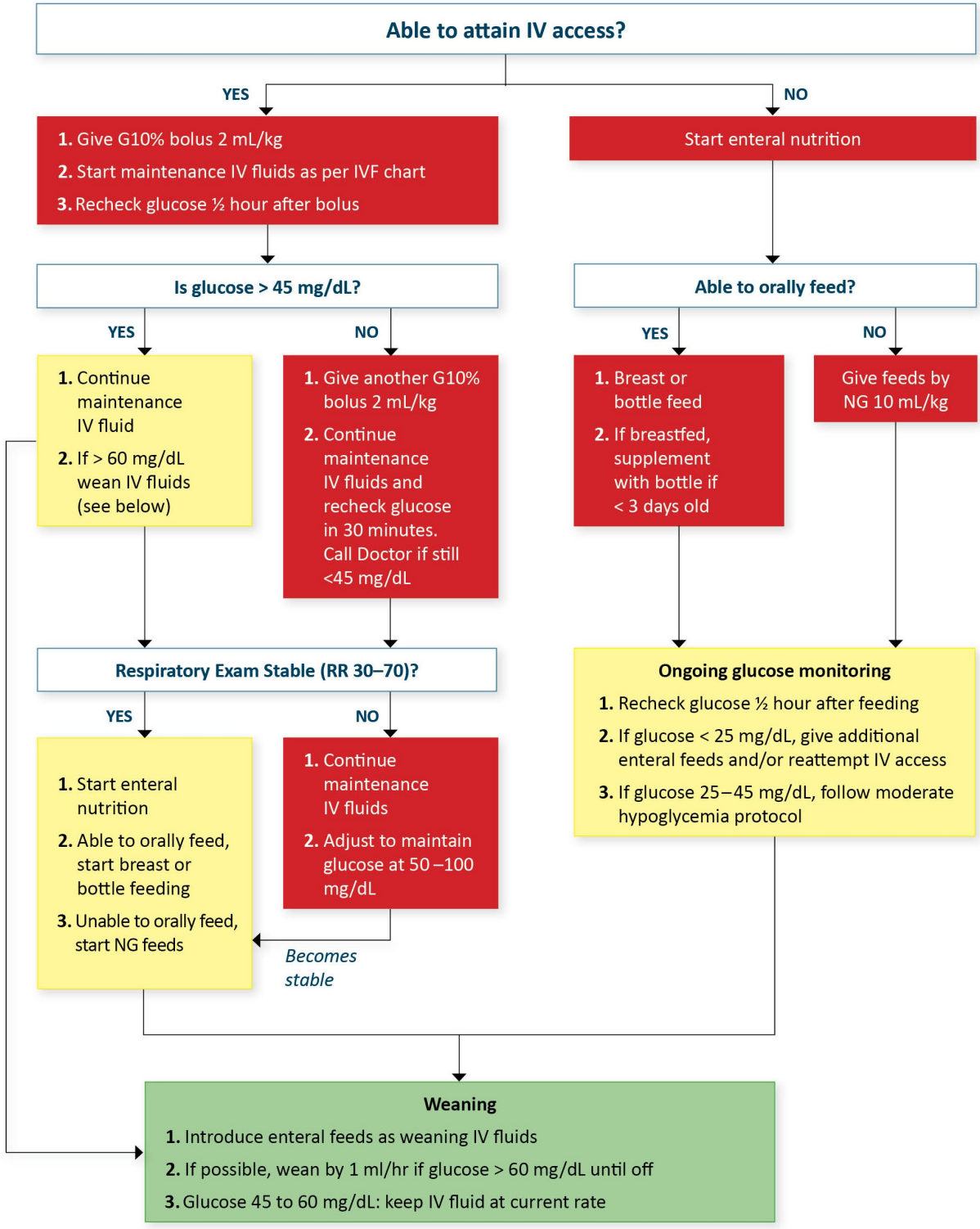
Moderate Hypoglycemia Protocol

Glucose 25–45 mg/dL (1.4–2.5 mmol/L)



Severe Hypoglycemia Protocol

Glucose < 25 mg/dL (1.4 mmol/L)



CHAPTER 8

Hyperbilirubinemia

Definition/Background

Physiologic jaundice is the normal rise in indirect bilirubin to peak of about 12 mg/dL in the first weeks of life due to increased bilirubin production and immature bilirubin metabolism and excretion. Unless it crosses phototherapy threshold, it typically does not require treatment and resolves spontaneously over the first month of life. Physiologic jaundice rarely occurs on the first day of life.

Nonphysiologic jaundice is a more extreme hyperbilirubinemia with an earlier and/or higher peak. It can be direct, indirect, or both, is typically due to an underlying medical condition, and requires further evaluation and treatment. Some causes are sepsis, hypothyroidism, and congenital syphilis.

Neonatal hyperbilirubinemia is due to both:

- *Increased production* of bilirubin due to excessive breakdown red blood cells (e.g. hemorrhage, hemolysis, bruising)
- *Decreased metabolism/excretion* of bilirubin, a complex process that requires both hepatic function and intestinal excretion

Both physiologic and nonphysiologic jaundice peaks earlier and higher in preterm newborns because of both increased production and decreased metabolism/excretion of bilirubin.

Assessment

- High levels of bilirubin can cause permanent brain damage (kernicterus), and therefore requires prompt screening and treatment for prevention
- Hyperbilirubinemia is ideally diagnosed with a serum bilirubin measurement of total, direct and indirect bilirubin
- Measure bilirubin in any infant with jaundice on DOL 0, preterm infants (< 35 weeks) with jaundice on DOL 1, and any infant with jaundice below chest (especially on palms/soles) at any age
- Additional testing may be obtained based on suspected cause (ie. concern for hemolysis could prompt FBC, blood type of mother and infant, Coombs test. Concern for sepsis could prompt WBC, CRP, blood culture)

Treatment

Risk of hyperbilirubinemia requiring treatment is based on degree of production, metabolism and excretion of bilirubin. See “Hyperbilirubinemia Assessment and Treatment” algorithm below for protocol and phototherapy threshholds.

If there is evidence of moderate to severe jaundice by physical exam (jaundice appears below the chest), start phototherapy regardless of serum bilirubin laboratory measurement. Jaundice of palms and soles is consistent with a bilirubin level of at least 340 µmol/L = 20 mg/dL.

Exchange transfusion is a treatment for extreme hyperbilirubinemia. If bilirubin level exceeds the thresholds below, consider referral if exchange transfusion possible. Never discontinue phototherapy when planning or conducting an exchange transfusion.

Exchange Transfusion Treatment Thresholds (Based on WHO 2013 recommendations)

Days	< 35 weeks gestation, <2 kg , sepsis, hemolysis, poor feeding	≥ 35 weeks gestation, ≥ 2 kg Healthy (no risk factors)
DOL 0	220 µmol/L (10 mg/dL)	260 µmol/L (15 mg/dL)
DOL 1	260 µmol/L = 15 mg/dL	425 µmol/L = 25 mg/dL
DOL ≥2	340 µmol/L = 20 mg/dL	425 µmol/L = 25 mg/dL

Other Therapy

- If suspected sepsis, start antibiotics. If suspected hemolysis, assess for blood type incompatibility, assess and treat malaria, and monitor FBC.

Hyperbilirubinemia Assessment and Treatment

Assess for jaundice and start phototherapy if

Days of Life	< 35 wks gestation, sepsis, hemolysis, poor feeding, < 2 kg	≥ 35 wks gestation, no risk factors, ≥ 2 kg
0	Any visible jaundice*	
1	170 µmol/L = 10 mg/dL	260 µmol/L = 15 mg/dL
2+	250 µmol/L = 15 mg/dL	310 µmol/L = 18 mg/dL

Bilirubin conversion: 1 mg/dL = 17.1 µmol/L.
**Or excessive bruising or anticipated prolonged NPO course in the VLBW. Source: WHO 2013*

Physical Examination – Assessment for Jaundice

- If visible scleral icterus and facial jaundice → estimate bilirubin ~ 5 mg/dL
- If visible jaundice of palms and soles → estimate bilirubin > 20 mg/dL

Initiate Phototherapy

1. Place newborn in bassinet or incubator (if available or LBW)
2. Ensure wearing protective eyewear
3. Ensure naked except for diaper and protective eyewear
4. Position distance of phototherapy source based on machine specifications
5. Minimize interruptions

Monitor Phototherapy

1. Check temperature every 3 hours (goal 36.5 –37.5°C)
2. Monitor hydration status
3. Monitor feeding (7–8 times/day or on IV fluids)
4. Monitor urine output (> 6 voids/day)

Repeat Lab Testing: Total and Direct Bilirubin

1. If initial total bilirubin > 340 µmol/L (20 mg/dL), repeat in 6–12 hrs
2. If initial total bilirubin < 340 µmol/L (20 mg/dL) and NOT on ful volume feeds, repeat in 12 hrs; if on full volume feeds, repeat in 24 hrs

If Bilirubin Rising Despite Phototherapy

1. If > 340 µmol/L (20 mg/dL) take additional measures to reduce bilirubin (see box below)
2. If > 425 µmol/L (25 mg/dL)
   - Consider exchange transfusion
   - Apply below measures (see box below)
   - Give 10–20 mL/kg IV fluid bolus
   - Consider NG tube feeding until bilirubin level < 425 µmol/L (25 mg/dL)
   - Ask mother to manually express breast milk
   - If not orally feeding well, place NGT and give ~150 mL/kg/day of breastmilk/formula

Discontinue Phototherapy

1. When total serum bilirubin level < treatment thresholds
2. Recheck total bilirubin level after 24 hours
3. If bilirubin is above the treatment threshold, restart phototherapy

Additional Measures to Reduce Bilirubin

- Conduct feedings under phototherapy lights
- Ensure maximum skin exposed to light and cover incubator with white sheet to create reflective surface
- If not already receiving IV fluids, start IV and provide IV hydration to avoid hemoconcentration (additional 20–40 mL/kg to total fluid intake)
- Continue enteral intake PO or NG to promote excretion of metabolized bilirubin

CHAPTER 9

Infectious Disease

9.1 Bacterial Infection and Sepsis

DEFINITION

Neonatal sepsis is a clinical syndrome of systemic illness accompanied by bacteremia occurring in the first 28 days of life. A bacterial infection such as sepsis, urinary tract infection or meningitis can have serious consequences for newborns. Unfortunately, even serious infections can be difficult to detect in newborns. One must have a high degree of suspicion and a low threshold for treating newborns with antibiotics.

See "Assessment and Treatment of Bacterial Infection/Sepsis" below for sepsis screening and management.

GENERAL CONSIDERATIONS

- Antibiotics that cover gram positive and negative organisms must both be given for the same duration to ensure adequate treatment, unless specific organism identified
- Ampicillin should be given by IV push followed by a saline flush prior to administering gentamicin. If beta lactam therapy (ampicillin, cephalosporins, etc.) is given in same syringe or immediately before/after aminoglycoside therapy, it may result in inactivation of the aminoglycoside.
- Infusion rates of antibiotics:
  - Ampicillin may be administered by slow push (3–5 minutes)
  - Gentamicin should be administered over 30 minutes by syringe pump or slow push to avoid toxicity. Follow with saline flush to clear all medication from the infusion line
- Gentamicin has been proven to be safe and effective with therapeutic peaks and troughs, and without renal complications in neonates with normal renal function at the prescribed once-daily doses
  - If the newborn has adequate urine output, do NOT stop Gentamicin before Ampicillin
  - If the newborn does not have adequate urine output, use a third generation cephalosporin (Cefotaxime or Ceftriaxone) instead of Gentamicin

Assessment and Treatment of Bacterial Infection / Sepsis

- Presence of maternal risk factors for infection (*refer to table 1)
- Newborn is preterm or low birth weight (< 2.5 kg)?
- Presence of newborn danger signs (*refer to table 2)

1. Immediately notify the doctor
2. Obtain blood for laboratory testing
3. Start IV antibiotics

INVESTIGATION	
Exam	**Assessment**
FBC	Concern for sepsis if: total WBC is abnormal (< 5,000 or > 20,000) and/or differential with granulocytes > 70%
CRP	Concern for sepsis if positive
Blood cultures	Concern for sepsis if positive
Lumbar puncture	Diagnosis of meningitis if CSF cloudy, WBC or protein elevated, glucose low or gram stain/culture positive
Chest x-ray	If respiratory distress or hypoxia
Urinalysis and gram stain	If age > 7 days and concern for sepsis

SELECTION OF ANTIBIOTIC THERAPY

Sepsis evaluation	Suspected sepsis, pneumonia or UTI	Suspected meningitis
Ampicillin + Gentamicin	First-line therapy: Ampicillin + Gentamicin	First-line therapy: Ampicillin + Cefotaxime (preferred) or Ceftriaxone

Table 1: Maternal risk factors	Table 2: Newborn danger signs
• Maternal fever (temp > 38°C) during labor or within 24 hours after delivery • Maternal urinary tract infection during current pregnancy • Duration of membrane rupture > 18 hours before delivery • Uterine tenderness or foul smelling amniotic fluid • Obstetric diagnosis of chorioamnionitis • Meconium stained amniotic fluid • Resuscitation at birth • Invasive procedures • Home delivery	• Abnormal vital signs • Fever (temp > 38 °C), hypothermia (temp < 36 °C) or temperature instability • Tachycardia (HR > 180) or bradycardia (HR < 80) • Tachypnea (RR > 60) or bradypnea (RR < 30) including apnea • Poor perfusion: capillary refill time > 3 seconds, hypotension • Abnormal breathing: gasping, grunting, severe chest indrawing, nasal flaring or apnea • Abnormal color: cyanotic, pale, grey, mottled, jaundiced, erythematous including umbilical flare • Abnormal activity: tremors, irritability, seizures, stiffness, hypotonia or lethargy • Abnormal feeding: poor feeding, abdominal distention, recurrent vomiting, diarrhea, otherwise unexplained hypo- or hyperglycemia • Bulging fontanelle

Drug	Dose	Interval			Infusion Time	Comments
		Preterm (< 35 weeks gestation) or < 2 kg	Term[1] ≤ 7 days	Term > 7days		
Acyclovir	20 mg/kg/dose IV or PO	Every 12 hours	Every 8 hours		60 minutes IV	Ensure adequate hydration due to risk of nephrotoxicity Treatment of herpes simplex infection: 14 days if localized, 21 days if disseminated
Ampicillin or Cloxacillin	50 mg/kg/dose IV[2]	Every 12 hours		Every 8 hours	IV slow push 3–5 minutes	Ampicillin should be followed by a saline flush BEFORE administering gentamicin. Never combine medications in same syringe.
	Meningitis: Preterm or < 2.5kg and Term ≤ 7 days: 150 mg/kg/dose IV Term > 7 days: 100 mg/kg/dose IV					
Cefotaxime[3]	50 mg/kg/dose	Every 12 hours	Every 8 hours	Every 6 hours	IV slow push 3–5 minutes	Preferred over Ceftriaxone due to improved safety profile
Ceftriaxone[4]	50 mg/kg/dose IV meningitis	Every 12 hours			IV slow push 3–5 minutes	Avoid unless Cefotaxime unavailable. For IM injection, dilute to 350 mg/mL. Max dose ½ mL = 175 mg
	50 mg/kg/dose IM or IV or eye pus	Once				
Gentamicin	Preterm or < 2.5 kg: 3 mg/kg/dose IV	Every 24 hours			30 minutes IV	If inadequate urine output, use third generation cephalosporin (Cefotaxime or Ceftriaxone) instead of gentamicin
	Term: 5 mg/kg/dose IV					
Metronidazole	7.5 mg/kg/dose IV	Every 12 hours			30 minutes IV	Anaerobic coverage including treatment of necrotizing enterocolitis

[1]Preterm means GA < 35 weeks or weight < 2 kg if GA unknown. Term means GA ≥ 35 weeks or weight ≥ 2 kg if GA unknown.

[2]If continuing antibiotics beyond 48 hours, must rule-out meningitis by lumbar puncture or clinically to determine dose and duration of antibiotic therapy.

[3]Cefotaxime: to replace gentamicin in the setting of renal dysfunction, or to treat presumed meningitis due to poor CNS penetration of gentamicin.

[4]Ceftriaxone: Do not use in setting of hyperbilirubinemia because displaces bilirubin from albumin; do not administer within 48 hours of IV calcium in newborns due to risk of lethal precipitation

Antibiotic Coverage Summary by Condition for newborns < 1 month of age					
Condition	**Clinical Condition**	**Laboratory Results**	**Treatment recommends**	**Therapy Duration**	**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 hrs	Abnormal WBC, differential, CRP, CXR	Ampicillin Cephalosporin	7–14 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 + 21 days if gram -	Cefotaxime preferred over Ceftriaxone
Urinary Tract Infection	Abnormal vital signs, ill appearing	Urinalysis concerning for urinary tract infection	Ampicillin Gentamicin	7 days	Generally considered in newborns ≥ 7 days

9.2 Congenital Infection

NEWBORN OF HIV-POSITIVE MOTHER

- Transmission of HIV from mother to newborn
  - The transmission of HIV from mother to newborn must be prevented before, during and after delivery
  - Transmission occurs across the placenta, during passage through birth canal or during breastfeeding
  - During pregnancy
    - Mothers should be screened for HIV
    - All HIV+ mothers should receive post-test counseling and take ARVs according to national protocols
  - During delivery
    - ARV prophylaxis: Refer to national document on Elimination of Mother to Child Transmission (EMTCT)
    - During expulsion, avoid episiotomy, instrumental delivery and do not "milk" the cord
    - During post-natal period
      - ARV prophylaxis: Refer to national EMTCT protocol

NEWBORN OF MOTHER WITH SYPHILIS

- If the mother has a positive syphilis serology during pregnancy and:
    A. 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
    B. 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*
    C. Mother not treated and infant with signs/symptoms of syphilis:
        - Early signs include:
            - Bullous rash (especially of palms and soles)
            - Anemia
            - Hepatosplenomegaly
            - Osteitis (presenting as pseudo-paralysis of limb)
            - Coryza
            - Jaundice
        - Treatment:
            - Hospitalize newborn for a treatment of 50,000 IU/kg/per dose of IM or IV *Penicillin G* 2 times a day for 10 days followed by long term follow-up

NEWBORN OF MOTHER WITH HEPATITIS B

- If the mother is HBsAg positive, there is a risk of transmission during pregnancy and delivery
- Administer the first dose of *Anti-hepatitis B vaccine preferably* 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 12 hours of life

NEWBORN OF MOTHER WITH TUBERCULOSIS

- Refer to national TB guidelines
- If signs of TB in the newborn, provide anti-tuberculosis treatment according to national protocol

9.3 Newborns with minor infections

Cutaneous infections (pustules and vesicles):

- Clean lesion with antiseptic
- If closed, keep clean and monitor. If open, apply *topical antibiotic ointment*.
- 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 large and/or numerous, hospitalize the newborn and treat with antibiotics against staphylococcus aureus

CHAPTER 10

Hematology

Newborns are born with a physiologic polycythemia due to relative hypoxia in utero.
Normal hemoglobin for a newborn is 15–18 g/dL, normal hematocrit for newborn: 45–55%.
(Conversion: Hemoglobin x 3 = Hematocrit).

10.1 Anemia

BACKGROUND

- Over the first weeks of life, newborns develop a physiologic anemia because erythropoietin and fetal hemoglobin production decreases in response to relatively rich oxygen supply
  - Term newborns typically reach a physiologic nadir with hemoglobin of 9–11 g/dL at 6–12 weeks of age
  - Preterm newborns typically have an earlier and more severe physiologic nadir, reaching a hemoglobin of 8–10 g/dL at 5–10 weeks of age
- The nadir results in insufficient oxygen delivery to tissues, prompting a rise in erythropoietin levels rise and adult hemoglobin production, and rarely requires treatment

Pathologic Anemia: some conditions can exaggerate the physiologic nadir to the point that treatment may be required:

- Obstetric blood loss: early cord clamping, placental abruption, placenta previa, placental laceration during caesarian section
- Fetoplacental bleeding
- Neonatal blood loss: phlebotomy, cephalohematoma, subgaleal hemorrhage, intracranial hemorrhage, bleeding into abdominal organs
- Hemolysis
  - Immune (ABO, Rh or minor blood group incompatibility)
  - Hereditary red blood cell disorders (G6PD deficiency, red blood cell membrane defects, hemoglobinopathies)
  - Acquired coagulopathy (infection, DIC)
- Diminished red blood cell production: iron deficiency, infection, medications
- Repeated phlebotomy

DIAGNOSIS

- Family history, laboratory testing may include FBC, reticulocyte count, smear, Coombs test

TREATMENT

- Decision regarding need of red blood transfusion includes clinical condition of newborn, etiology of anemia, hemoglobin/hematocrit value and trend over time

- Indications for red blood cell transfusion
  - Significant cardiorespiratory distress
  - Blood loss more rapid than ability for newborn to generate red blood cells (e.g. rapid bleeding, severe hemolysis)
  - Severe anemia (hemoglobin < 7 g/dL) with poor reticulocytosis or impaired newborn growth (e.g. average of < 10 gm/day) despite adequate nutrition
- Volume of transfusion depends on
  - Current and goal hemoglobin/hematocrit
  - Ongoing blood loss and expected tolerance of transfusion. Tolerance is dependent on whether the volume of circulation is low (as with acute blood loss) or normal (as with chronic anemia)
  - Presence of chronic lung disease or other conditions in which transient fluid overload is poorly tolerated

TRANSFUSION PROCEDURE

- Typical transfusion is 10–15 ml/kg given over 3 to 4 hours
- May need second transfusion (preferably from same donor) if anemia not adequately corrected
- Wait at least 6 hours after completion of transfusion if post transfusion hemoglobin/hematocrit needed in order to allow time for re-equilibration
- Whole blood should be given to correct the anemia of rapid blood loss
- If concern for severe anemia and hemoglobin/hematocrit is not available: give 10–20 ml/kg, monitor

PREVENTION

- Newborns at risk of iron deficiency should receive supplemental iron (2–4 mg of elemental iron/kg/day) once they are tolerating full enteral feeds (see discharge planning Chapter 13)
- At risk newborns include preterm infants and those with substantial blood loss via bleeding or phlebotomy

10.2 Bleeding

ETIOLOGY

- Bleeding can be due to many causes including
  - Deficiency of clotting factors
  - Inherited clotting abnormalities
  - Low or poorly functioning platelets
- It is important to distinguish whether a newborn with a bleeding disorder is otherwise sick or well.
  - Sick newborns tend to have:
    - Disseminated intravascular coagulopathy (DIC)
    - Platelet consumption

        - Liver dysfunction
    - Well newborns tend to have:
        - Immune thrombocytopenia
        - Hemorrhagic disease of the newborn (Vitamin K deficiency)
        - Hereditary clotting factor deficiencies

INVESTIGATION

- FBC including platelet count, smear and coagulation studies if possible

TREATMENT

- Vitamin K 1 mg IM if not given after birth, or if unclear documentation (0.5 mg if preterm/< 1.5 kg)
- Administer platelets and/or fresh frozen plasma if available

10.3 Polycythemia

DEFINITION

Polycythemia in the newborn is defined as a venous hemoglobin > 22 g/dL or hematocrit > 65%.

ETIOLOGY

- Placental red blood cell transfusion (e.g. delayed cord clamping, maternal fetal hemorrhage)
- Placental insufficiency (maternal hypertension syndromes, post-term and small for gestational age newborns, high altitude, maternal cardiovascular/pulmonary conditions causing chronic hypoxia, smoking)
- Newborn of diabetic mother
- Some maternal medications
- Hemoconcentration due to dehydration

SYMPTOMS: DUE TO INCREASED VISCOSITY OF BLOOD

- CNS: poor feeding, lethargy, seizures
- Cardiorespiratory: cyanosis, tachypnea/respiratory distress, pulmonary hypertension
- Other: jaundice, thrombosis, hematuria, proteinuria, hypoglycemia

TREATMENT

- Isovolumetric, dilutional partial exchange transfusion

INDICATIONS:

- Hematocrit > 65% and symptomatic
- Hematocrit > 70% and asymptomatic
- Volume: Typically 15–25 mL/kg body weight; depends on observed and desired hematocrit (usually 50%), circulating blood volume estimated at 80 mL/kg
- Slowly withdraw the calculated volume of blood and replace with normal saline. Ideally one provider should draw blood off of large bore IV or from peripheral vein while 2nd provider infuses replacement volume of IVF to keep the circulating blood volume in balance.

CHAPTER 11

Neurology

11.1 Asphyxia

DEFINITION

Asphyxia is defined as inadequate delivery of oxygen to meet metabolic demand. This can occur perinatally due to fetal, maternal and/or placental etiology.

RISK FACTORS AND CONDITIONS ASSOCIATED WITH NEONATAL ASPHYXIA

Fetal	Maternal	Placental
- Preterm and post-dates - Multiple births - Forceps or vacuum assisted delivery - Abnormal presentation - Emergency caesarean section - Intrauterine growth restriction (IUGR) - Meconium stained amniotic fluid - Abnormal fetal heart rate trace - Anemia - Infection - Congenital malformations	- General anesthetic - Maternal drug therapy - Pregnancy-induced Hypertension - Chronic hypertension - Maternal infection - Maternal diabetes mellitus - Hemorrhage	-Chorioamnionitis - Placenta previa - Placental abruption - Cord prolapse - Polyhydramnios - Oligohydramnios

HYPOXIC ISCHEMIC ENCEPHALOPATHY

- Due to inadequate pre-, intra- and/or post-partum oxygen delivery and blood flow
- Consider this diagnosis if low Apgar scores (< 5 at 5 minutes), delayed first breath, absence of cry at 5 minutes of life, need for neonatal resuscitation, abnormal neurologic exam, abnormal tone, and seizures

- Assess by Sarnat stage:

SARNAT STAGE			
	STAGE 1	**STAGE 2**	**STAGE 3**
Level of consciousness	Hyperalert	Lethargic or obtunded	Stupor or coma
Activity	Normal	Decreased	Absent
Neuromuscular Control			
Muscle tone	Normal	Mild hypotonia	Flaccid
Posture	Mild and 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, incomplete, 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 multifocal	Uncommon (excluding decerebration)

TREATMENT

- Avoid hyperthermia (temp should remain < 37.5); no bundling, no warmer, or incubator
- Supportive care:
  - Start supplemental oxygen if respiratory distress or O2 sat < 90%
  - NPO if respiratory distress, seizures or Sarnat Stage 3
  - IV fluid: G10% at 60 mL/kg/day to avoid cerebral edema
  - Monitor and normalize glucose and electrolytes
- Monitor and treat seizures

11.2 Seizures

- Vigilantly diagnose and manage seizure:
  - Frequent vital signs, close general observation

DIAGNOSIS

- Neonatal seizures can be subtle compared to older patients:
  - Non-extinguishable twitching, rhythmic lip or jaw movements, staring or eye twitching, extension of extremities, clenching of fists, and changes in vital signs including apnea

TREATMENT

- Acute: Ideally seizures should be controlled within half an hour of initial presentation
  1. Phenobarbital:
     Loading dose: 20 mg/kg IV slow push
     - Subsequent doses: May repeat 10 mg/kg after 20–30 minutes if seizures continue, and repeat again after 20–30 minutes (max dose 40 mg/kg/day)
  2. Phenytoin (fosphenytoin preferable) as second agent if seizures persist after second dose of phenobarbital:
     Loading dose: 15 mg/kg/dose IV
     - If administering phenytoin, IV tubing containing glucose must be flushed with normal saline before and after to prevent precipitation and loss of IV access
     - Subsequent doses: May repeat 5 mg/kg after 20–30 minutes if seizures continue
  3. Diazepam: as alternative second agent if phenytoin not available
     - 0.1 mg/kg given over 3–5 minutes. May repeat same dose after > 15 minutes if seizures continue or recur
- Maintenance: If seizures recur after acute treatment, start maintenance therapy 24 hours after 1st loading dose of Phenobarbital given.
  - Phenobarbital: 5 mg/kg/day IV/PO every 24 hours
  - In unlikely event that second agent maintenance therapy needed, give Phenytoin: 5 mg/kg/dose IV every 24 hours

Ongoing monitoring

- Anticonvulsants can cause apnea, especially at high doses and in combination; monitor closely.
- Be prepared to provide bag mask ventilation while awaiting return of respiratory drive.

Discontinuation of anticonvulsants

- After 3 days without seizures on maintenance dosing of anticonvulsants, trial discontinuation of therapy to determine whether or not infant will require longer term, outpatient anticonvulsant therapy
- If on second agent (phenytoin or diazepam), discontinue that first. Monitor for 48 hours and if seizures recur, re-bolus with loading dose and restart maintenance
- If seizures do not recur, discontinue Phenobarbital. Monitor for 48 hours
  - If seizures do not recur, newborn may be discharged home off anticonvulsant therapy
  - If seizures do recur then re-bolus with loading dose and restart maintenance

Discharging a newborn who has required anticonvulsant therapy

- If newborn requires longer term, outpatient anticonvulsant therapy, the Phenobarbital should be changed to PO route. The same IV dose can be given orally
- Phenytoin cannot be orally dosed with adequate serum levels. Therefore, infant must remain in the hospital if phenytoin is required for seizure control
- Any infant who has required an anticonvulsant should be observed for at least 48 hours after the last dose to ensure that seizures do not recur
- If newborn has HIE, especially if seizures occur during the hospitalization, arrange follow-up appointment after discharge to home. Frequency and duration of follow-up depends on severity of HIE and seizures

11.3 Pain Control

Newborns experience pain:

- Preterm newborns 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 (such as holding and swaddling)
- For major procedures (e.g. intubation, chest tube insertion)
  - Give morphine 0.02 to 0.05 mg/kg IV, may repeat (maximum 0.1 mg/kg/4 hours)
  - Administer slowly; may cause dose-related respiratory depression

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

CHAPTER 12

Discharge Planning

Discharge criteria

The infant must meet the following criteria before being discharged:

- Feeding
  - Infant does not require intravenous fluids
  - Infant is receiving at least 8 feeds per day (i.e. 3 hourly feeds) of a total of more than 120 ml/kg/day or is breast-feeding well on demand
  - Infant has gained at least 15 g/kg/day for at least 3 days and weighs more than birth weight
  - The mother/care giver is confident to feed and look after the infant
  - Infant is passing urine and stool normally
- Respiratory
  - There are no signs of respiratory distress
  - For preterm or low birth weight infants, no apnea for 3 days without caffeine or aminophylline
- Temperature
  - Infant can maintain own temperature 36.5–37.5 ^{o}C without the use of incubator or radiant heater sources for at least 3 days
- Neurologic
  - For those with HIE and treated with anticonvulsants, no convulsions for 48 hours off anti-convulsant therapy

General

- Has no danger signs including fever, jaundice, convulsions, abdominal distension
- Mother/care giver has been advised on warning signs of illness
- Mother/care giver has been advised on safe methods of newborn care including sleeping on back (not side or stomach) and not covering newborn's face with blankets or clothes
- Community support systems have been offered for HIV positive mothers, adolescent mothers, or single care givers
- Drugs or supplements have been prescribed or given to mother/care giver
  - For HIV-exposed newborns, prophylaxis has been provided and follow up arranged including review of drugs and serology testing
  - Preterm/LBW infants: Infants born at < 35 weeks or with BW < 2 kg should be prescribed iron (Fe) from two weeks through 6 months of age

If NOT anemic, give preventive dose: 2 mg/kg/day of elemental Fe:

Weight	**Tot'hema Syrup** Ferrous Gluconate (5 mg elemental iron/ml)	**Palafer Syrup** Ferrous Gluconate 300 mg/5 ml (7 mg elemental iron/ml)	**Iron Fumarate Syrup** Ferrous Fumarate 100 mg /5 ml (6.67 mg elemental iron/ml)
1 kg	0.4 ml	0.3 ml	0.3 ml
2 kg	0.8 ml	0.6 ml	0.6 ml
3 kg	1.2 ml	0.8 ml	0.9 ml
4 kg	1.6 ml	1.1 ml	1.2 ml
5 kg	2 ml	1.4 ml	1.5 ml

If anemic (based on laboratory testing or clinical symptoms of pallor, lethargy or increased HR), give treatment dose: 4 mg/kg/day elemental Fe for 3 months:

Weight	**Tot'hema Syrup** Ferrous Gluconate (5 mg elemental iron/ml)	**Palafer Syrup** Ferrous Gluconate 300 mg/5 ml (7 mg elemental iron/ml)	**Iron Fumarate Syrup** Ferrous Fumarate 100 mg /5 ml (6.67 mg elemental iron/ml)
1 kg	0.8 ml	0.5 ml	0.6 ml
2 kg	1.6 ml	1.1 ml	1.2 ml
3 kg	2.4 ml	1.7 ml	1.8 ml
4 kg	3.2 ml	2.2 ml	2.4 ml
5 kg	4.0 ml	2.8 ml	3.0 ml

**Iron in syrup is available in several different salt forms and concentrations. Each salt (i.e. ferrous fumarate, ferrous sulfate) contains a different portion of elemental iron. The medication label should be checked carefully to confirm the concentration of elemental iron contained in the syrup for prescribing. Parents should be instructed on exact volume to administer since accidental overdose of iron can result in serious illness to infants.*

Document the following parameters on discharge

- Contact details for follow up
- Weight
- Head circumference
- Final diagnosis
- Drugs prescribed
- If newborn died, cause of death

Discharge Examination

- All newborns discharged from neonatal unit should have had a physical examination prior to discharge
- Weight and head circumference must be documented and plotted on growth charts

Follow Up

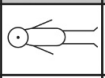
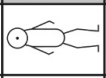
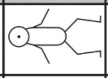
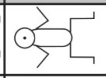
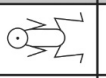
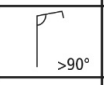
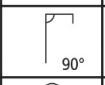
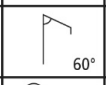
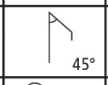
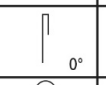
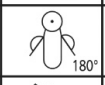
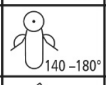
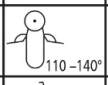
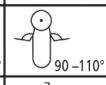
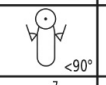
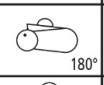
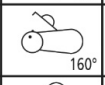
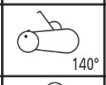
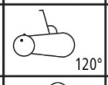
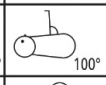
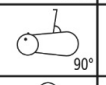
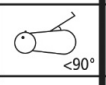
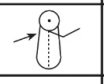
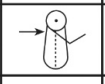
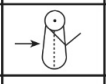
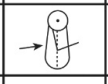
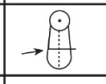
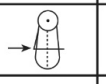
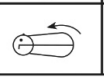
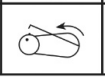
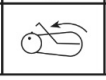
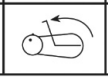
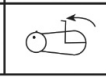
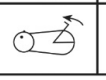
Recommended in 1–2 weeks at the hospital or health center for the following infants:

- LBW < 2 Kg
- Preterm newborns (especially those born < 35 weeks GA)
- Newborns with concern for feeding difficulty (suspected genetic syndrome, congenital anomalies)
- HIV positive mother/at risk of HIV infection
- Severe birth asphyxia
- Confirmed meningitis
- Other concerns for vulnerability

APPENDIX A

Ballard Score

NEUROMUSCULAR MATURITY

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

PHYSICAL MATURITY

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

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

SCORE

Neuromuscular _____
Physical _____
Total _____

MATURITY RATING

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

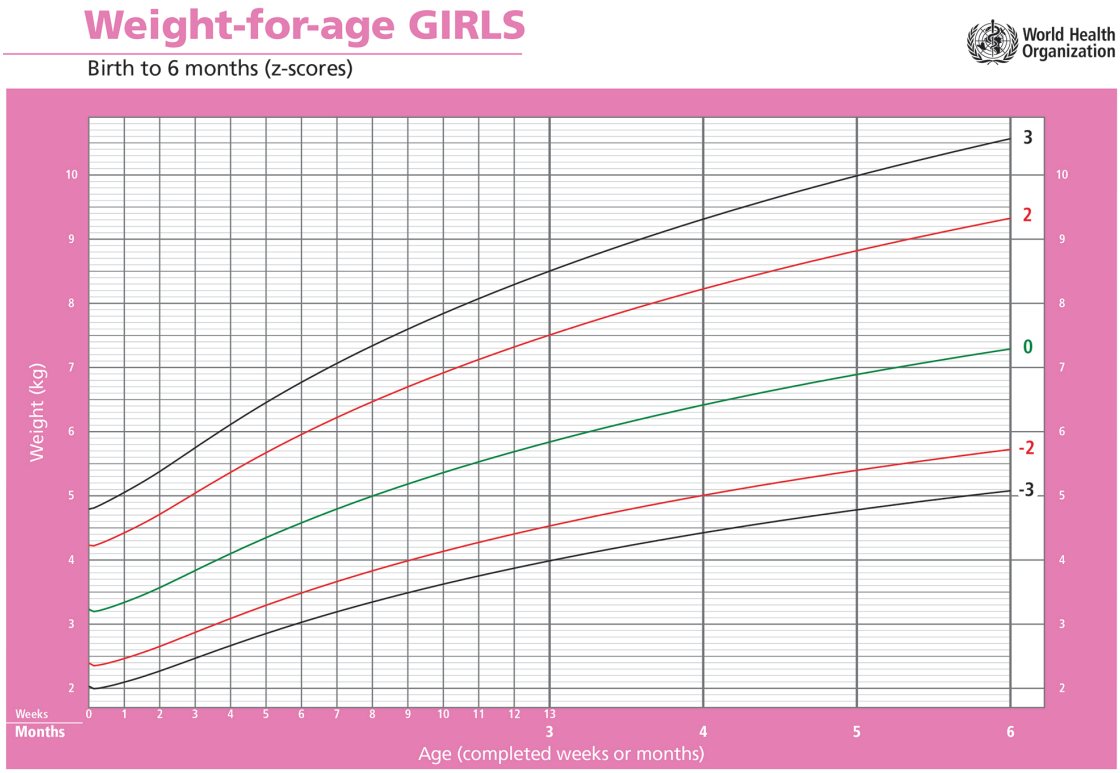
GESTATIONAL AGE (weeks)

By dates_____
By ultrasound_____
By exam_____

Maturational assessment of gestational age. Ballard JL et al. New Ballard Score, expanded to include extremely premature infants. J Pediatrics 1991; 119:417

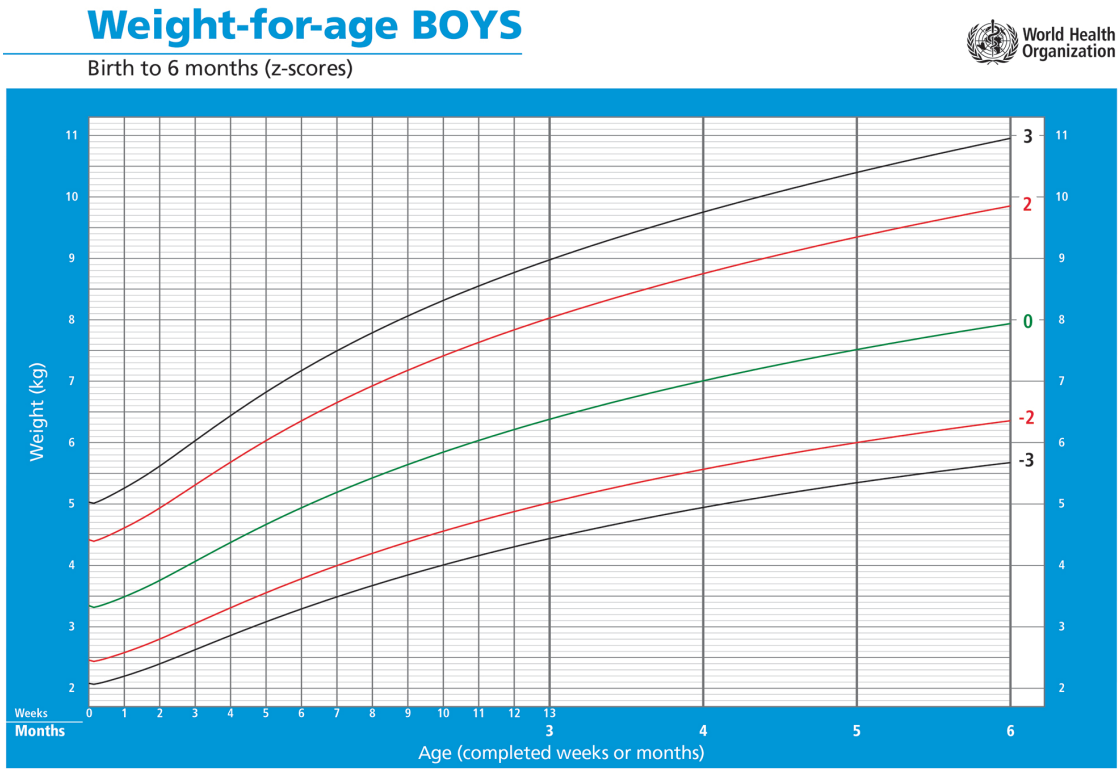
APPENDIX B

Term Growth Charts: Girls



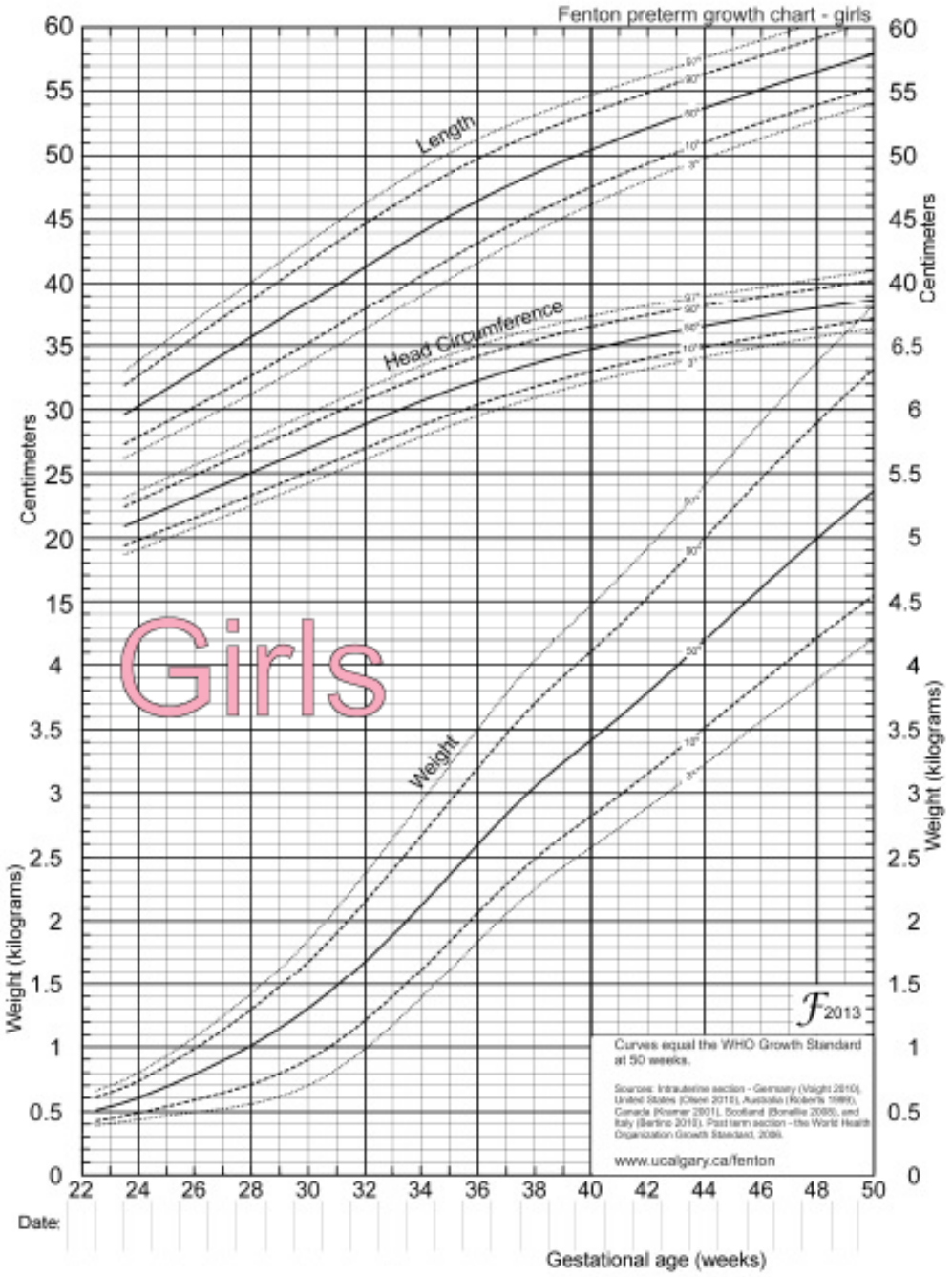
WHO Child Growth Standards

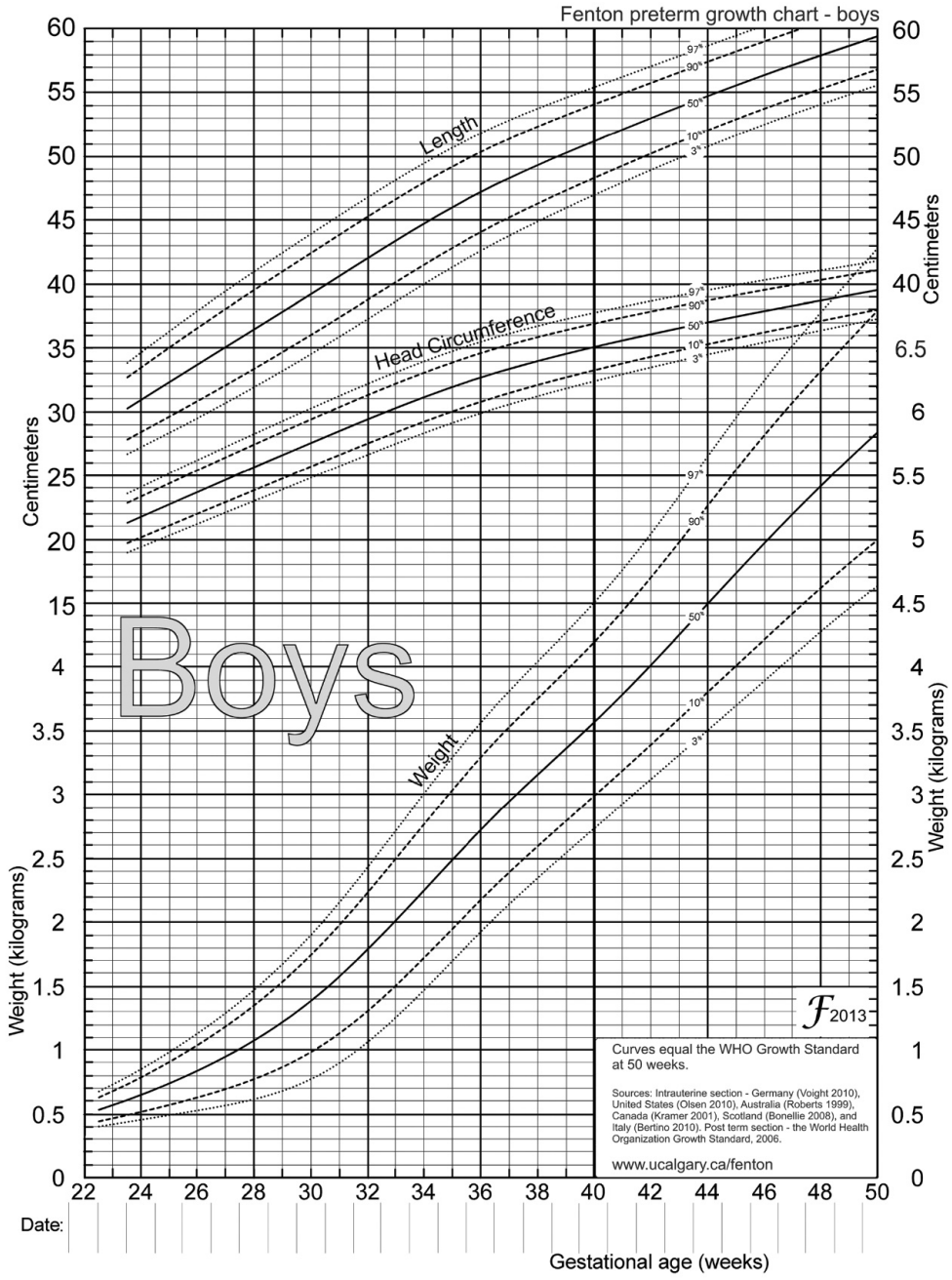
Term Growth Charts: Boys



APPENDIX C

Preterm Growth Charts




Fenton preterm growth chart - boys
Length
Head Circumference
Weight
97th
90th
50th
10th
3rd
Boys
Centimeters
Weight (kilograms)
Date:
Gestational age (weeks)
Curves equal the WHO Growth Standard at 50 weeks.
Sources: Intrauterine section - Germany (Voight 2010), United States (Olsen 2010), Australia (Roberts 1999), Canada (Kramer 2001), Scotland (Bonellie 2008), and Italy (Bertino 2010). Post term section - the World Health Organization Growth Standard, 2006.
www.ucalgary.ca/fenton
F 2013

APPENDIX D

IV Fluid Recipes

G10% IV fluid from G5% and G50%, *Use premixed G10% if available*

1. Remove 28 ml from 250 ml bag of G5%
2. Add 28 ml G50% to bag in step1
3. Mix bag to make G10%

G10% ¼ Ringers Lactate (RL) from G5%, G50% and RL

1. Remove 95 ml from 250 ml bag of G5%
2. Add 35 ml G50% to bag in step1
3. Add 60 ml RL to bag in step 2
4. Mix bag to make G10% ¼ Ringers lactate

G10% ¼ Ringers Lactate (RL) from G10%, G50% and RL

1. Remove 75 ml from 250ml bag of G10%
2. Add 15 ml G50% to bag in step1
3. Add 60 ml RL to bag in step 2
4. Mix bag to make G10% ¼ Ringers lactate

G10% ¼ Normal Saline (NS) from G5%, G50% and NS

1. Remove 95 ml from 250ml bag of G5%
2. Add 35 ml G50% to bag in step1
3. Add 60 ml NS to bag in step 2
4. Mix bag to make G10% ¼ Normal saline

G10% ¼ Normal Saline (NS) from G10%, G50% and NS

1. Remove 75 ml from 250ml bag of G10%
2. Add 15 ml G50% to bag in step1
3. Add 60 ml NS to bag in step 2
4. Mix bag to make G10% ¼ Normal saline

G12.5% ¼ Ringers Lactate (RL) from G5%, G50% and RL

1. Remove 108 ml from 250ml bag of G5%
2. Add 48 ml G50% to bag in step1
3. Add 60 ml NS to bag in step 2
4. Mix bag to make G12.5% ¼ Ringers Lactate

G12.5% ¼ Ringers Lactate (RL) from G10%, G50% and RL

1. Remove 90 ml from 250 ml bag of G10%
2. Add 30 ml G50% to bag in step1
3. Add 60 ml NS to bag in step 2
4. Mix bag to make G12.5% ¼ Ringers Lactate

APPENDIX E

IV and Enteral Fluid Rates for Newborns in Neonatal Unit

Birth Weight < 1 kg (ELBW) (Estimated as **0.9 kg** for calculation)						
			IV		Enteral	
DOL	**IV Fluid**	**Total Fluid: IV+PO ml/kg/day**	**ml/kg/24hrs**	**ml/hr**	**ml/kg/24hrs**	**ml/3hrs**
0	G10%	**80**	80	3	0	0
1	G10%	**100**	90	3	10	1
2	G10%	**120**	90	3	30	3
3	G10%	**140**	90	3	50	6
4	G10%	**150**	80	3	70	8
5	G10%	**150**	60	2	90	10
6	G10%	**150**	40	2	110	12
7	G10%	**150**	20	1	130	15
8	n/a	**160**	0	0	150	17
9	n/a	**170**	0	0	170	19
10	n/a	**180**	0	0	180	20

Birth Weight 1 – 1.5 kg (VLBW) (Estimated as **1.25 kg** for calculation)						
			IV		Enteral	
DOL	IV Fluid	Total Fluid: IV+PO ml/kg/day	ml/kg/24hrs	ml/hr	ml/kg/24hrs	ml/3hrs
0	G10%	**80**	80	4	0	0
1	G10%	**100**	75	4	25	4
2	G10%	**120**	70	4	50	8
3	G10%	**140**	65	3	75	12
4	G10%	**150**	50	3	100	16
5	G10%	**150**	25	1	125	20
6	n/a	**150**	0	0	150	24
7	n/a	**170**	0	0	170	26
8	n/a	**180**	0	0	180	28

Birth Weight 1.5 – 2 kg (LBW) (Estimated as **1.75 kg** for calculation)						
			IV		Enteral	
DOL	IV Fluid	Total Fluid: IV+PO ml/kg/day	ml/kg/24hrs	ml/hr	ml/kg/24hrs	ml/3hrs
0	G10%	**60**	60	4	0	0
1	G10%	**80**	50	4	30	7
2	G10%	**100**	40	3	60	13
3	G10%	**120**	30	2	90	20
4	G10%	**140**	20	1	120	26
5	n/a	**150**	0	0	150	33
6	n/a	**170**	0	0	170	37

Birth Weight 2 – 2.5 kg unable to breastfeed (Estimated as **2.25 kg** for calculation)						
			IV		Enteral	
DOL	**IV Fluid**	**Total Fluid: IV+PO ml/kg/day**	**ml/kg/24hrs**	**ml/hr**	**ml/kg/24hrs**	**ml/3hrs**
0	G10%	**60**	60	6	0	0
1	G10%	**90**	50	5	40	11
2	G10%	**120**	40	4	80	23
3	G10%	**150**	30	3	120	34
4	n/a	**150**	0	0	150	42

Birth Weight 2.5 – 3 kg unable to breastfeed (Estimated as **2.75 kg** for calculation)						
			IV		Enteral	
DOL	**IV Fluid**	**Total Fluid: IV+PO ml/kg/day**	**ml/kg/24hrs**	**ml/hr**	**ml/kg/24hrs**	**ml/3hrs**
0	G10%	**60**	60	7	0	0
1	G10%	**90**	50	6	40	14
2	G10%	**120**	40	5	80	28
3	G10%	**150**	30	3	120	41
4	n/a	**150**	0	0	150	52

Birth Weight > 3 kg unable to breastfeed (Estimated as **3.5 kg** for calculation)						
			IV		Enteral	
DOL	**IV Fluid**	**Total Fluid: IV+PO ml/kg/day**	**ml/kg/24hrs**	**ml/hr**	**ml/kg/24hrs**	**ml/3hrs**
0	G10%	**60**	60	9	0	0
1	G10%	**90**	40	6	50	22
2	G10%	**120**	20	3	100	44
3	n/a	**150**	0	0	150	66

APPENDIX F

Enhanced Calorie Feeding for Low Birth Weight Infants

Enhanced Calories with addition of formula powder

- Standard (20 kcal/30 mL) formula is made by adding one scoop of powder to 30 mL boiled water
- The addition of ⅕ of a scoop of powdered formula, provides an additional 4 kcal/30 mL
- Therefore adding ⅕ scoop formula powder to 30mL of expressed breast milk or prepared formula, adds 4 kcal/30mL milk

RECIPE

- **To add 4 kcal/30 mL formula:**

  30 mL boiled water + 1 scoop formula powder + ⅕ scoop formula powder
- **To add 4 kcal/30 mL maternal milk:**

  30 mL of expressed maternal milk + ⅕ scoop formula powder

Enhanced Calories with Addition of Oil

Occasionally, infants do not gain adequate weight gain despite receiving full volume milk feedings with additional caloric density. First, ensure that environmental measures have been taken to minimize the metabolic demands of maintaining euthermia (e.g. KMC or incubator). Then consider the further caloric enhancement with fat.

- Safflower, sunflower and olive oil can all be used.
  - Add 2 kcal of oil to 30 mL of milk to enhance by total of 6 kcal/30 mL milk when combined with addition of formula
  - 1 mL oil = 8.4 kcal
- For infants with BW of 1–1.5 kg, total feeding volume is 25 mL every 3 hours
  - Add 0.2 ml of oil to 25mL of enhanced milk to increase caloric density by a total of 6 kcal/30 mL
- For infants with BW of 1.5–2 kg, total feeding volume is 33 mL every 3 hours
  - Add 0.3 ml of oil to 33mL of enhanced milk to increase caloric density by a total of 6 kcal/30 mL

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