Chapter 4:

FEEDING AND FLUID MANAGEMENT

Student Author: Kira Düsterwald

Specialist Advisor: Dr Farhaad Khan

This chapter covers the following topics:

- Neonatal and infant feeding
- General fluid management

NEONATAL AND INFANT FEEDING

Breastfeeding

Breast milk should be the exclusive food for infants in the first six months of life. The World Health Organisation's (WHO's) Baby-Friendly Hospital Initiative encourages breastfeeding (see related image here) at all baby-friendly hospitals and has published a ten-step guideline to promote and support breastfeeding at these facilities.

Advantages

- Breast milk is free
- It reduces infant morbidity and mortality
- The constituents meet the neonate's nutritional needs and include fatty acids important for neurodevelopment and development of the retina
- Breast milk is safer than formula for the prevention of infection and does not require knowledge about sterilisation of cups or clean water
- It contains important immune-protective factors, like IgA and IgM
- The skin-to-skin contact is good for establishing a bond and passing on skin commensals to enhance immunity
- Breast milk reduces the risk of necrotising enterocolitis and sepsis, when compared to formula feeds
- Breastfeeding encourages the release of metabolic regulatory hormones and stimulates the growth of gastrointestinal bacteria like *Lactobacilli* and *Bifidobacteriae*

Practical advice

One must educate the mother antenatally about the advantages of breastfeeding and the technique, so that she knows how she will feed after delivery. The baby should latch over the whole areola, not just the nipple. The nurse on duty may help the mother with the latching technique.

The initial feed, colostrum, is very nutritious and, if possible, should be given within half an hour of birth. Early breastfeeding also stimulates prolactin and oxytocin and helps to promote uterine tone.

Breastfeeding should be done on demand and the infant allowed to drink from one breast until it is empty before moving on to the other breast. Breasts should be alternated at the start of each feed. Initially the baby will have small but frequent feeds, but over time this pattern will change. Neonates need to be fed at least three-hourly.

Mothers can also express the breast milk and this may be done using their hands. The infant should be fed this expressed milk with a cup rather than a teat. Pretoria pasteurisation/flash heating is the process of heat-treating breast milk so that it is safer for babies to drink in the case of maternal HIV. Expressed milk can be stored in a clean container with a tight lid:

- At room temperature – for up to four hours
- In the refrigerator – for up to four days
- In the freezer – for 6–12 months

If the mother is worried about the amount of food that the infant is receiving, one can educate her on the signs of correct feeding:

  - Approximately six wet nappies daily
  - Gaining weight
  - Good technique (high BFAS score)

Common Problems

Common problems during breastfeeding include:

- Concerns about inadequate milk supply:
  - Reassure, counsel, and ensure the mother has adequate nutrition and rest
- Full or engorged breasts:
  - Hot, lumpy, heavy breasts without fever are “full” and should resolve with demand feeds
  - Painful, shiny, erythematous breasts with poor expression are “engorged”. Demand feeds can continue. The application of warm compresses or warm water are often helpful for milk flow
  - Expressing before feeds can help soften the areola
- Blocked ducts:

    - Encourage frequent feeds, the use of warm/cold compresses and first breastfeeding with the affected breast
- Mastitis and breast abscesses:
    - The mother will present with severe breast pain and fever and/or pus.
    - These mothers require antibiotic treatment (e.g. flucloxacillin), analgesia and, sometimes, surgical management (incision and drainage; often in theatre)
    - The infant should be fed from the unaffected breast and the mother advised to express and discard the milk from the affected side
- Painful nipples:
    - Feeding should be observed to assess for correct positioning and attachment
    - She should be encouraged to express milk before the feed to soften the areola
- Breast candida infection:
    - The mother will present with an itchy/sore, red, shiny and flaky nipple
    - The baby's mouth will have the characteristic creamy white infection
    - One should treat the baby with an oral antifungal (nystatin) and the mother with an antifungal nipple cream
- Flat or inverted nipples:
    - The mother should be advised that continued feeds will help correct the shape. If it does not correct, cup feeds may be considered

Feeding Principles for the Preterm or Sick Neonate

The aim when feeding any neonate should be to maintain a growth rate similar to the intrauterine rate for the same gestational age, and to reach developmental goals for corrected gestational age. Premature and sick neonates struggle to meet their nutritional requirements through demand breastfeeding for the following reasons:

- They often have higher energy needs per kilogram because of their relative stress state and increased growth requirements
- They have reduced hepatic glycogen stores and are reliant on frequent external sources of glucose to avoid hypoglycaemia

- To breastfeed, the neonate needs to be able to root, latch and suck. Neonates below 35 weeks gestation may struggle to breastfeed because of immature feeding reflexes
- These infants often require higher amounts of sleep and get tired sooner when feeding, which can lead the mother to think the infant is full too early into a feed
- The breast milk supply of a sick or preterm mother (whose condition might pre-empt the birth of a sick or premature neonate) is likely to be lower and come in later

For these reasons, high-risk infants may need supplemental feeds, which can be given as enteral feeds or intravenously (parenteral feeds). There is a push by some to give as much volume enterally as is possible, if the baby tolerates oral cup or naso/oro-gastric feeds i.e. does not vomit and has a soft abdomen etc. This is an area of debate as the benefits of enteral feeds also come with the disadvantage of higher rates of necrotising enterocolitis in formula-fed infants. Expressed breast milk, if available, is used preferentially.

The mother should be encouraged to express after every feed or 8–10 times daily. The first bit of breast milk, the colostrum, is especially beneficial. However, waiting for colostrum should not delay feeding, as hypoglycaemia should be avoided in neonates. Very sick babies might require IV 10% dextrose solution within 30 minutes of birth. Donor breast milk can also be used.

Calculating Feeds in Sick and Premature Neonates

In general, the total daily fluid intake (TFI) is calculated in units of mL per kg per day and then split over routes of administration depending on how sick the infant is – IV (parenteral) and oral feeds. The neonate's highest weight achieved is used for the TFI. See Table 4.1 below for daily requirements. One is encouraged to memorise the first column for infants over 2 kg.

The TFI amount should be increased daily by 10–20 mL/kg/day, taking into consideration the new weight and age of the baby but making sure not to increase too fast as the neonate may not tolerate large volumes. The child can be switched to full enteral feeds when they comprise > 80% of the split. In premature neonates, TFI is often increased up to 160–180 mL/kg/day.

Table 4.1: TFI by Weight

	> 2000 g	1500–1999 g	1000–1499 g	< 1000 g
Day 1	60 mL/kg/day	70	80	90
Day 2	75	80	90	100
Day 3	100	110	120	130
Day 4	125	130	140	150
Day 5+	**150 mL/kg/day** Titrate mL/kg/day to growth from this point onwards – not an exact science Observe how infant feeds and tolerates increments If growing well (average 15 g/day over 3 days), maintain TFI NEVER increase TFI above 200 mL/kg/day without consultant input			

For enteral feeds, try to substitute some of the formula volume for expressed breast milk if the infant is too young to suck effectively. Blood glucose should be regularly checked (three hourly) and maintained within 2.6–7.0 mmol/L. Urgently treat hypoglycaemia with additional feeds and manage hyperglycaemia by switching to 5% glucose-containing fluids.

Table 4.2: Notes on and Examples of TFI Calculations

Notes:

- Term infants may feed three hourly or on demand
- Pre-terms should, at first, feed orally, two hourly (as far as they can tolerate)
- In general, give full parenteral feeds for infants < 1500 g (except for colostrum) with gradual introduction of enteral feeds starting at 24 mL/kg/day and increasing by 36 mL/kg daily via orogastric tube (this is a good route for all infants < 34 weeks)
- Give IV maintenance of 10% dextrose solution (also known as neonatalyte) at approx. 1 mL/kg/hour. However, neonates < 1000 g need 5% dextrose water for the first 36-48 hours
- Feeds should be increased (by 10–15 mL/kg/day) for infants receiving conventional phototherapy

- One can substitute a “feed” for a breastfeeding session. 100 mL of breast milk has 67 kcal, while 100 mL pre-term formula has 85–87 kcal
- Premature infants lose up to 15% of their weight from water loss in the first week (term infants lose about 10%)

Example: Write up feeds for a 2000 g 34-week prem with presumed neonatal sepsis on day 1 of life. What are her feeds on day 5, when she weighs 1800 g, and her sepsis has resolved?
Day 1: TFI = 60 m/kg/day, therefore baby requires 120 mL per day (60 x 2 = 120) in 2 hourly feeds. Thus, she should be given 10 mL per feed (120/12 = 10). Give colostrum if available. Give EBM if available, otherwise use formula. She will likely need cup feeds. If cup feeds are not tolerated, she should be given orogastric tube feeds. If she is very sick or has severe respiratory distress, she will need parenteral feeds.
Day 5: TFI = 150 mL/kg/day, therefore baby requires 300 mL per day (150 x 2 = 300; use her highest-ever weight, i.e. birth weight, rather than her current weight). This should be given in 2 hourly feeds of 25 mL per feed (300/12 =25). Give EBM if available, otherwise continue PreNAN®, Similac® or equivalent. Assess the mother’s breastfeeding technique and the baby’s suck to determine when to transition to breastfeeding.

Supplementation

One should work with a dietician, especially regarding formula and availability. Breast milk fortifier should be given to infants < 2000 g, once s/he is on full feeds i.e. 150 mL/kg/day. This supplement is usually called FM85 and 0.5–1g is added depending on feed volume. It should NOT be added to formula, only expressed breastmilk. Medium chain triglycerides may be given if there has been inadequate weight gain.
When the neonate has been switched to only enteral feeds, s/he should also be started on multivitamin drops until mixed feeding is well established (including breast milk).

Iron (ferrous gluconate/Ferrodrops®) should be given from one month old until the neonate is weaned as there is a high risk of anaemia in pre-term babies (have low iron stores).
One should also check phosphate and ALP levels in infants < 32 weeks and VLBW infants. Abnormal serum sodium can be an indicator of poor intake / inadequate fluid management.

Solid Food

It should be introduced when the child is six months old. Small amounts of solid food should be given, starting with cereals (see image here), puréed fruits and vegetables. There should be a gradual progression to a mixed diet and breastfeeding continued for as long as possible (WHO recommends two years).

If there is a family history of food allergy:

- Cow's milk should be avoided for six months
- No citrus/egg/cheese should be given before 9–12 months
- The child should only be given wheat-free cereals

GENERAL FLUID MANAGEMENT

Fluid requirements in paediatrics fall under four main categories – resuscitation, rehydration, maintenance and replacement of ongoing losses.

Resuscitation

Resuscitation fluids are indicated for the child in shock (an emergency). The following signs may be used to recognise the shocked child:

- Early:
    - Cold peripheries
    - Increased capillary refill time (3–4 seconds) – check this on the sternum in a young child)
    - Decreased urine output
- Late:
    - Decreased level of consciousness
    - Poor pulses

- Low systolic blood pressure – indicates decompensation (>20% loss); responds to gravity i.e., lifting legs in hypovolaemia
- Acidotic breathing (Kussmaul's) – fast, hungry for air

It may be difficult to identify these signs in a malnourished child.

Table 4.3: Types of Shock

Recall that there are four types of shock:

- Hypovolaemic:
  - Large volume e.g. acute gastroenteritis (AGE), burns, sepsis, abdominal pathology
  - Low volume e.g. myocarditis, severe acute malnutrition (SAM), drowning, diabetic ketoacidosis (DKA), traumatic brain injury (TBI), status epilepticus, toxins
- Cardiogenic
- Distributive:
  - Septic
  - Anaphylactic
  - Neurogenic
- Obstructive

Management

The correction efforts for hypovolaemia should have the same focus as any resuscitation situation:

- **A** – airway:
  - Maintain the airway and suction any secretions
- **B** – breathing:
  - Give supplemental oxygen via a facemask
  - One may need to give ventilatory support (PEEP, CPAP, etc.) depending on the scenario
- **C** – circulation:
  - Insert an IV or interosseous (IO) line (if no success after two attempts at a venous drip) and cautiously give fluid boluses

- Rapidly give a 10 mL/kg bolus of isotonic crystalloids e.g. Ringer's lactate, modified Ringer's lactate (Plasma-Lyte A or B, normal saline) using a three-way tap and syringe. Check for improvement and check for signs of fluid overload e.g. enlarged liver, respiratory crackles, S3 gallop rhythm
- If the patient is still shocked, give repeat boluses, but take care not to fluid overload the child, especially if s/he is malnourished (if overloaded, s/he will develop cardiac failure, hepatomegaly, cardiac gallop rhythm and/or basal lung crepitations). Also monitor urinary output
- Oral feeding and fluid intake should be encouraged once perfusion is re-established

- **DEFG** – do not ever forgot glucose:
  - Administer dextrose if the fingerprick glucose level is <3 mmol/L

The patient's response to treatment should then be reassessed. If s/he is still shocked, give more fluid boluses and administer ceftriaxone (80 mg/kg stat to cover for possible sepsis). If after 15–20 minutes, the patient has still not improved, contact one's regional hospital to discuss further management and, if necessary, contact the flying squad to discuss transfer.

If the child is transferred to a provincial hospital, s/he may be started on inotropes (dopamine 10 μg/kg/min) and admitted to PICU.

Table 4.4: Management of the Malnourished Child with Shock

MANAGEMENT OF THE MALNOURISHED CHILD WITH HYPOVOLAEMIC SHOCK
Severely malnourished children have a high risk of mortality if they are given too much IV fluid because they are more likely to become fluid overloaded. Thus, IV fluid must be carefully titrated because it may not reverse the shock if too little is given, may be life-saving if the correct amount is given or may be life-threatening if given in excess. The approach to shock is initially the same as in the non-malnourished. Once perfusion is restored, the child should be switched to enteral fluids and rehydrated over 24 hours (see treatment section below).

If fluid overload develops then all fluids must be stopped and the child urgently discussed with a senior clinician; see related image here.

Rehydration

Evaluate the child's hydration status by assessing the characteristics laid out in the table below.

Table 4.5: Features of Mild-to-Moderate and Severe Dehydration

	5% Dehydrated (Mild-to-Moderate) **50 mL/kg loss**	**10% Dehydrated (Severe)** **100 mL/kg loss** *(>2 of the signs below)*
Body weight loss	5–10%	> 10%
Eyes	Sunken	Sunken
Thirst	Increased and drinking regularly	Drinking poorly
Activity	Restless/irritable	Lethargic
Skin turgor (pinch)	Normal (raised for < 2 seconds)	Decreased (stays raised for >2 seconds)
Mucous membranes	Dry	Dry
Tears	Normal/slightly reduced	Absent
Urine output	Oliguric	Oliguric or anuric
Anterior fontanelle	Normal	Sunken
Shock	No signs	May have signs if very severe – use resuscitation algorithm

One should also evaluate nutritional status – assess the patient for SAM as it is commonly associated with AGE.

Management

Admission criteria for the dehydrated child are:

- Shock
- Severe dehydration
- Neurological abnormalities (including coma/severe lethargy)
- Intractable vomiting
- Failure of oral rehydration solution (ORS) out of hospital
- Concerns about care or conditions needed for recovery at home

- Underlying condition exacerbating presentation e.g. bowel obstruction/prior surgery

Rapid Rehydration

Otherwise healthy children should be rapidly rehydrated via the gut. Enteral rehydration should be performed whenever possible. IV and IO lines are only for patients who are shocked or have failed oral therapy, since there is greater danger of fluid overload, among other concerns. A nasogastric tube can be used, especially in patients whose airways are at risk e.g. very lethargic children, severely dehydrated children who refuse to or are unable to drink. The estimated hydration status assessment shown above is important as one does not want to give too much fluid (such that the child cannot tolerate it and becomes fluid overloaded) nor too little fluid (such that the rehydration is ineffective). One may adjust the amount of rehydration fluid given if need be e.g. if the child is not responding after a few hours or does not tolerate the volume of feeds/fluids.

Table 4.6: Rehydration of Mild-to-Moderate and Severe Dehydration

Mild-to-moderate Dehydration	Severe Dehydration
● Give ORS at a rate of 10–12,5 mL/kg/hour for 4–6 hours (one is aiming to replace the 50 mL/kg loss i.e. 10 mL/kg/hour for 5 hours) ● Breastfeed if tolerated, but initially continue ORS feeds if the child is usually formula-fed ● Replace ongoing losses with ORS ● Resume age-appropriate diet once rehydrating	● Give ORS at a rate of 20–25 mL/kg/hour for 4–6 hours (one is aiming to replace the 100 mL/kg loss i.e. 20 mL/kg/hour for 5 hours) ● Breastfeed if tolerated, but initially continue ORS feeds if the child is usually formula-fed ● Replace ongoing losses with ORS ● Resume age-appropriate diet once rehydrating

If the child is not tolerating oral fluids, ½ Darrows dextrose (DD) may be given IV. However, in the child who is vomiting, one should give rehydration fluid (0,45% normal saline and 5% dextrose) with added potassium (20 mmol/L), as this is most appropriate.

Slow Rehydration

Rapid rehydration should be avoided in certain sick children. These children include those with:

- Shock
- SAM
- Age < 2 months or > 5 years
- Encephalopathy
- Cardiac disorders
- Severe pneumonia

Instead one should rehydrate these children over 24–48 hours, using the same amounts as above over the longer period i.e. 100 mL/kg/day for severe and 50 mL/kg/day for mild-moderate cases (see hydration formula recommended by UNICEF here).

Maintenance

Maintenance fluid requirements are calculated as follows for children less than 60 kg, and **added to the above** rehydration prescription if necessary:

Table 4.7: Maintenance Fluids

All ages	Can get fluids by breastfeeding on demand, replacing the below
< 3 months old	150 mL/kg/day
3 months – 1 year	120 mL/kg/day
> 1 year	1–10 kg: 100 mL/kg/day for 1st 10 kgs
	10–20 kg: 50 mL/kg/day for 2nd 10 kgs
	For every kg > 20 kg: 25 mL/kg/day

Maintenance fluids for children >1 year old can be remembered using the 4:2:1 rule: 4 x every kg in the first 10 kg, 2 x every kg in the next 10 kg, and 1 x every kg thereafter (i.e. >20 kg). The sum of these amounts gives you the hourly maintenance fluid requirement. If this sum is multiplied by 25, one will get the daily total.

Example: A 24 kg child needs 64 mL/hour (10x4 + 10x2 + 4x1) and 1600 mL/day (24x25). That can be distributed as nasogastric feeds at a rate of 67 mL per hour.
If maintenance is to be given intravenously only, one must choose an age-appropriate dextrose-containing solution e.g. neonatalyte (10% dextrose) in neonates and small infants; maintelyte (5% dextrose) in older children. These solutions are usually mildly hypotonic and often equivalents can be made up by adding the desired dextrose concentration to a crystalloid.
For small children and infants, total daily fluid intake should be carefully tallied, considering all supplemental fluids, including any dilutants for medications. These additional fluids should be considered part of fluid provision and, therefore, subtracted from the maintenance amount (see hospitalized child with Intravenous Fluids here).
The child should be weighed six-hourly to objectively assess gains or losses.

Ongoing losses
Ongoing losses should be calculated for continuous losses (usually stools but sometimes vomits). These can be counted precisely, using an estimate of 5–10 mL/kg/stool. These feeds can be given immediately after stools if stool passage is measured e.g. in a high-care setting where monitoring, care and staff is plentiful. Often such precision is impossible, and ongoing losses are assumed to be 20–30 mL/kg/day if the bout of acute gastroenteritis is known to be ongoing. This amount can be added to the daily fluid requirements for rehydration and maintenance.