
CHAPTER 4 – FLUID MANAGEMENT

First Nations and Inuit Health Branch (FNIHB) Pediatric Clinical Practice Guidelines for Nurses in Primary Care.
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FLUID REQUIREMENTS IN CHILDREN

GENERAL INFORMATION

Prolonged diarrhea resulting in dehydration is a significant cause of morbidity and mortality in First Nations communities.¹ Hypovolemia is the most common cause of shock in children² and requires fluid therapy. This is usually from diarrhea and vomiting.³ Children become dehydrated more easily as their body surface area compared to their weight is much larger than that of an adult.⁴

Maintenance fluid is the amount of fluid the body needs to replace usual daily losses from the respiratory tract, the skin and the urinary and gastrointestinal (GI) tracts.

A well child usually drinks more than maintenance requirements. If a child takes in significantly less than maintenance requirements, he or she will gradually become dehydrated.

The requirement for maintenance fluids varies with the weight of the child (*see Table 1, "Hourly Maintenance Fluid Requirements"*). Infants need more fluid per kilogram of body weight than do older children. Various medical conditions will also affect these requirements (*see Table 2, "Conditions Modifying Daily Maintenance Fluid Requirements"*). Increase daily maintenance fluids by 12% for every degree body temperature above 37.5°C (rectal). Maintenance fluids can be given intravenously or by mouth.

Table 1 – Hourly Maintenance Fluid Requirements (1-hour periods)

Calculation:

- 4 mL/kg/hour for first 10 kg of body weight
- + 2 mL/kg/hour for the next 10 kg of body weight (over the initial 10 kg of body weight)
- + 1 mL/kg/hour for each kilogram over 20 kg of body weight

Maximum of 100 mL/hour or 2400 mL a day needed for maintenance

Examples:

For 10 kg child: 10 kg x 4 mL/kg/hour = 40 mL/hour

For 15 kg child: (10 kg x 4 mL/kg/hour) + (5 kg x 2 mL/kg/hour) = 50 mL/hour

For 25 kg child: (10 kg x 4 mL/kg/hour) + (10 kg x 2 mL/kg/hour) + (5 kg x 1 mL/kg/hour) = 65 mL/hour

Adapted from: Somers MJ, Endom EE. (2008, May 30). *Maintenance fluid therapy in children*. UptoDate Online 16.3. Maintenance Water Needs section.

Table 2 – Conditions Modifying Daily Maintenance Fluid Requirements

Requirements Increased	Requirements Decreased
<ul style="list-style-type: none"> • Fever, sweating, vomiting or diarrhea • Diabetes • Burns 	<ul style="list-style-type: none"> • Meningitis • Congestive heart failure • Renal failure

Note: with a fever, daily maintenance fluids should be increased by 12% for every degree body temperature above 37.5°C (rectal)

DEHYDRATION IN CHILDREN

DEFINITION

Abnormal decrease in volume of circulating plasma.

CAUSES

- Increased fluid loss (for example, gastroenteritis [most common cause in childhood], fever, diabetes mellitus [ketoacidosis] or GI obstruction)
- Inadequate fluid intake (for example, secondary to stomatitis, pharyngitis, altered level of consciousness, pyloric stenosis or GI obstruction)
- Translocation of fluids (for example, ascites or burns)

Newborns and young children have a much higher water content than adolescents and adults, and are therefore more prone to loss of water, sodium and potassium during illness.

HISTORY^{5,6,7,8}

History is of importance as it may determine cause and degree of dehydration, dictating the management.

- Parent concern regarding no tearing or depressed fontanelle
- Recent exposure to illness, injury or stress
- Fever
- Vomiting (onset, duration, frequency, volume, colour)
- Diarrhea (duration, frequency, consistency, blood or mucus)
- Urine output (frequency, volume)
- Fluid intake (volume, frequency, type)
- Lethargy
- Irritability
- Weight loss
- Sick contacts
- Travel
- Past medical history (including diabetes, cardiac disease, renal disease, cystic fibrosis)
- Associated symptoms (including ear pain, UTI symptoms, vision changes, cough, headache, seizures, polydipsia, polyuria, polyphagia, anorexia)

All body systems must be reviewed and assessed to ascertain underlying cause of dehydration.

PHYSICAL ASSESSMENT TO DETERMINE EXTENT OF DEHYDRATION

- General appearance and behaviour
- Vital signs, including blood pressure and temperature
- Weight (without clothes)
- Capillary refill time
- Tearing and salivation
- Mucous membrane moisture
- Skin colour and moisture
- Skin turgor
- Fontanelles
- Urine output
- Mental status
- Neurological examination

See Table 3, “Clinical Features of Dehydration” to quantify dehydration status based on physical findings.

Table 3 – Clinical Features of Dehydration

Feature	Mild Dehydration (< 5%)	Moderate Dehydration (5% to 10%)	Severe Dehydration (> 10%)
Heart rate	Normal	Slightly increased	Rapid, weak
Systolic blood pressure	Normal	Normal to orthostatic, > 10 mm Hg change	Hypotension
Urine output	Decreased	Moderately decreased	Markedly decreased, anuria
Mucous membranes	Slightly dry	Very dry	Parched
Anterior fontanel	Normal	Normal to sunken	Sunken
Tears	Present	Decreased, eyes sunken	Absent, eyes sunken
Skin*	Normal turgor	Decreased turgor	Tenting
Skin perfusion	Normal capillary refill (< 2 seconds)	Capillary refill slowed (2–4 seconds); skin cool to touch	Capillary refill markedly delayed (> 4 seconds); skin cool, mottled, gray
Mental status	Alert	Irritable	Lethargic

*Skin condition is less useful in diagnosis of dehydration in children > 2 years of age⁹

DIAGNOSTIC TESTS

- Urinalysis to check for ketones
- Blood glucose to rule out diabetes (if no diarrhea)
- Others depending on suspected cause of dehydration (for example, electrolytes)

MANAGEMENT**Goals of Treatment**

- Correct dehydration using oral rehydration therapy (ORT) with or without IV fluids
- Treat shock or impending shock (for example, give oxygen and fluids)
- Prevent complications (for example, seizures or edema)

Appropriate Consultation

Consult a physician as soon as possible for any infant or young child with signs of dehydration. If the child has presented with severe signs (for example, shock), this consultation may have to wait until the child's condition has been stabilized.

Nonpharmacologic Interventions

- Using the criteria presented in Table 3, “*Clinical Features of Dehydration*” decide if child is mildly, moderately or severely dehydrated
- Once you have determined the degree of dehydration based on clinical features, use the appropriate degree of dehydration in Table 4, “*Fluid Resuscitation*” to determine rate of fluid administration and special considerations during rehydration
- Ongoing losses (emesis, diarrhea) also need to be added to the fluid requirements,¹⁰ as noted in Table 4, “*Fluid Resuscitation*”

Table 4 – Fluid Resuscitation¹¹

Mild Dehydration (<5%)	Moderate Dehydration (5% to 10%)	Severe Dehydration (>10%)
<p>Start rehydration with oral replacement solution: 50 mL/kg over 4 hours at an approximate rate of 1 mL/kg every 5 minutes¹² (this is the fluid deficit volume). Close observation is recommended</p> <p>Reassess at 4-hour intervals</p> <p>From 4 to 24 hours, give oral replacement therapy as the child desires, ensuring replacement of maintenance requirements (see <i>Table 1, “Hourly Maintenance Fluid Requirements”</i>) and any losses.</p> <p>Give extra oral replacement solution after each emesis (for example, 2 mL/kg) or diarrheal stool (for example, 5–10 mL/kg)¹³</p> <p>Give fluid frequently, in small amounts</p> <p>Monitor urine output (output should be at least 1 mL/kg body weight per hour)</p> <p>Continue breastfeeding; if child is bottle-fed, early refeeding of child’s normal formula (within 6–12 hours) is recommended</p> <p>Full, age-appropriate diet should be reinstated after 4 hours, if possible</p> <p>Delay refeeding only if there is severe, protracted vomiting</p>	<p>Start rehydration with oral replacement solution; 100 mL/kg over 4 hours at an approximate rate of 2 mL/kg every 5 minutes¹² (this is the fluid deficit volume). Close observation is recommended</p> <p>From 4 to 24 hours give oral replacement therapy as the child desires, ensuring replacement of maintenance requirements (see <i>Table 1, “Hourly Maintenance Fluid Requirements”</i>) and any losses</p> <p>Give extra oral replacement solution after each emesis (for example, 2 mL/kg) or diarrheal stool (for example, 5–10 mL/kg)¹³</p> <p>Give fluid frequently, in small amounts</p> <p>Monitor urine output (output should be at least 1 mL/kg body weight per hour)</p> <p>Continue breastfeeding; if child is bottle-fed, early refeeding of child’s normal formula (within 6–12 hours) is recommended</p> <p>Full, age-appropriate diet should be reinstated after 4 hours, if possible</p> <p>Delay refeeding only if there is severe, protracted vomiting</p>	<p>Medical emergency</p> <p>Normal saline or Ringer’s lactate 20–40 mL/kg/hour intravenous¹¹ (a minimum of 5–20 minutes for 20 mL/kg boluses)¹⁴; repeat boluses may be given up to a maximum total fluid amount of 40–80 mL/kg during the first hour¹⁴; reassess the patient, particularly cardiac and respiratory function, after each bolus¹⁵</p> <p>If unable to start an intravenous line in three attempts (or within 60–90 seconds), establish intraosseous access. For intraosseous infusion, see <i>“Intraosseous Access”</i> in the chapter, <i>“Pediatric Procedures”</i>; this technique can save the child’s life and is not technically difficult; when line is in place, use as you would a regular intravenous line</p> <p>Monitor blood pressure</p> <p>Reassess child, particularly cardiac and respiratory function, and repeat bolus if signs of shock persist (for example, tachycardia, decreased systolic blood pressure, poor perfusion, skin grey and mottled)</p> <p>Start oral replacement therapy when child is stable at 100 mL/kg over 4 hours¹⁶</p> <p>Replace ongoing losses with oral replacement solution (for emesis 2 mL/kg or diarrheal stool 5–10 mL/kg)</p> <p>Monitor urine output (output should be at least 1 mL/kg body weight per hour)</p> <p>Full, age-appropriate diet should be reinstated after rehydration, if possible</p>

Monitoring and Follow-Up

Reassess level of consciousness (according to Pediatric Glasgow coma scale in the chapter, *“Central Nervous System”*), vital signs, skin perfusion, skin turgor and urine output frequently.

Referral

Medevac any child with moderate to severe dehydration as soon as possible.

GENERAL COMMENTS ABOUT FLUID MANAGEMENT

Intravenous therapy should usually be used only in cases where oral replacement therapy is contraindicated; oral therapy is always safer and as effective as intravenous therapy. Oral replacement therapy is contraindicated in children with protracted vomiting (even with small, frequent feedings); severe dehydration with shock, impaired consciousness; paralytic ileus; and monosaccharide malabsorption.

Oral replacement solution (ORS) should be given frequently and in small amounts while gradually increasing the volume until the child drinks as desired (for example, 5 mL every 1–2 minutes can give 150–300 mL/hour).

The oral replacement solution may be administered by nasogastric tube if necessary.

Use of a premixed oral replacement solution such as Pedialyte or Gastrolyte to replace the calculated deficit is safest. Parents must be educated that if mixing up a dry solution, it must be mixed exactly as per instructions.

Carbonated beverages and sweetened fruit juices should **not** be used for rehydration due to their high carbohydrate and low electrolyte content. Parents should not offer plain water to children with gastroenteritis to avoid hyponatremia and hypoglycemia.¹¹ Give extra fluids if there are ongoing fluid losses (for example, if diarrhea or vomiting continues).

If the child is breast-feeding and is able to nurse, then breast-feeding should be continued for maintenance requirements; supplement with Pedialyte or Gastrolyte to make up the deficit.

If a marked increase in diarrhea occurs (as defined by an increase in stool frequency to twice the usual number in infants or three or more loose or watery stools per day in older children¹⁷) when a bottle-fed child returns to his or her usual cow's milk formula, consult a physician about changing to a soy-based formula (for example, Prosobee or Isomil). Switch back to regular cow's milk formula within 7–10 days. Do not go back to Pedialyte unless there is a marked increase in stools while on soy formula. Some increase in stools does not matter, as long as the child takes in enough to keep up with losses. In other words, treat on the basis of the child's condition, not on the basis of the stools.

If the child is vomiting, he or she will usually tolerate fluids by mouth if given in small amounts (one sip at a time). If child will not suck or drink, try giving sips frequently by spoon, dropper or syringe. Allow mother and other family members to administer fluid.

SOURCES

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ENDNOTES

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