

Fluids and Electrolytes



Lisa Martin, MD, MPH

Objectives

- Know maintenance water and electrolyte requirements for children.
- Assess hydration status in children.
- Determine replacement fluids (oral and iv) for dehydrated patients with a variety of electrolyte disturbances.

Maintenance Fluids

- Holliday-Segar Method
 - Estimates caloric expenditure from weight, assuming that for each 100 calories metabolized, 100 ml H₂O are required.

Body Weight	Water	
	ml/kg/day	ml/kg/hr
First 10 kg	100	4
Second 10 kg	50	2
Each additional kg	20	1

Example: 8 year-old weighing 25kg

- ml/kg/day
 - _____ ml/kg/day

- ml/kg/hr
 - _____ ml/kg/hr

Maintenance Electrolytes

Electrolyte	mEq/L H ₂ O (~mEq/kg)
Na ⁺	3 (2-4)
K ⁺	2 (2-3)
Cl ⁻	2

Assessing Hydration Status

Dehydration	Mild	Moderate	Severe
	<u>Older Child</u> 3%	6%	9%
	<u>Infant</u> 5%	10%	15%
Examination			
Skin turgor	Normal	Tenting	None
Skin – touch	Normal	Dry	Clammy
Lips/ MM	Moist	Dry	Parched/Cracked
Eyes	Normal	Deep set	Sunken
Crying/tears	Present	Reduced	None
Fontanelle	Flat	Soft	Sunken
CNS	Consolable	Irritable	Lethargic
Pulse	Regular	Slightly increased	Increased
Urine output	Normal	Decreased	Anuric

Assessing Hydration Status

■ History

- Volume of liquid intake
- Frequency of wet diapers/urination
- Frequency/quantity of diarrhea
- Recent weight (if known)

■ Labs

- BMP if admitting the patient
 - Serum sodium

Classifying based on Na⁺

- Hyponatremic
 - Serum Na⁺ < 130 mEq/L
 - Implies excess Na⁺ loss
- Isonatremic (isotonic)
 - Serum Na⁺ 130-150 mEq/L
- Hypernatremic
 - Serum Na⁺ > 150 mEq/L
 - Implies free water (FW) loss

How dehydrated is this patient?

- A 15 month old boy has had vomiting and diarrhea for the last 3 days. He usually drinks ~40 ounces/day, but is only drinking sips. His pulse is 130, and his lips are slightly dry. He is fussy during the exam and cries a few tears. His capillary refill is brisk, and skin turgor is normal.

Fluid Resuscitation

- Phase I - Emergency Management
- Phase II - Deficit Replacement, Maintenance and Ongoing Losses
- Oral vs. IV

Deficit Replacement

- Most precise – use patient's weight
 - Fluid deficit (L) = preillness wt (kg) – current wt (kg)
 - % dehydration = $\frac{\text{preillness wt} - \text{current wt}}{\text{preillness wt}} \times 100\%$
- Otherwise, estimate based on clinical exam

Oral vs. IV Replacement

- Oral rehydration therapy (ORT) is preferred for mild – moderate dehydration unless
 - emesis is intractable
 - stool losses > 10 cc/kg/hr
 - consciousness is impaired

Oral Rehydration Therapy

- Give 5-10cc of oral rehydration solution (ORS) every 5-10 minutes, increasing the amount as tolerated.
- Deficit replacement
 - Mild dehydration: 50 cc/kg ORS over 4 hours.
 - Moderate dehydration: 100 cc/kg ORS over 4 hours.

Oral Rehydration Solutions

■ Acceptable

- Pedialyte
- Infalyte (Ricelyte)
- WHO/UNICEF ORS

■ Suboptimal

- Apple juice
- Coca-Cola
- Gatorade
- Tea
- Chicken broth



Oral Maintenance Therapy

- GOAL: Usual diet + replace ongoing losses
- Infants
 - Resume breastfeeding or regular formula
 - Soy or other lactose-free formulas are usually unnecessary.
- Older children
 - Encourage starchy foods, clear broth soups, yogurt, fresh fruits and vegetables.
 - Avoid foods high in fat or simple sugars.

IV Emergency Replacement – AKA “Boluses”

- What fluid?
- How much fluid?
- How many boluses?

IV Maintenance Fluids

- 3 important components
 - Dextrose
 - D₅ for most children; D₁₀ in the NICU
 - Potassium (except for patients with decreased urine output or renal insufficiency)
 - Usually add 20 mEq/L
 - Sodium



Common IV Fluids

Fluid	Na (mEq/L)
D ₅ W	0
0.9% NaCl (NS)	154
0.45% NaCl (1/2 NS)	77
0.2% NaCl (1/4 NS)	34
Lactated Ringers	130

Which fluid do I choose?

- Consider the patient's daily free water and sodium needs.
 - 5 kg infant
 - FW:
 - Na⁺:
 - Fluid =
 - 20 kg child
 - FW:
 - Na⁺:
 - Fluid =

Hypernatremic Dehydration

■ Water loss

- Insensible
 - Fever, burns
- Renal
 - DI, diuretic use
- GI
 - Diarrhea
- Hypothalamic disorders
 - Hypodipsia

■ Excess sodium

- Excess ingestion
 - Improper formula mixture, Munchausen-by-proxy
- Iatrogenic
 - Hypertonic NaCl IV fluid, excess IV NaHCO₃
- Endocrine
 - Hyperaldosteronism

Hypernatremic Dehydration

■ Symptoms

- Lethargy, weakness, irritability, seizures, coma, death
- Skin may be doughy

■ Treatment Goals

- Replace FW deficit
- Lower serum sodium
 - Do not lower serum sodium more than 1 mEq/L per hour.
 - Want to avoid cerebral edema

Managing Hypernatremic Dehydration

- Emergency management
- FW deficit =
 $0.6 \times \text{body wt (kg)} \times [1 - (140/\text{serum Na})]$
- Calculate replacement + maintenance rate so serum sodium falls 0.5-1 mEq/L/hour.
 - If serum sodium is 164 and goal is 140, must take at least 24 hours to replace FW deficit.
 - Therefore, *hourly* fluid rate is the usual maintenance plus $1/24^{\text{th}}$ of total free water deficit.
- Check serum sodium every 4-6 hours. If falling too fast, slow down FW replacement rate or increase sodium in IV fluid.

Hyponatremic Dehydration

- GI
 - Diarrhea
- Water intoxication, polydipsia
- Diuretics
- Factitious
 - Hyperglycemia, hyperlipidemia
- SIADH
 - CNS injury
 - Pneumonia, ARDS
 - Decreased pulmonary venous return activates release of ADH
 - Post-op patients – spinal fusion

Hyponatremic Dehydration

■ Symptoms

- Seizures, lethargy if sodium < 120 mEq/L

■ Treatment Goals

- Raise sodium acutely to 120-125 mEq/L
 - Replace Na in patients who are volume depleted.
 - Restrict water intake in normovolemic or edematous patients.
- Treat the underlying cause.

Managing Hyponatremic Dehydration

- Emergency management
- Sodium deficit =
 $0.6 \times \text{body wt (kg)} \times (140 - \text{serum Na})$
- Give 3% saline to raise serum sodium to 120-125 mEq/L.
 $0.6 \times \text{body wt (kg)} \times (125 - \text{serum Na})$
- If patient is hypovolemic, continue to replace sodium deficit with fluid to raise serum sodium ~ 2 mEq/L/hour