Pediatric Fluid and Electrolyte Management

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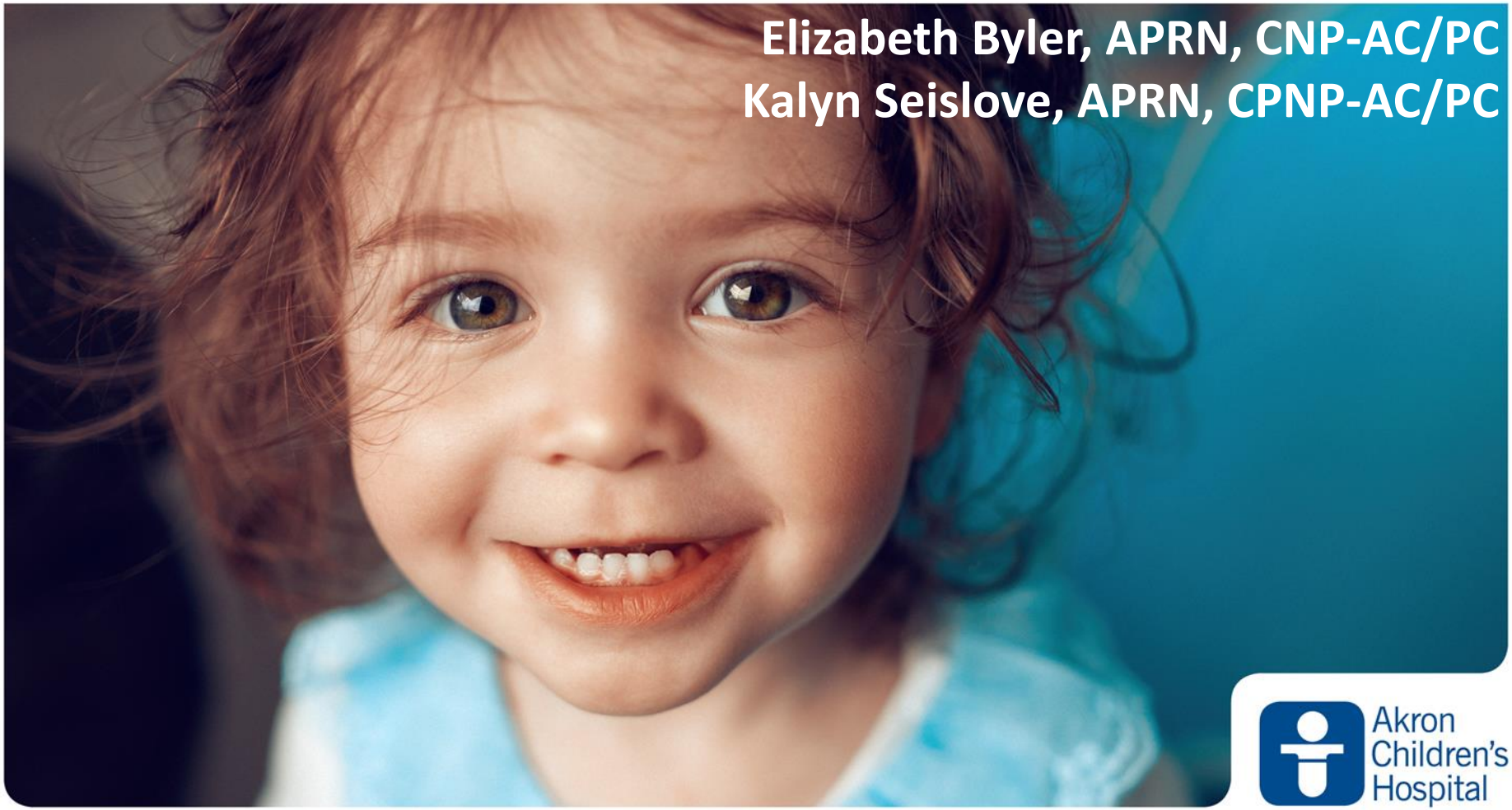

Akron Children's Hospital

No Disclosures to Learners

Objectives

- Discuss fluid and electrolyte basic concepts
- How to quantitively estimate dehydration and treat mild dehydration
- How to define and properly order fluid bolus
- How to correct hyponatremia and hypernatremia dehydration
- Discuss replacement of electrolytes

F&E Basic Concepts

- Water loss sources
  - Insensible, 35%
  - Stool, 5%
  - Renal, 35%
  - Consider conditions that increase loss!
- Pediatric specific considerations
  - Increased metabolic rate
  - Increased rate of ketosis
  - Frequency of eating
  - Body composition of water

Dehydration

Calculation for Percent of Weight Loss

(estimating severity of dehydration)

[(pre-illness weight in kg-illness weight in kg) / pre-illness weight in kg] x100

Calculation for Estimated Fluid Deficit

(pre-illness weight in kg x percent in weight loss) x10

Exam Findings with Dehydration

Area of Assessment	Mild	Moderate	Severe
% Weight Loss	Infant <5% Children <3%	Infant 6-10% Children 4-6%	Infant >11% Children >7%
Anterior Fontanel	Slight	Moderate	Intense
Extremities/Capillary Refill	Warm, pink, brisk cap refill	Grayish, delayed cap refill	Cool, mottled, dusky, very delayed cap refill
Blood pressure	Normal	decreased	Low *
Pulse	Slightly increased	Increased and Weak	Tachycardic*
Respirations	Normal	Normal to rapid	Rapid *
Mucous Membranes	Normal to dry	Dry	Dry, cracked
Eyes/Tears	Normal/Present	Slightly depressed/Decreased	Sunken/Absent
Urine Output	Slightly decreased	<1ml/kg/hr	<1ml/kg/hr
Mental Status	Alert	Irritable or lethargic	Lethargic or limp *

* Signs of Shock

The Rehydration Process

FIGURE OUT DEHYDRATION

PLAN FOR REHYDRATION

FIX ELECTROLYTES

Oral Rehydration

- Mild or moderate dehydration
- Oral solutions
  - Consider sodium and osmolarity of the solution
  - Isotonic!
- Give up to 4 hours and consider proceeding to IV hydration

Composition of oral rehydration solutions (ORS) and commonly used beverages

	Carbohydrate (g/L)	mEq/L			Osmolarity (mOSM/kg H_2O)
		Sodium	Potassium	Base (HCO_3-)	
Oral rehydration solutions					
CeraLyte	40	70	20	10	235
Enfalyte	30	50	25	30	200
Pedialyte	25	45	20	30	250
Rehydralyte	25	75	20	30	310
WHO (1975)	20	90	30	30	310
WHO (2002)	13.5	75	20	30	245
Commonly Used Beverages (not appropriate for repletion therapy)					
Apple juice	100 to 150	3	20	0	700
Chicken broth	0	250	5	0	450
Colas	100 to 150	2	0.1	13	550
Gatorade	45	20	3	3	330
Ginger Ale	90	3.5	0.1	3.6	565
Tea	0	0	0	0	5

Oral Versus IV Rehydration

RCT: 34 patients 3 months-17 years with moderate dehydration

Oral Rehydration: 5-10 mL ORS Q5min for 1st hour, then doubled if no emesis

- Mean LOS 225 min
- Staff time 36 min
- 11% admitted
- 78% highly satisfied

IV Rehydration: 20 ml/kg NS +/- additional bolus if needed mIVF at 1.5 times maintenance, THEN PO 5-10 mL Q5min

- Mean LOS 358 min
- Staff time 65 min
- 25% admitted
- 37% highly satisfied

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IV Hydration

- Key Statement by the American Academy of Pediatrics in 2018 Clinical Practice Guideline: Maintenace IV Fluid in Children

"Patients 28 days-18 years of age requiring Maintenace IVF fluids should receive isotonic solutions with appropriate potassium chloride and dextrose because they significantly decrease the risk of developing hyponatremia."

Case Scenario #1

- Previously healthy 2-year-old with 1 day of vomiting and 2 days of diarrhea. Has drank 8 oz apple juice in last 24 hrs. Voided 3 times in last 24 hrs.
- Vital signs: 36.5, 142, 22, 88/45, 98% RA
- Exam: warm, well perfused. Active/alert.

3 Components of Fluid Therapy

1) **Maintenance**: Fluids to compensate for normal daily losses

- 4-2-1 Rule or Holiday-Segar Method
- Euvolemic vs hypovolemic

2) **Deficit**: Fluids to compensate for prior losses.

- Think fluid boluses!

3) **Replacement**: Fluids to compensate for ongoing losses during rehydration

Fluid Composition

Solution	Na+ (mEq/L)	K+ (mEq/L)	Cl- (mEq/l)	HCO3- (mEq/L)
NS (0.9% NaCl)	154	_	154	_
½ NS (0.45% NaCl)	77	_	77	_
LR	130	4	109	28

LR versus NS

- WHO recommends either for rapid rehydration
- Large amounts of NS can cause hyperchloremic metabolic acidosis
- LR is a balanced crystalloid (contains bicarbonate)

Fluid Bolus

Evaluate for shock and restore circulatory volume

- Improvement in tachycardia, hypotension, urine output

Based on severity of dehydration, patient should receive 20ml-60ml/kg of isotonic (NS) fluids intravenously

- Should not have dextrose or potassium in these fluids

Basic Metabolic Panel

- Sodium: 133-145
- Potassium: 3.3-5.1
- Chloride: 96-108
- Carbon Dioxide: 20-29
- BUN: 4-19
- Glucose: 70-99
- Creatinine: 0.2-0.4
- Calcium: 7.6-11

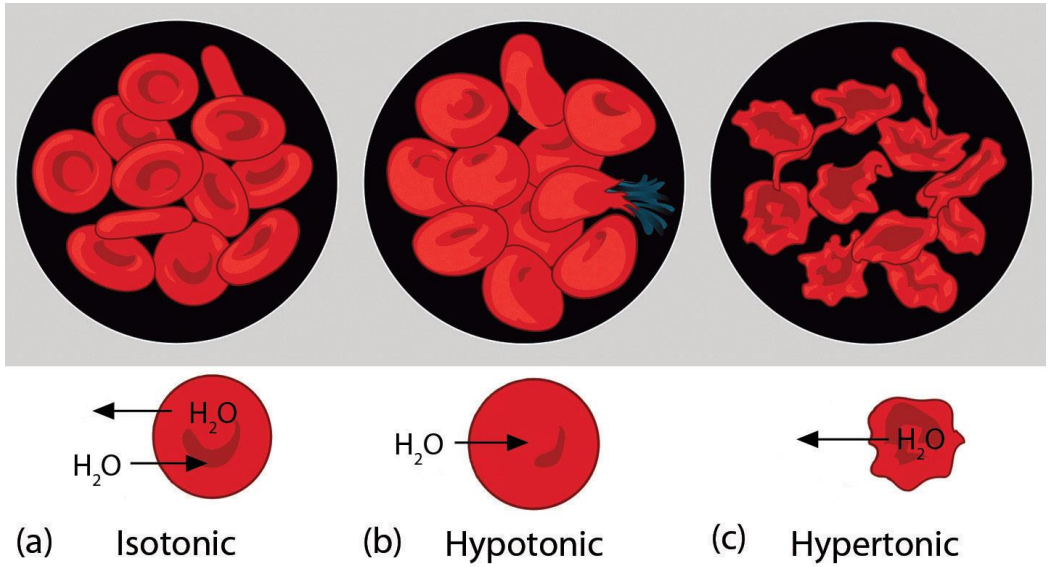
Anion Gap Calculation:

(Sodium-Chloride-Bicarb)

Goal <12

Types of Dehydration

- Isotonic
- Hypotonic
- Hypertonic



Isotonic Dehydration

Sodium: 135-145

Osmolality: 285-395

Water to Sodium Loss: Equal

Causes:

- Deceased oral intake
- Excessive vomiting and/or diarrhea

Isotonic Dehydration Treatment

- Administer MIVF + replacement of deficit with normal saline fluid
  - 2/3 of deficit fluid is replaced at 50% over the first 8 hours with the remainder infused over 16 hours

Hyponatremic Dehydration

Sodium: <130

Osmolality: <260

Water to Sodium Loss: Less

Causes:

- Excessive oral intake of free water with vomiting
- Water intoxication
- IV administration of sodium free solutions
- Inadequate electrolyte replacement with gastric suctioning
- Inadequate replacement of sodium loss from diarrhea or diuretic therapy
- Hyperglycemia
- Renal dysfunction

Hyponatremic Dehydration Treatment

In addition to MIVF, half of deficit can be replaced over 8 hours with the remaining half the following sixteen hour

- Sodium correction should not exceed 8-10meq/L/day
- May need 2 bag system
- Frequent Serum Sodium checks- every 2-4 hours
- May have to consider fluid restriction (2/3 MIVF) and oral supplementation

Correction of severe hyponatremia is corrected over 24-48 hours

- Rapid correction can cause osmotic demyelination syndrome (central pontine myelinolytic)
  - Headache, confusion, altered mental status, gait disturbance, respiratory arrest

Symptomatic hyponatremic (seizures)

Bolus with hypertonic (3%) saline to reach goal sodium goal of 120
3% saline = 0.513meq/mL

- Sodium deficit= (sodium desired-sodium actual) x VOD (0.6) x weight in kg

Case Scenario

10kg infant with Na of 115 and seizing

1. Treat symptomatic hyponatremia:

Sodium deficit= (sodium desired-sodium actual) x VOD (0.6) x weight in kg

120-115 x 0.6 x10 = 30

2. Dose 3% bolus in 3-5mL/kg = 0.513meq/ml = 1.5-2.5meq

-may have to give multiple bolus until seizure stops, then can start slow correction

3. MIVF with isotonic fluid (NS) and follow Na closely- may have to use 2 bag system to slowly correct Na

Hypernatremic Dehydration

Sodium: >150

Osmolality: >300

Water to Sodium Loss: Greater

Causes:

- Vomiting, burns, high fever (insensible losses), DI
- Inadequate replacement of fluids and electrolytes
- Administration of high protein feeds
- Poor renal function
- Large intake of salt/incorrect formula mixture
- Incorrect use of commercial electrolyte solutions
- Overdiuresis

Hypernatremic Dehydration Treatment

- Replacement of free water loss

- Estimate free water deficit

  (0.6L/kg) x (weight in KG) x ({current Na/goal sodium}-1)

- Administer MIVF in addition to replacement of deficit fluid (2/3 over the first 24 hours and remainder over the next 12 hours)
  - Two bag system-> D50.45%NS with D5W0.2%NS
    - Require frequent Serum Sodium checks
  - Correction of severe hypernatremia is SLOW- do not exceed 8-10meq/L/day or 0.5meq/hr
    - Rapid correction results in cerebral edema due to intracellular swelling

Case Scenario

10 kg Infant with 10% dehydration with Na of 156

1. Estimate Total Fluid Deficit: Weight in KG X % dehydration x 10

10 X 10 X 10 = 1000ML

2. Estimate Free Water Deficit: (TBW ~ 0.6L/kg) x ({current Na/desired Na} -1)

0.6L x (156/140) -1 = 600ml x (1.1142-1) = 686ml

3. Estimate Isotonic Loss: Total fluid deficit- Water Deficit

1000ml-686ml =314ml

-Give 20ml/kg (200ml) of isotonic fluid in acute resuscitation

4. 2/3 of free water deficit= 460ml + remaining isotonic loss = 114ml + maintenance of 1000ml/day / 24= 65ml/hr

5. D5W + D5 0.2 % titrate to lower 0.5meq/hr

Other Considerations

- Stable IV access
  - May require midline, PICC or central line specifically due to frequent lab draws and essential need for rehydration
  - Consider prophylaxis anticoagulation with severe dehydration with central line presence

- Daily weights
- Strict I/O
- Just in time education
- Family Education

Electrolytes

Sodium: daily requirement of 2-3 meq/kg/day

Glucose:

- Hypoglycemia
  - Lethargic or altered mental status
  - Treat with 5ml-10ml/kg of D10% or 2-4ml/kg of D25% and reassess BGT after each bolus
- Hyperglycemia
  - Lethargic, altered mental status, Kussmaul breathing
  - Treat with rehydration and insulin

Potassium: daily requirement of 2-3meq/kg/day

- Hypokalemia
  - No not add potassium to MIVF until resuscitated and has adequate urine output
  - Usually add 20meq/L
  - Can give Oral or IV riders- 0.5- 1meq/kg dose or MAX 20meq

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