Convenient Formulas

Formula Name	Formula	Clinical Use
Modified Bedside Schwartz	eGFR = 0.413 x (height/Scr); ht in cm	Used ages 1-18 to estimate GFR
Insensible Fluid Loss	IFL = 300 mL/m^2/day BSA (m^2) = sqrt[(ht [in cm] x wt [in kg])/3600]	Use for oliguric patients when replacing insensible fluid plus urine/stool losses
Free Water Deficit	[(Current Na^+/Desired Na^+) - 1] x total body water (weight in kg x 0.6 for males, 0.5 for females) = water deficit in **liters**	Calculating **water** to be replaced in **hypernatremic** dehydration
Sodium Deficit	(140-actual Na^+) x TBW (wt in kg x 0.6 for males, 0.5 for females) = Na^+ deficit in **mEq**	Calc **Na** to be replaced in **hyponatremic** dehydration
Fractional Excretion of Sodium	**FENa** = (Urine Na x Plasma Cr) / (Plasma Na x Urine Cr)	Use in oliguric **AKI** to determine **pre-renal** (<1%, sodium-avid) vs **intrinsic renal** (>2%, tubular dysfunction) etiology
Fractional Excretion of Urea	**FEUN** = (Urine urea nitrogen x Plasma Cr)/ (Plasma urea nitrogen x Urine Cr)	Use in **AKI** if patient has recently been given **diuretics** (would alter Na excretion and therefore FENa), acute GN, or CKD; **pre-renal** <35%, **intrinsic renal** >50%
Urine Protein:Cr	Urine Protein:Cr on spot urine sample	Normal <0.2. > 3.5 indicates nephrotic-range proteinuria.
Transtubular Potassium Gradient	(urine K / plasma K) / (urine osm / plasma osm)	Normal = 8-9. TTKG <7 + **hyperkalemia** → aldo def / resistance TTKG >3 + **hypokalemia** → aldo ↑ vs renal K loss
Tubular Reabsorption of Phosphate	[1 - (urine phosphate x plasma creatinine) / (plasma phosphate x urine creatinine)] x 100%	Normal 80-98%. ↓ TRP can be seen in conditions with prox tubular dysfx, such as Fanconi syndrome / Type 2 RTA
Urine Calcium:Cr	Urine Ca:Cr on spot urine sample	Normal < 0.2. Use to assess for hypercalciuria in patients with hematuria, stones, and/or hypercalcemia.
Calcium levels w/ low albumin	Corrected Ca^{2+} = (4 - patient's albumin) x 0.8 + measured Ca^{2+}	Albumin = negatively charged, and therefore carries calcium.
Serum Osmolality	[2 x (Na^+ + K^+)] + (glucose/18) + (BUN/2.8) = Sosm in mOsm/kg Osmolar gap = measured serum osm - calculated serum osm	Osmolar gap >10 can be caused by toxic alcohols (ethanol, methanol, ethylene glycol, isopropyl alcohol), mannitol, and lorazepam infusions (which contain propylene glycol).

Fluid Management

Dehydration

Severity	% Volume Loss	Vital Signs	Physical Exam
Mild	3-5%	Normal	Oliguria
Moderate	6-9%	Inc HR, Orthostatic BP	Decreased skin turgor, delayed cap refill, dry mucosa, sunken fontanelle, oliguria
Severe	≥10%	Inc HR, Dec BP	Markedly decreased peripheral perfusion (cool, mottled extremities), lethargy/AMS, deep respirations, anuria

Is this child dehydrated? Steiner MJ; DeWalt DA; Byerley JS. JAMA 2004 Jun 9;291(22):2746-54.

Fluid Management

Dehydration

- **PowerPlans:** Gastroenteritis CPG Admit Plan, ED Gastroenteritis Pathway Plan
- **Clinical Pathways**: Gastroenteritis Clinical Pathway
- **Clinical Pearls**: Estimate degree of dehydration by s/sx above to calc amt of fluid necessary to replace
  - Fluid deficit = dry weight - current weight
  - If dry weight unknown, estimate: dry weight = (current wt) / (1 - p*[%dehyd/100]), where p = 0.6 for boys, 0.5 for girls (as % of total weight is water is 60% in boys and 50% in girls)
  - Oral rehydration is preferred to IV rehydration when possible
  - If giving IV rehydration: 20cc/kg bolus of normal saline - consider D5NS if hypoglycemic or acidotic, rpt PRN until HDS, if ongoing IV rehydration necessary, start IVF @ maintenance (D5NS unless child is <1 mo, has renal disease, etc); for hypernatremic dehydration, give hypotonic fluids (e.g., D5 ½ NS) **after** volume resuscitation

Maintenance Fluid Therapy

Fluid	Dex	Na^+	Cl^-	K^+	Ca^{++}	Buffer	Osm
Unit	g/dL	mEq/L					mOsm/L
Plasma	0.07-0.11	135-145	95-105	3.5-5	4.4-5.2	23-30 bicarb	308
NS (0.9%)	0	154	154	0	0	0	308
D5 NS	5	154	154	0	0	0	308
D5 ½ NS	5	77	77	0	0	0	154
D5 ¼ NS	5	34	34	0	0	0	78
3% saline	0	513	513	0	0	0	1026
D5 LR	5	130	109	4	3	28 lactate	284

Holliday-Segar Method (use for children > 14 days old)

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

- Insensible Fluid Losses*:* 300 cc/m^2/day, with body surface area in m^2= square root of [(ht cm x wt kg)/3600]
- Maintenance Electrolyte Requirements: **Na**: 2-4 mEq/kg/day / **K**: 1-2 mEq/kg/day
- Choice of fluid depends on age, serum sodium, and degree of dehydration.
- **2018 AAP Clinical Practice Guideline** by Feld LG, Neuspiel DR, Foster BA, et al. *Pediatrics*. 2018;142(6):
  - **Bottom line**: when in doubt, use isotonic fluids + KCl and dextrose (e.g., D5NS + 20 mEq/L KCl)
  - **Exceptions**: neonates <28d or in NICU, CHF, renal disease, massive burns, hepatic disease, neurosurgical disorders, voluminous diarrhea, DI
  - **Why**: avoids iatrogenic hyponatremia (hypotonic fluids + non-osmotic stimuli to ADH release) without a notable increase in iatrogenic hypernatremia or hypertension.
  - **Note**: large amounts of NS → hyperchloremic non-gap metabolic acidosis. **Keep this in mind** when you see a persistent acidosis despite a normal anion gap when correcting patients in DKA!