Intravenous fluid therapy in dehydrated children

Dr.Zahra Pournasiri
Pediatric Nephrologist
Assistant Professor Of Pediatric,
Shahid Beheshti University Of Medical Sciences,
loghman hospital
SBMU

By the end of this lecture, you should be able to:

- Calculate maintenance IV fluid in normal children
- Calculate maintenance IV fluid in oligouric children
- Calculate maintenance IV fluid in polyuric children
- Correct fluid deficit in isonatremic dehydrated children
- Correct fluid deficit in hyponatremic dehydrated children

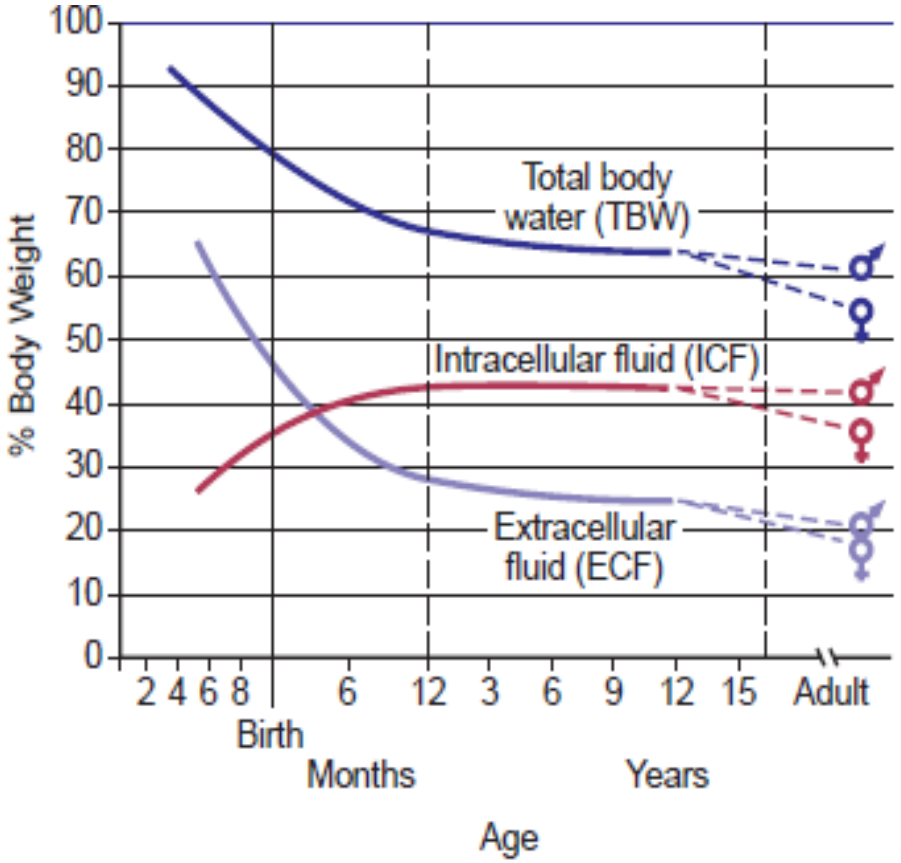

Figure 55-1 Total body water, intracellular fluid, and extracellular fluid as a percentage of body weight and a function of age. *(From*

A 5-y-old girl is admitted in ENT ward and is candidate for adenoidectomy tomorrow morning .Her physician consulted with you for time of beginning fasting , type and amount of intravenous fluid before surgery and after operation.

Weight of the patient is 18 kilogram and her body surface area is 0.7 m_2.

GOALS OF MAINTENANCE FLUIDS

- Prevent dehydration
- Prevent electrolyte disorders
- Prevent ketoacidosis
- Prevent protein degradation

Maintenance fluids

- A normal teenager who is given nothing by mouth (NPO) overnight for a morning procedure does not require maintenance fluids because a healthy adolescent can easily tolerate 12 or 18 hr without oral intake.
- In contrast, a 6 mo old child waiting for surgery should begin receiving intravenous fluids within 8 hr of the last feeding. Infants become dehydrated more quickly than, older patients.
- A child with obligatory high urine output from nephrogenic diabetes insipidus should begin receiving intravenous fluids soon after being classified as NPO.

The Holliday and Segar method

Table 56-2	Body Weight Method for Calculating Daily Maintenance Fluid Volume
BODY WEIGHT	**FLUID PER DAY**
0-10 kg	100 mL/kg
11-20 kg	1,000 mL + 50 mL/kg for each kg >10 kg
>20 kg	1,500 mL + 20 mL/kg for each kg >20 kg*

Electrolyte

- Required Sodium =3MEQ/kg
- Requied Potassium=2MEQ/kg
- 1 cc Nacl 3% ⟶ 0.5meq Na
- 1 cc Nacl5% ⟶ 0.85meq Na
- 1 cc Nacl20% ⟶ 3.4 meq Na

- 100*10 +8*50=1400 cc/24hours
- Type of fluid ??

Required water for any person

- **INSESIBLE WATER LOSS +URINE OUTPUT+DEHYDRATION+ONGOING LOSS**

- **INSESIBLE WATER LOSS +URINE OUTPUT= Maintenance**
- **INSESIBLE WATER LOSS(*Respiratory loss+ Skin loss*) = 400 ml/lit # 1/3 maintenance**

Required water for this person

- **INSESIBLE WATER LOSS(400/0.7=280 ml) +URINE OUTPUT(1_4ml/kg)+~~DEHYDRATION+ONGOING LOSS~~**

- **INSESIBLE WATER LOSS +URINE OUTPUT= Maintenance**

Composition of intravenous solution

Fluid	Na	Cl	K	Ca	Lactate	Osmolality
Normal salin(0.9% Nacl)	154	154	_____	_____	_____	308
1/2NS(0.45 %Nacl)	77	77	_____	_____	_____	154
1/4NS (0.225Nacl)	38.5	38.5	_____	_____	_____	77
Ringer	147	156	4	4.5	_____	311
Ringer lactate	130	109	4	3	28	273
DW	_____	_____	_____	_____	_____	252(5%)
1/3(NS) 2/3(DW5%)	51	51	_____	_____	_____	274
1/2(1/2DW 51/2(1/2NS)	77	77	_____	_____	_____	280

- A normal plasma osmolality is 285-295 mOsm/kg. Infusing an intravenous solution peripherally with a much lower osmolality can cause water to move into red blood cells, leading to hemolysis.
- Thus,intravenous fluids are generally designed to have an osmolality that is either close to 285 or greater (fluids with moderately higher osmolality do not cause problems).

- D5 1/2NS + 20 mEq/L KCl is recommended in children without volume depletion or with risk factors for SIADH.
- Children with volume depletion, baselin hyponatremia, or at risk for nonosmotic ADH production (lung infections such as bronchiolitis or pneumonia; central nervous system infection) should receive D5 NS + 20 mEq/L KCl.

- 100*10 +8*50=1400 cc/24hours
- **Type of fluid ??**
- Before operation:
- IV fluid :1400 cc serum DHS+ 14cc kcl 15%(20 meq K per lit) in 24 hr
- Or 14oo cc DW5% + 31 cc Nacl 20% (75 meq Na per liter) +14cc kcl 15% (20 meq per lit K) in24 hr

After operation:

- In the postoperative patient who is intravascularly volume-depleted from surgical losses, third space losses , and venous pooling (due to lying supine and the effects of anesthesia and sedation):
- Receive approximately 2/3 of the calculated maintenance rate as isotonic fluids (NS, LR) during surgery and in the recovery room for for 6-8 hr postoperatively;
- Receive Subsequent maintenance fluids during 16 hours as DS

After operation:

- 930 cc NS / 8 hrs.
- 470 cc DS + 4.7 cc kcl 15% in next 16 hrs .

A 5-y-old girl with CRF is admitted in general surgery ward because sever abdominal pain and she is candidate for doing abdominal CT scan with oral and iv contrast .she should be NPO and her physician consulted with you for type and amount of intravenous fluid . Her mother claims her urine in 24 hours is only 200 cc.

Weight of the patient is 18 kilogram and her body surface area is 0.7 m2.serum electrolyte is in normal range

Required water for any person

- **INSESIBLE WATER LOSS +URINE OUTPUT+DEHYDRATION+ONGOING LOSS**

- **INSESIBLE WATER LOSS +URINE OUTPUT= Maintenance**
- **INSESIBLE WATER LOSS(*Respiratory loss+ Skin loss*) = 400 ml/lit # 1/3 maintenance**

Required water for any person

- **INSESIBLE WATER LOSS +URINE OUTPUT+DEHYDRATION+ONGOING LOSS**

- *INSESIBLE WATER LOSS +URINE OUTPUT= Maintenance*
- INSESIBLE WATER LOSS(*Respiratory loss+ Skin loss* = 400 ml/lit # 1/3 maintenance
    - **1/3 maintenance + ongoing loss**

Table 56-9	Adjusting Fluid Therapy for Altered Renal Output
OLIGURIA/ANURIA Replacement of insensible fluid losses (25-40% of maintenance) with D5 ½NS Replace urine output mL/mL with D5 ½NS ± KCl	
POLYURIA Replacement of insensible fluid losses (25-40% of maintenance) with D5 ½NS ± KCl Measure urine electrolytes Replace urine output mL/mL with solution based on measured urine electrolytes	

- 350 cc DW10% +7.7 CC Nacl20% (75meq/lit) /24 hr (without potassium)

A 5-y-old girl is admitted in neurosurgery ward and is candidate for remove of craniopharingioma tomorrow morning .Her physician consulted with you for time of beginning fasting , type and amount of intravenous fluid before surgery and after operation. She suffer from polyuria and DI duo to this tumor and her urine output is 6cc/hr.

Weight of the patient is 18 kilogram and her body surface area is 0.7 m2.serum electrolyte is in normal range ,urin sodium 75 meq/lit,urine potassium 20 meq/lit

Required water for this person

- **INSESIBLE WATER LOSS(1/3 Maintenance=350 cc) +URINE OUTPUT(6ml/kg/hr)+~~DEHYDRATION+ONGOING LOSS~~**
- **350 cc + 6*18*24 =2950 cc**
- **Type of fluid ??**

Table 56-9	Adjusting Fluid Therapy for Altered Renal Output
OLIGURIA/ANURIA Replacement of insensible fluid losses (25-40% of maintenance) with D5 ½NS Replace urine output mL/mL with D5 ½NS ± KCl	
POLYURIA Replacement of insensible fluid losses (25-40% of maintenance) with D5 ½NS ± KCl Measure urine electrolytes Replace urine output mL/mL with solution based on measured urine electrolytes	

- 2950 cc ½ ½ +29.5 cc kcl 15% /24 hrs
- Or
- 2950 cc DW% +66 ccNacl20% +29.5 cckcl 15%/24 hrs.

DEFICIT THERAPY

- **Even children with mild to moderate hyponatremic or hypernatremic dehydration can be managed with oral rehydration.**

Finding	Mild (3-5 percent)	Moderate (6-9 percent)	Severe (10 percent)
Pulse	Full, normal rate	Rapid	Rapid and weak
Systolic pressure	Normal	Normal to low	Low
Respirations	Normal	Deep, rate may be increased	Deep, tachypnea
Buccal mucosa	Tacky or slightly dry	Dry	Parched
Anterior fontanelle	Normal	Sunken	Markedly sunken
Eyes	Normal	Sunken	Markedly sunken
Skin turgor	Normal	Reduced	Tenting
Skin	Normal	Cool	Cool, mottled, acrocyanosis
Urine output	Normal or mildly reduced	Markedly reduced	Anuria
Systemic signs	Increased thirst	Listlessness, irritability	Grunting, lethargy, coma

Table 57-1 Clinical Evaluation of Dehydration

Mild dehydration (<5% in an infant; <3% in an older child or adult): Normal or increased pulse; decreased urine output; thirsty; normal physical findings

Moderate dehydration (5-10% in an infant; 3-6% in an older child or adult): Tachycardia; little or no urine output; irritable/lethargic; sunken eyes and fontanel; decreased tears; dry mucous membranes; mild delay in elasticity (skin turgor); delayed capillary refill (>1.5 sec); cool and pale

Severe dehydration (>10% in an infant; >6% in an older child or adult): Peripheral pulses either rapid and weak or absent; decreased blood pressure; no urine output; very sunken eyes and fontanel; no tears; parched mucous membranes; delayed elasticity (poor skin turgor); very delayed capillary refill (>3 sec); cold and mottled; limp, depressed consciousness

APPROACH TO SEVERE DEHYDRATION

- Resuscitation phase:
- Rapid restoration of the circulating intravascular volume and treatment of shock with an isotonic solution, such as normal saline (NS) or Ringer lactate (LR) . The child is given a fluid bolus,usually 20 mL/kg of the isotonic fluid, over approximately 20 min.
- In a child with a known or probabl metabolic alkalosis (the child with isolated vomiting),LR should not be used because the lactate would worsen the alkalosis.

Fluid therapy for the next 24 hr

- In isonatremic or hyponatremic dehydration, the entire fluid deficit is corrected over 24 hr; a slower approach is used for hypernatremic dehydration.
- The volume of isotonic fluids that the patient has received is subtracted from this total.The remaining fluid volume is then administered over 24 hr. The potassium concentration may need to be decreased or, less commonly,
- increased, depending on the clinical situation.

Fluid management of dehydration

Restore intravascular volume

N/S :20 cc/kg over 20 min

repeat as needed

Rapid volume repletion:20cc/kg N/S or ringer lactate over 2 hr

Calculate 24-hr fluid needs:maintenance + deficit volume

Subtract isotonic fluid already administered from 24 hr fluid needs

Administer remaining volume over 24 hr using DS + 20 meq/l kcl

Replace ongoing losses as they occur

Table 57-2	Fluid Management of Dehydration

Restore intravascular volume:
- Normal saline: 20 mL/kg over 20 min
- Repeat as needed

Calculate 24-hr fluid needs: maintenance + deficit volume

Subtract isotonic fluid already administered from 24 hr fluid needs

Administer remaining volume over 24 hr using 5% dextrose NS + 20 mEq/L KCl

Replace ongoing losses as they occur

A 3yrs boy with GE,10% dehydration ,Na=137,K=4.5
Wt=15kg,[reseived 300cc NS as boluses dose]

A 3yrs boy with GE,10% dehydration ,Na=137,K=4.5
Wt=15kg,[reseived 300cc NS as boluses dose]

- Water deficit: percent of dehydration × Wt(gr)

10/100×15000=1500(-300)=1200

Maintenance:1250 water

Maintenance+ deficit=2250 cc

Total body need: 2250Ds (dextrose saline)+ 22.5cc kcl15% (potassium 20meq/lit) /24hr

DR.POURNASIRI

A 3yrs boy with GE,10% dehydration ,Na=137,K=6
Wt=15kg,[reseived 300cc NS as boluses dose]

A 3yrs boy with GE,10% dehydration ,Na=137,K=6
Wt=15kg,[reseived 300cc NS as boluses dose]

- Water deficit: percent of dehydration × Wt(gr)

10/100×15000=1500(-300)=1200

Maintenance:1250 water

Maintenance+ deficit=2250 cc

Total body need: 2250 DS (dextrose saline)/24hr (without potassium)

A 3yrs boy with GE,10% dehydration ,Na=137,K=2.5
Wt=15kg,[reseived 300cc NS as boluses dose]

A 3yrs boy with GE,10% dehydration ,Na=137,K=2.5
Wt=15kg,[reseived 300cc NS as boluses dose]

- ✓ Water deficit: percent of dehydration × Wt(gr)

10/100×15000=1500(-300)=1200

Maintenance:1250 water

Maintenance+ deficit=2250 cc

Total body need: 2250Ds (dextrose saline)+ 33 cc kcl15% (potassium 30meq/lit) /24hr

DR.POURNASIRI

- You checked potassium 4 hours later it was 2.7meq/lit,you should increase iv fluid potassium for example 40 meq/lit
- **Total body need: 2250Ds (dextrose saline)+ 50cc kcl15% (potassium 40meq/lit) /24hr**
- **Upper allowed iv fluid potassium is 60meq/lit through peripheral veins**
- **If there is a need for more potassium administration give o.5cc/kg kci15% q8h by oral route.**

Table 57-3	Monitoring Therapy

Vital signs:
- Pulse
- Blood pressure

Intake and output:
- Fluid balance
- Urine output

Physical examination:
- Weight
- Clinical signs of depletion or overload

Electrolytes

HYPONATREMIC DEHYDRATION

- An overly rapid(>12 mEq/L over the first 24 hr) or overcorrection in the serum sodium concentration (>135 mEq/L) is associated with an increased risk of **central pontine myelinolysis.**

Hyponatremia:

- CALCULATION OF THE SODIUM DEFICIT:

- Sodium deficit = 0.6 ×Wt (desired Na - actual Na)
- Symptomatic hyponatremia:1.5 to 2 meq/L per hour for two or three hours, then a slower rate of correction(max:12meq/l/24hr)
- Asymptomatic hyponatremia:correct 0.5 meq/L per hour

A 3yrs boy with GE,10% dehydration ,Na=137,K=4.5
Wt=15kg,[reseived 300cc NS as boluses dose]

- A 3yrs boy with GE,10% dehydration ,Na=120,K=4.5

Wt=15kg,[reseived 300cc NS as boluses dose]

- ✓ Water deficit: percent of dehydration × Wt(gr)

10/100×15000=1500(-300)=1200

Maintenance:1250 water

Maintenance+ deficit=2250 cc

sodium deficit for 24 hr=0.6*15*(132-120)= 108 meq =31 cc Nacl 20%

Total body need: 2250Ds (dextrose saline)+ 31 cc Nacl 20%/24hr

DR.POURNASIRI

Central pontine myelinolysis

- Within the first day of acute hyponatremia, the brain begins to lose extracellular water into the cerebrospinal fluid and loses intracellular water by extruding sodium and potassium salts and certain organic solutes (called osmolytes), thereby lowering the brain volume toward normal.

- An initial increase in cell cation concentration due to potassium and sodium movement back into the cells during recovery may directly injure the brain cells, causing apoptosis

Central pontine myelinolysis

- The clinical manifestations of osmotic demyelination are typically delayed for two to six days after the elevation in the plasma sodium concentration .
- The symptoms, which are often irreversible or only partially reversible, include dysarthria, dysphagia, paraparesis or quadriparesis, behavioral disturbances, lethargy, and coma; seizures

Replacement Fluid or ongoing loss

Table 56-7	Replacement Fluid for Diarrhea
AVERAGE COMPOSITION OF DIARRHEA Sodium: 55 mEq/L Potassium: 25 mEq/L Bicarbonate: 15 mEq/L	
APPROACH TO REPLACEMENT OF ONGOING LOSSES Solution: D5 ½NS + 30 mEq/L sodium bicarbonate + 20 mEq/L KCl Replace stool mL/mL every 1-6 hr	

Table 56-8	Replacement Fluid for Emesis or Nasogastric Losses
AVERAGE COMPOSITION OF GASTRIC FLUID Sodium: 60 mEq/L Potassium: 10 mEq/L Chloride: 90 mEq/L	
APPROACH TO REPLACEMENT OF ONGOING LOSSES Solution: normal saline + 10 mEq/L KCl Replace output mL/mL every 1-6 hr	

Third space losses and chest tube output

- isotonic fluid, such as NS or LR
- Protein losses from chest tube drainage can be significant, occasionally necessitating that 5% albumin be used as a replacement solution.

DR.POURNASIRI