Dehydration and fluid therapy

Dr. Jumana Albaramki

Body composition

- TBW varies with age
- Water 50-75 % of body weight,more young age
- average 60 % : 40 % intracellular, 20 % extracellular .There is osmotic eq. between ICF,ECF freely permeable to water
- extracellular :(15% interstitial, 5 % blood)
- There is a balance between hydrostatic and oncotic pressure.
- Nephrotic syndrome (decrease OP): edema
- GN,heart failure :(increase HP) :edema

- Na ,CL main extracellular
- K, Phosphate main intracellular
- Serum electrolytes don't reflect total body stores…(DKA)

Blood osmolality (mmol/l)=2 × Na +glucose (mg/dl)/18 +BUN (mg/dl)/2.8

normal: 286-295

Urea : ineffective osmsole

In DKA: shifting of fluid cause hyponatremia

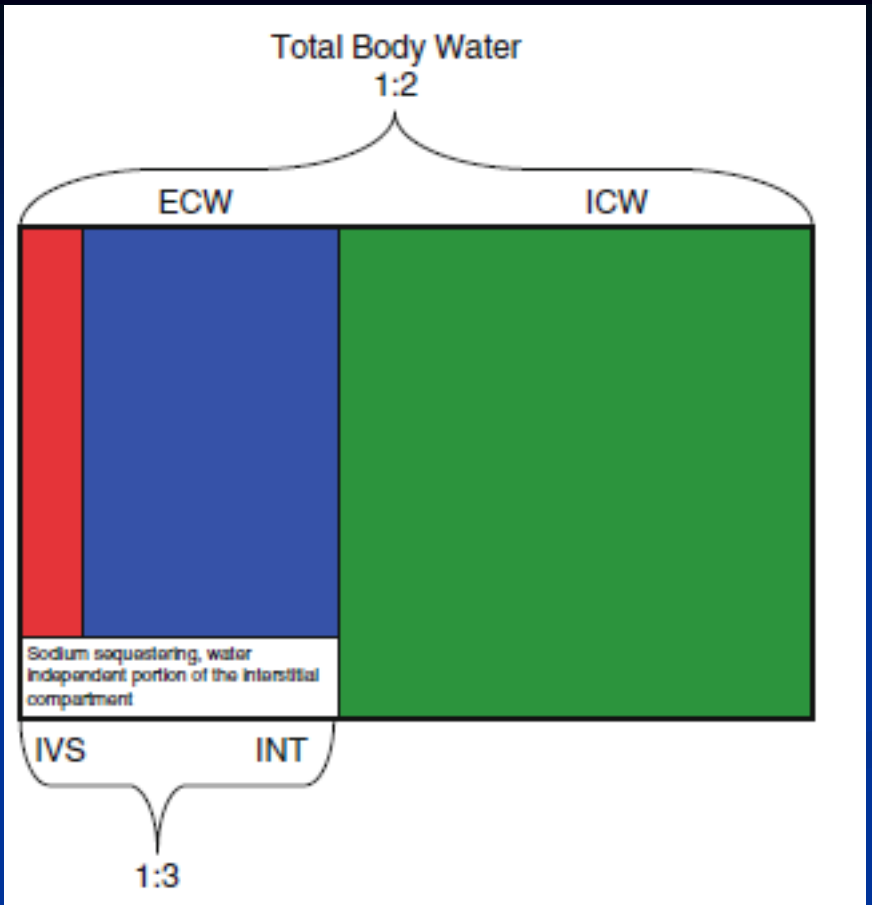


Table 1 Electrolyte (and ion) composition in body fluids (*ECF* extracellular fluid, *ICF* intracellular fluid)

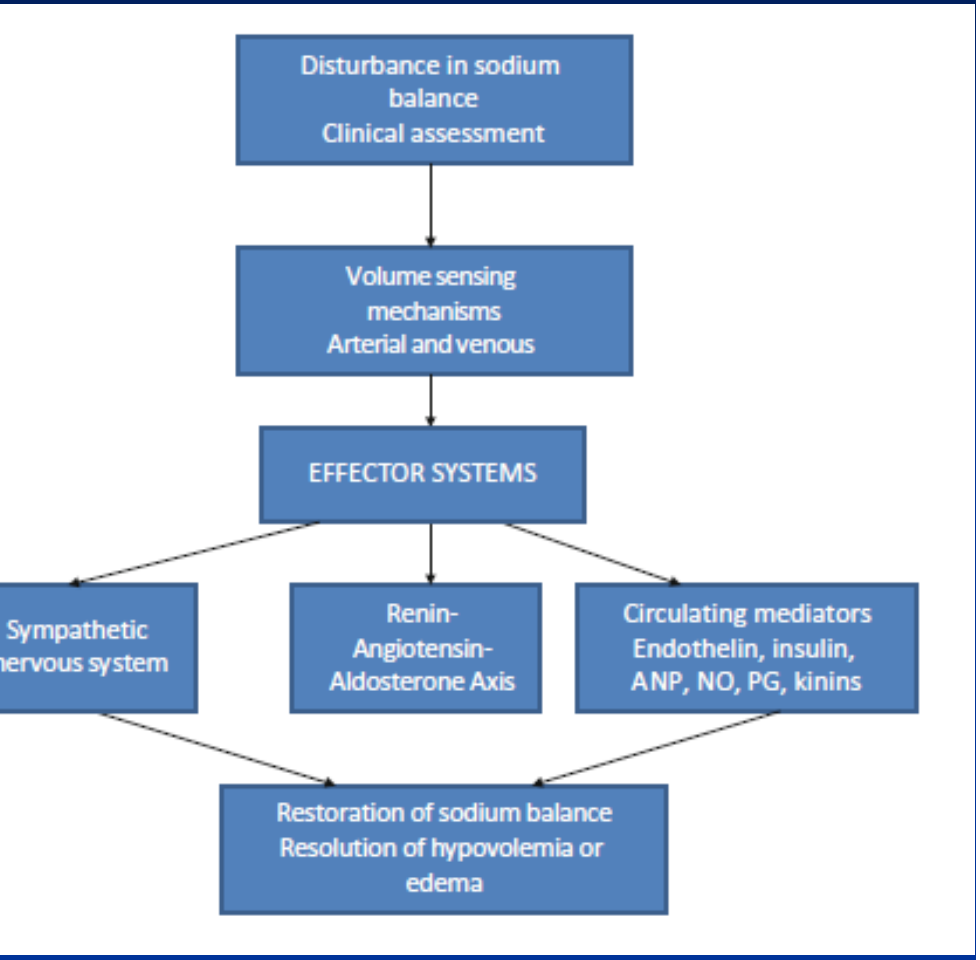
Ion	ECF	Interstitial	ICF
Sodium	135–145 mEq/l	145 mEq/l	10–20 mEq/l
Potassium	3.5–5.5 mEq/l	3.5–5.5 mEq/l	130–150 mEq/l
Chloride	95–105 mEq/l	100–115 mEq/l	<3 mEq/l
Bicarbonate	22–30 mEq/l	25–35 mEq/l	<10 mEq/l
Phosphate	2 mEq/l	2 mEq/l	110–120 mEq/l
Other	Albumin (plasma space)	No albumin	No albumin

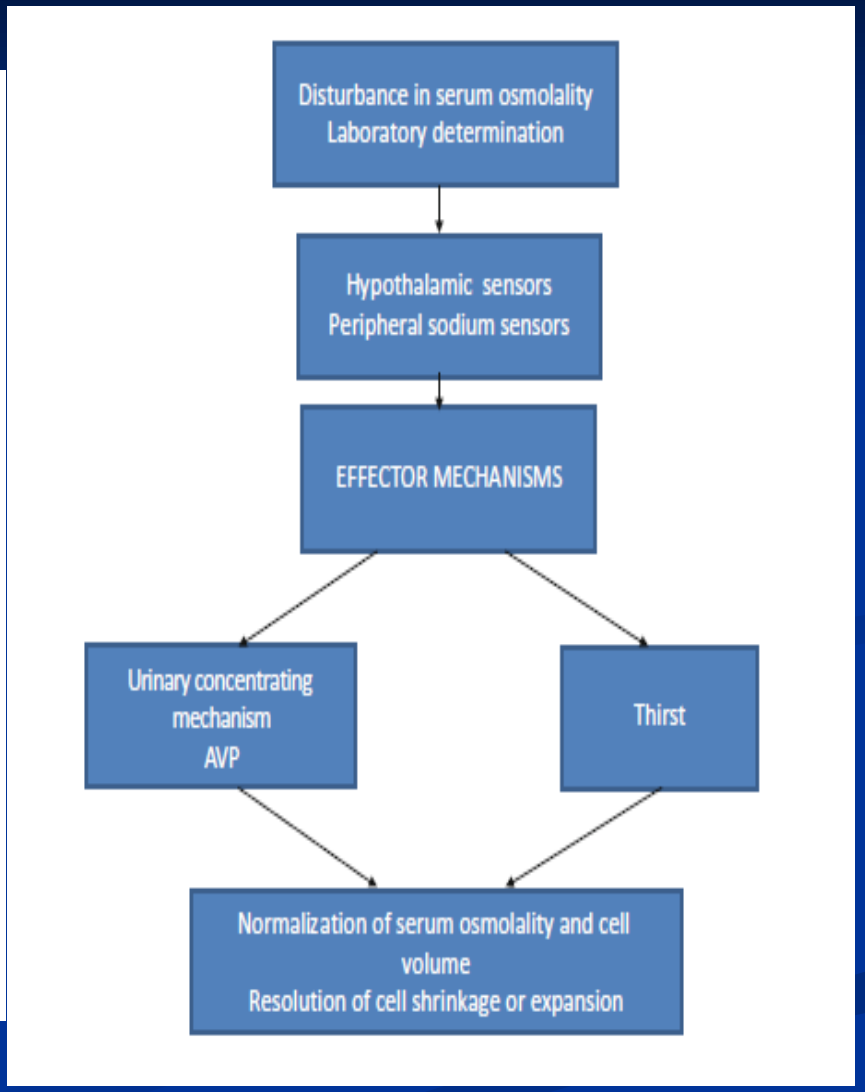
- Measured osmolarity within 10mosml difference between calculated
- Osmolar gap more than 10; consider mannitol,ethelyne glycol poisoning
- Effective circulatory volume : sustain perfusion,doest correlate with ECF
- Nephrotic,liver disease :TBW (interstitial) high,decreased ECV
- Tachycardia and delayed cap refill precede signs of ineffective circulation as hypotension,oligurea

Regulatory mechansim

- Glomerular hypoperfusion: < Na to macula densa. ⬆ Renin and aldosterone ⬆ salt reabsorption

- Osmoreceptors in hypothalamus : ⬆ADH and thirst


Disturbance in sodium balance
Clinical assessment
Volume sensing mechanisms
Arterial and venous
EFFECTOR SYSTEMS
Sympathetic
ervous system
Renin-
Angiotensin-
Aldosterone Axis
Circulating mediators
Endothelin, insulin,
ANP, NO, PG, kinins
Restoration of sodium balance
Resolution of hypovolemia or
edema


Disturbance in serum osmolality
Laboratory determination
Hypothalamic sensors
Peripheral sodium sensors
EFFECTOR MECHANISMS
Urinary concentrating
mechanism
AVP
Thirst
Normalization of serum osmolality and cell
volume
Resolution of cell shrinkage or expansion

maintenance

- Daily maintenance estimated and based on energy expenditure 1 ml/kg= 1 Kcal of energy expenditure

For each of the first 10 kg of body weight:	100 ml/kg/day or 4 ml/kg/hr
+ For each of the second 10 kg of body weight:	50 ml/kg/day or 2 ml/kg/hr
+ For every subsequent kg of body weight:	25 ml/kg/day or 1 ml/kg/hr

Columns **1-5** below show the actual quantities for various sizes of patient

Maintenance fluids

- Maintenance =insensible water (ISW) + urine output (UOP)
- ISW : evaporative losses from skin and respiratory,unmeasured
- UOP: 2/3 maintenance,
- measured

Insensible water loss

- This is very variable and impossible to measure.

A starting figure is

25 ml/kg/day for newborns,
20 ml/kg/day for 10 kg baby
15 ml/kg/day for 20-30 kg child
10 ml/kg/day for adults

or 400 ml/m^2/day.

Table 13-3

Factors affecting insensible water losses

Increased losses	% Change	Decreased losses	% Change
Prematurity	100–300	Enclosed incubator	25–50
Radiant warmer	50–100	Humidified air	15–30
Phototherapy	25–50	Sedation	5–25
Hyperventilation	20–30	Decreased activity	5–25
Increased activity	5–25	Hypothermia	5–15
Hyperthermia	12%/°C		

1. Daily water requirement = 100 ml/kg for a child weighing less than 10 kg + 50 ml/kg for each additional kg up to 20 kg + 20 ml/kg for each kg in excess of 20 kg

   The second method is based on BSA and utilizes the following formula:

2. Daily water requirement = 1500 ml/m^2 BSA

   The last method is a refinement of the second and utilizes the following formula:

3. Daily water requirement = Urine output + insensible water losses

Maintenanace

- Maint: to prevent dehydration, elect imbalance, prevent ketoacidosis, protein degradation
- Daily Na req: 2-3 mmol/kg
- Daily K req: 1-2 mmol/100 ml. We should check urine output

Glucose 5% saline .45 %: contain 75 mmol/ 1 l

In small infants G 5%.18 % may be used: contain 30 mmol/l (a 5 kg child will have 500 ml with 15 mmol)

Maintenance lack proteins,fat : need enteral feeds /TPN

- So a child with a weight of 15 Kg has a maintenance of : 100 x 10=1000 , 5*50=250
- Total = 1250 ml
- If a child weighs 25 Kg
- maint= 1000 + (10*50) 500+ (5*20=100)= 1600
- Maximum 2.5 L

Causes of dehydration

- 1.losses : vomiting, diarrhea, third spacing as in burns, bleeding

- 2. renal losses :polyuria as in osmotic diuresis,DKA,post obstructive diuresis,diabetes insipidus

Types of dehydration

- Types :
- according to sodium level
- 1.isotonic
- 2.hypotonic/hyponatremic :Na< 130 mmol/l
- 3.Hypertonic /Hypernatremic : Na > 150 mmol/l

Degree of dehydration

- mild :no signs,only symptoms ,< 5 %
- Moderate dehydration: 5-10 %
- Severe dehydration : > 10%

Assessment of dehydrayion

- Assess dehydration : **history** of losses, intake and feeding, thirst, urine output, activity of child, lethargy

- **Exam**: HR, RR (increased from metabolic acidosis,LA in gastroenteritis),postural hypotension. Hypotension seen in severe dehydration

- Capillary refill, sunken eyes, tented skin,crying with tears, weight loss, lethargy, dryness mucus membranes, sunken fontanelle

Table 13-6

Clinical assessment of dehydration

	Degree of dehydration		
	Mild	Moderate	Severe
Vital signs			
Pulse	Normal	Rapid	Rapid and weak
Blood pressure	Normal	Normal to slightly low	Shock
Weight loss			
Infant	<5%	10%	>15%
Older child	<3%	6%	>9%
Mucous membranes	Tacky	Dry	Parched
Skin turgor	Slightly decreased	Decreased	Tenting
Eye appearance	Normal tearing	Decreased tearing ± sunken	No tears + very sunken
Capillary refill	Normal	Delayed (>3 s)	Very delayed (>5 s)
Urine output	Decreased	Minimal	Anuric

Physical findings of volume depletion in infants and children

Finding	Mild (3 to 5%)	Moderate (6 to 9%)	Severe (≥10%)
Pulse	Full, normal rate	Rapid	Rapid and weak OR absent
Systolic pressure	Normal	Normal to low	Low
Respirations	Normal	Deep, rate may be increased	Deep, tachypnea OR decreased to absent
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

Volume depletion in dehydration

- Repletion : replaces ongoing losses ,deficit
- maintenance :
- Emergent repletion phase: in severe hypovolumeia with delayed capillary refill
- Management by rapid restoration of IVS by 20 ml/kg normal saline bolus over 20 min and then reassessment up to three boluses up to 60 ml/kg
- Route intravenous /intraosseous

Volume repletion

- After saline boluses fluid is initiated according to deficit
- Deficit= weight x 10 x % of dehydration
- Oral rehydration solution can be used in children with mild to moderate dehydration, but intravenous route is needed if the child was oral intolerant and has moderate dehydration and in children with severe dehyration

Oral Rehydration solution (ORS)

- Used in children with mild to moderate dehydration
- Has decreased mortality and morbidity from gastroenteritis in developed countries
- Uses glucose in formulation to facilitate sodium absorption through Na-Glucose channel
- There are many formulations: WHO with high Na content,newer has lower sodium

Oral rehydration solutions

	Concentration (mmol/L)					
Product						
	Na	Sugar	K	Cl	Base	Osmolality (mOsm/L)
WHO ORS[a]	90	111	20	80	30	311
CeraLyte 90[a]	90	220[b]	20	80	30	275
Low-Na ORS[a]	75	75	20	65	30	245
Rehydralyte	75	140	20	65	30	300
CeraLyte 70[a]	70	220[b]	20	60	30	230
CeraLyte 50[a]	50	220[b]	20	40	30	200
CeraLyte 50 lemon	50	170[b]	20	40	30	200
Enfalyte	50	170	25	45	34	167
Pedialyte	45	140	20	35	30	254

[a]Provided as powder. Needs to be reconstituted with water

[b]Contains rice-syrup solids substituted for glucose

Dosage

- 50 ml/kg within 4 hours in mild dehydration given every 5 min in small amount
- 100 ml/kg within 4 hours in moderate dehydration
- Supplementary ORS 10 ml/kg for ongoing stool losses

Intravenous Fluid contents

Each 1 l NS .9% HAS 154 mmol Na

Each ONE ML HTS 2.7%= .45 mmol Na

Each 1l GS.45% has 75 mmol Na

Each 1l GS.3% has 50 mmol Na

Each 1l GS.18% has 30 mmol Na

Isotonic dehydration management

- A child presents with gastroenteritis.On exam he was tachycardiac.Serum Na was 140, his weight 20 kg.How to calculate fluid?
- maint= 1500 ml
- Deficit= 20 x10 x 7%= 1400
- Total=2900 G5 .45 %, we divide half over first 8 hours and the remaining over 16 hours.

You were called to write the fluids of a 1 year old boy,who has not passed urine,his weight is 12 Kg?

insensible losses as 400 ml/m2 and replacement of urine output?

Hyponatremic dehydration

- Signs and symptoms are more evident
- Hyponatremic : shift of fluid to ICS,cerebral edema
- Correct hyponatremia by 10-12 mmol/day to avoid central pontine myelinolysis
- If symptomtic hyponatremia as seizures : use HTS 3% (1 ml contains .45 mmol)
- Use formula for mmol: (desired-actual) x weight o .6

Hypernatremic dehydration

- Signs and symptoms aren't evident
- Shift from ICS to ECS
- Cell shrinkage and cerebral bleeds and thrombosis
- Patients have doughy skin,irritable
- Sodium shouldn't be decreased more than 12 mmol/day to avoid cerebral edema

Hypernatremic dehydration

- Avoid use of hypotonic solutions. use GS .3% - GS .45%
- Start at a rate of 1.25- 1.5 maintaince over 24 hours
- Correct hypernatremia over 48-72 hours
- Adjust rate of drop by altering rate of fluids and concentration
- If drop too quickly : decrease rate of fluids or increase saline concentration

What other labs need to be done in a child with dehydration ?

- 1.elecrolytes
- 2. capillary blood gas : gastroenteritis causes metabolic acidosis from diarrhaea losses and dehydration cause lactic acidosis
- Dehydrated children are tachypnea
- The acidosis will be corrected by hydration
- 3. Hypokalemia : use 3- 4 mmol/100 ml

- 4. urea and creat: prerenal azotemia is seen,oliguria
- 5. urine specific gravity ,osmolarity
- Uirne sodium :low

- A child presents with gastroenteritis and severe dehydration. Weight was 10 kg,Na was 125
- Total fluid :1000 +1000= 2000L GS.45%
- Sodium =10*.6 *10 = 60 mmol
- 2 l has 150 mmol


THANK YOU