

# Dehydration and fluid therapy ,gastroenteritis 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

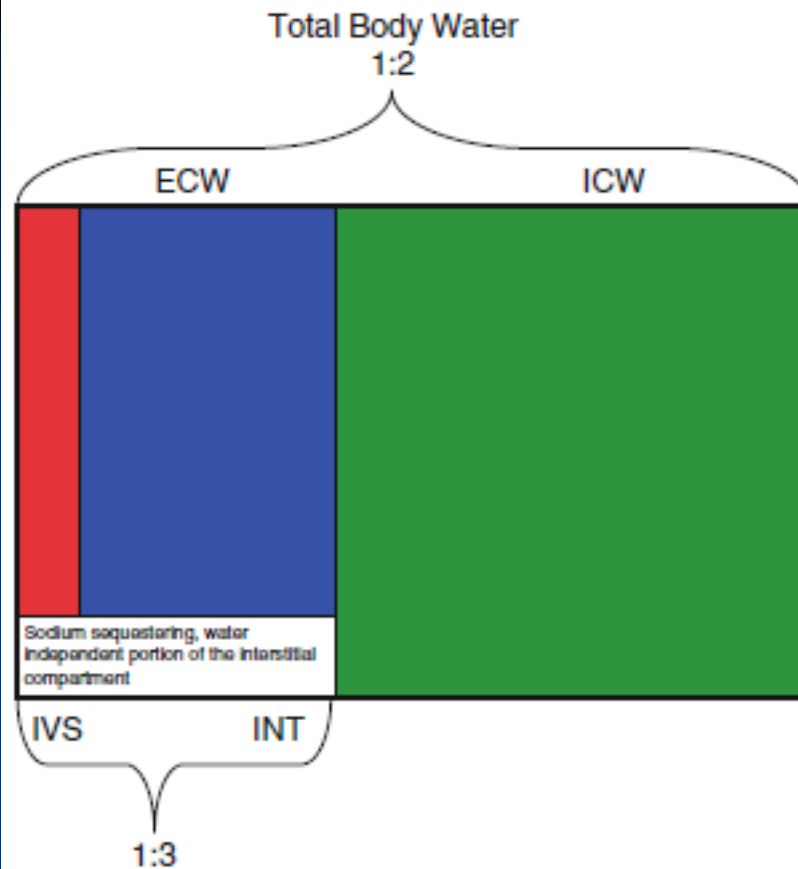
- Na, Cl main extracellular
- K, Phosphate main intracellular
- Serum electrolytes don't reflect total body stores...(DKA)

Blood osmolality (mmol/l) =  $2 \times \text{Na} + \frac{\text{glucose (mg/dl)}}{18} + \frac{\text{BUN (mg/dl)}}{2.8}$

normal: 286-295

Urea : ineffective osmole

In DKA: shifting of fluid cause hyponatremia






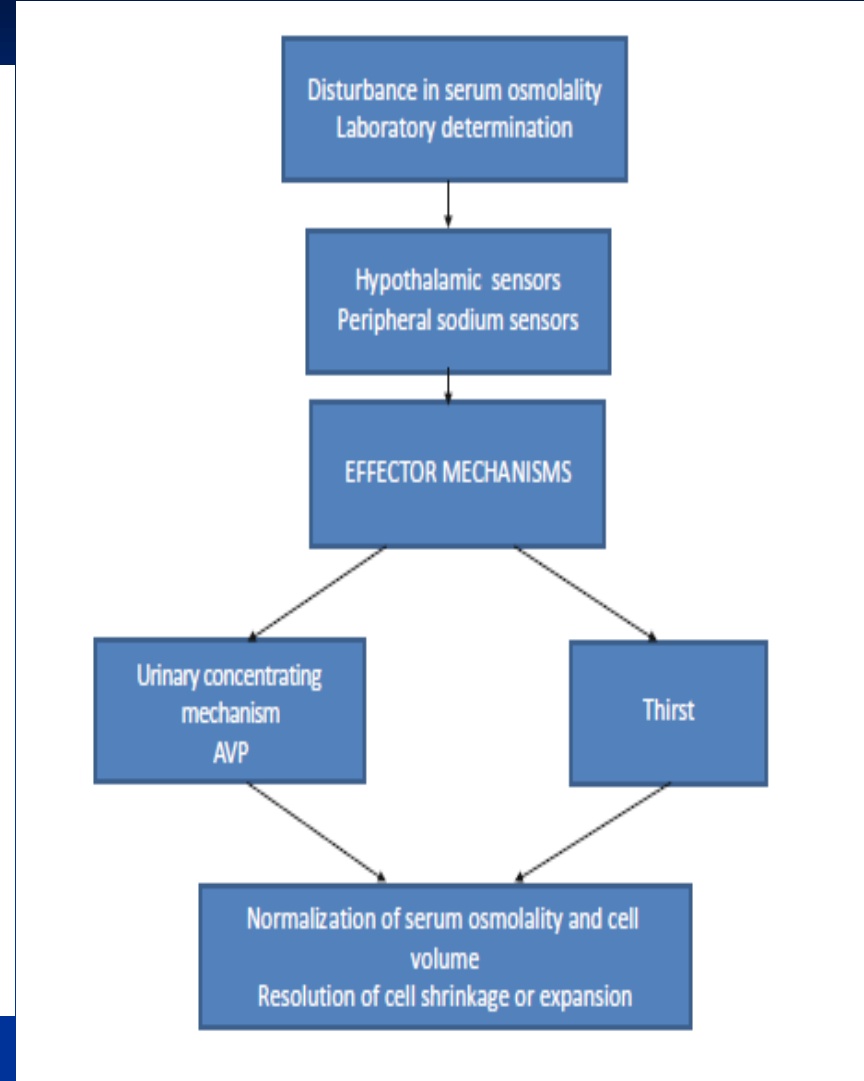
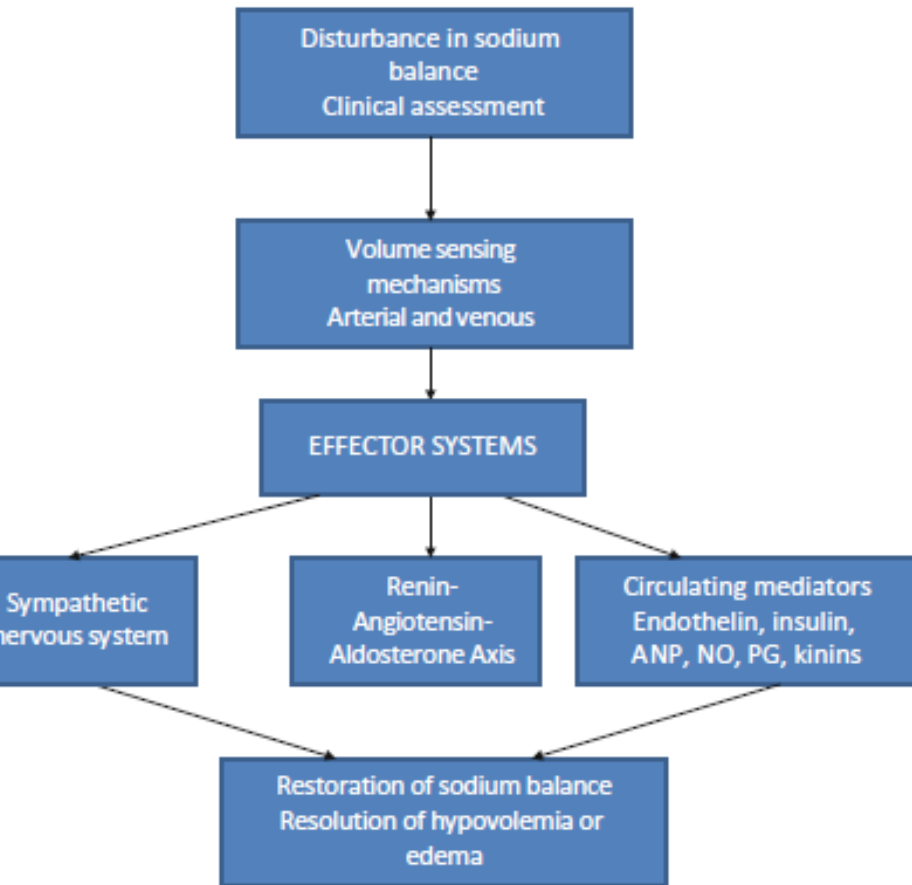
**Table 1** Electrolyte (and ion) composition in body fluids (*ECF* extracellular fluid, *ICF* intracellular fluid)

| 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, ethylene glycol poisoning
- Effective circulatory volume : sustain perfusion, does not correlate with ECF
- Nephrotic, liver disease : TBW (interstitial) high, decreased ECV
- Tachycardia and delayed cap refill precede signs of ineffective circulation as hypotension, oliguria

# Regulatory mechanism

- Glomerular hypoperfusion:  $< \text{Na}$  to macula densa.  Renin and aldosterone  salt reabsorption
- Osmoreceptors in hypothalamus :  ADH and thirst



# maintenance

- Daily maintenance estimated and based on energy expenditure  $1 \text{ ml/kg} = 1 \text{ Kcal}$  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<sup>2</sup>/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 =  $1500 \text{ ml/m}^2$  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 :  $100 \times 10 = 1000$  ,  $5 * 50 = 250$
- Total = 1250 ml
- If a child weighs 25 Kg
- $\text{maint} = 1000 + (10 * 50) 500 + (5 * 20 = 100) = 1600$
- 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 :  $\text{Na} < 130 \text{ mmol/l}$
- 3.Hypertonic /Hypernatremic :  $\text{Na} > 150 \text{ mmol/l}$

# Degree of dehydration

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



# Assessment of dehydration

- 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<br>(3 to 5%)        | Moderate<br>(6 to 9%)       | Severe<br>(≥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 hypovolemia 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 dehydration

# 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

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

<sup>a</sup>Provided as powder. Needs to be reconstituted with water

<sup>b</sup>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?
- $\text{maint} = 1500 \text{ ml}$
- $\text{Deficit} = 20 \times 10 \times 7\% = 1400$
- $\text{Total} = 2900$  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/m<sup>2</sup> 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 symptomatic hyponatremia as seizures : use HTS 3% ( 1 ml contains .45 mmol)
- Use formula for mmol: (desired-actual) x weight
  - .6

# Hypernatremic dehydration

- Signs and symptoms aren't evident
- Shift from ECS to ICS
- 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 maintenance 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. electrolytes
- 2. capillary blood gas : gastroenteritis causes metabolic acidosis from diarrhoea 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
- Urine sodium :low



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

# Therapy of gastroenteritis

- 1. fluid hydration with IV, ORS
- 2. antimotility drugs as loperamide aren't used because they prolong intestinal transit time and can increase risk of invasion
- 3. Anti-emetics are not used routinely, in children with mild – moderate dehydration and persistent vomiting, single dose of ondansetron can be used

- 4. adsorbants: smectite : binds digestive mucus and toxins and decrease water losses and can be considered
- 5. probiotics as lactobacillus may be considered and might have some benefit
- Lactose free formula are used

# General measures

- Fluid with high glucose as sweetened fruit juices, carbonated drinks have high osmolarity and increase diarrhea looses and should be avoided and predispose to hyponatremia due to their low Na content
- Early refeeding within 8-12 hours is recommended with breast or formula milk

# Indications for hospitalization

- Shock/severe dehydration
- Moderate dehydration with intractable vomiting
- Failure of ORS
- Neurological symptoms: seizures, altered LOC

# Need for antibiotics

- Viral gastroenteritis due to rota virus are self limited and only adequate hydration is needed
- Antibiotics are used in
  - 1.shigella
  - 2. Entamoeba histolytica
  - 3.cholera
- Others as campylobacter, EI ecoli.EH ecoli, nontyphoidal salmonella in special conditions

*THANK YOU*

