FLUID,ELECTOROLYTES ACID BASE BALANCE

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Body water 55 – 75% of Body mass .

average ~ 60%

2/3 Intracellular

1/3 Extra cellular

Extracellular Fluid

- Extravascular 75% (Interstitial fluid).
- Intervascular 25% (Plasma fluid).

S. Osmolality

no. of solute particles (osmoles)

per unite volume of water.

serum osmolality is high in deydration
serum osmolality is low in overhydration

S. Osmolality

2 x Na(MEq) + BUN + glucose (265 – 285 mosmol /L).

normal serum Na: 140 mEq
normal BUN: 4-6 mmol/L
If BUN is high, then patient is dehydrated or has renal failure
normal Glucose: 4-6 mmol
hypoglycemia: < 4
hyperglycemia: >6

S. Osmolality maintained by :

- Kidney function (diluting or concentrating urine)
  - ADH. retain water to the body
  - Aldosterone. retain Na to the body

- Thirst center.

  when the serum osmolality is high, we get thirsty in the past, kids died due to Rota virus -> gastroenteritis -> dehydration -> death

Principles of management of Dehydration

- Maintenance – Daily requirement.
- Deficit – volume & Electrolyte loss.
- Replenish abnormal ongoing losses.

replacement

Maintenance :

Sensible + Insensible fluid loss

urine and feces

- **Insensible water loss (30ml / kg / day):**
  - Skin.
  - Respiration.
- **Sensible loss:**
  - Urinary.

if a patient has for example oligouria, anuria or renal failure we don't replace his sensible loss, cuz he is unable to urinate!
we only replace him for the insensible fluid loss
because if you replace his sensible fluid loss, he will become over hydrated, -> pulmonary edema -> death

Physiological requirement of maintenance increase in:

- Fever (10% for each 1C°).

if the maintaninance for a baby is 100/kg/day, and the baby has fever 38 C.
we should increase his maintainance by 10%, becomes 110/kg/day

- Physical activity.

it is **mandatory** to check you patient urine output before giving him fluid

Physiological requirement decrease in :

- Anuria – ARF.
- Oliguria – ARF.
- Congestive heart failure.
- SIADH (↑ADH → H_2O retention) .
  - Meningitis. kids who have meningitis we give them only 2/3 of maintainance
  - Head trauma.

Maintenance requirement of water :

- 1st 10kg of weight — 100ml / kg / day (4ml / kg / hour).
- 2nd 10 – 20kg of weight — 50ml / kg / day (2ml / kg / hour).
- > 20kg of weight — 20ml / kg / day (1ml / kg / hour).

A child who is age is 9 months, his weight: 10 kg, going to MRI under general anesthesia tomorrow, and has to be NPO. how much fluid will you give him?
100 x 10 = 1000 ml
1000 ml / day
41.67 ml / h
Order:
Please give the patient 41.67 ml / h over the coming 24 hours and keep the patient NPO

A child who is age is 9 months, his weight: 15 kg, going to MRI under general anesthesia tomorrow, and has to be NPO. how much fluid will you give him?
(4 x 10) + (2 x 5) = 50 ml
50 ml / h
1250 ml / day
Order:
Please give the patient 50 ml / h over the coming 24 hours and keep the patient NPO

A child who is age is 9 months, his weight: 25 kg, going to MRI under general anesthesia tomorrow, and has to be NPO. how much fluid will you give him?
(4 x 10) + (2 x 10) + (1 x 5) = 65 ml
65 ml / h

Order:
Please give the patient 65 ml / h over the coming 24 hours and keep the patient NPO

Maintenance requirement of electrolyte:

- Na : 3 MEq / kg / day.
- K : 2 MEq / kg / day.
- Cl : 5 MEq / kg / day.

Deficit :

- ↑ Loss.
- ↓ Intake.
- Severity in infants :
    - Mild 5% of body wt.
    - Moderate 10% of body wt.
    - Severe > 15% of body wt.

Assessment of deficit :

1. Weight change. "the ideal way"

2. Physical signs :

OSCE

- Pulse.
- BP.
- Behavior.
- Skin turgor.
- Ant. Fontan.
- Tears. while crying
- Capillary refill.

compare his weight know to his normal weight
if he's 9 kg in ER, and 2 weeks ago he was 10 kg, how much deficit?
he lost 1 kg form 10 kg. so it is 10%(moderatley dehydrated)
if he's 9.5 kg in ER, and 2 weeks ago he was 10 kg, how much deficit?
5% (mild)
if he's 8.5 kg in ER, and 2 weeks ago he was 10 kg, how much deficit?
15% (severe)

Deficit calculation :

1kg = 1L (1000gm = 1000ml).

5% deficit = 50ml/kg.

10% deficit = 100ml/kg.

15% deficit = 150ml/kg.

A patient weight is 10 kg, he lost 10% of his weight (moderate dehydration). How will you calculate his fluid deficit?
10% x 10 = 100 ml / kg
100 x 10 kg = 1000 ml

if the deficit was 7%
7% x 10 = 70 ml / kg
70 x 10 kg = 700 ml

If we are giving a patient maintainance only, we give him equally over 24 hours
but if we are giving a patient maintainance and deficit (the patient is dehydrated) we don't give him equally. give half of the fluid in the first 8 hours and the other half over 16 hors in case of normal or low Na

Example of Deficit :

Wt of infant 10kg

Deficit 10%

10kg x 100ml = 1000ml.

Example of total water requirement :

Wt of infant 10kg Deficit 10%

- Maintenance 100ml x 10kg = 1000ml
- Deficit 100ml x 10kg =1000ml
- Total = 2000ml

in this example assuming he has normal or low NA, we give the first 1000 ml over 8 hours -> 1000/8 = 125 ml / h over the coming 8 hours
the remaining 1000 ml are given over the 16 hours -> 1000/16 = 62 ml / h over the comin 16 hours

Types of Dehydration (Depend on Na level):

- Isotonic (Normal Na).
- Hypotonic (Low Na).
- Hypertonic (High Na).

Replacement of fluids :

Isotonic

Hypotonic

> Deficit + maintenance
> ½ + ½
> 8 + 16hrs

Hypertonic

- 1st 24hrs
  maintenance + ½ deficit
- 2nd 24hrs
  maintenance + ½ deficit

Case 1 :

Wt 10kg   Deficit 10%   Na 135 or/130 MEq/L

A. Maintenance   10kg x 100ml = 1000ml

B. Deficit   1kg = 1000ml

(↓ 10% → 100ml)

10kg x 100ml = 1000ml

C. Total

Maintenance + Deficit

1000ml + 1000ml

= 2000ml

1st 8hrs 1000ml / 8hrs = 125ml / hr.

2nd 16hrs 1000ml / 16hrs = 62.5ml per hour.

Case 2

Wt 10kg   Deficit 10%   Na 155 MEq/L

hypernatremia

1st day   Maintenance + ½ deficit

1000ml + 500ml = 1500ml/24hrs = 62.5 ml/hr.

2nd day 1000ml + 500ml =1500ml /24hrs = 62.5 ml/hr.

other than the maintainance and deficit, if patient has NGT for example, we should calculate how much aspirated fluid through the NGT and add it to the fluid requirement

Electrolyte Sodium :

normal Na level is 135-145
average is 140

1) Na < 135 MEq/ L (Hyponatremia)

A. Urine Na < 20 MEq/L

- Dehydration
  most common cause
  - g.I loss.
  - Skin loss (C.F).
- Dilution
  - SIADH.
  - CHF.

B. Urine NA > 20 MEq/L
major problem in the tubules

- Diuretics. furosemide
- Salt wasting nephropathy.
- Deficiency / Resistant to aldosterone

Management : ↑ Nacl (if loss)
as NS or 1/2 NS

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2) Na > 145 MEq/ L (Hypernatremia)

- Loss of H_2O > Na (e.g viral g.E) .

moslt due to gastroenteritis due to Rota virus

Management : slow fluid replacement .

K^+

- Acidosis : shift k outside cells .

  acidosis -> hyperkalemia

- Alkalosis : shift k inside cells.

  alkalosis -> hypokalemia

• Hypokalemia (K< 3.5 mmol/L):

- GI loss

  vomiting → loss of HCl.

  as in pyloric stenosis: hypokalemia and metabolic alkalosis

- Renal loss

  - Diuretics. loss of Na and K
  - ↑ aldosterone.
  - Bartter syndrome (tubulopathy). genetic determined they have high K in urine
  - Systemic Alkalosis.

Management : KCL replacement .

IV or Oral

• Hyperkalemia (K> 5.5 mmol/L):

dangerous as it might cause arrhthmia

- Pseudohyperkalemia. most common, due to use of tourniquet while drawing blood sample
- Metabolic Acidosis.
- Tissue catabolism.
- Renal failure.
- Hypoaldosteronism.
- Diuretics(spironolactone).
- ACEi . like captopril, decreases GFR, يعطي فشل كلوي كاذب, decrease K excretion and hyperkalemia, when stopped, K level will improve

Management : Insulin , glucose, ca gluconate , alkali

to protect the heart

to avoid hypoglycemia due to insulin

sodium bicarbonate, to enhance K shifting to inside the cells

Acid – Base Balance:

- PH ~ 7.35.

Examles:
> 7.4 -> acidosis
< 7.34 -> alkalosis

- PH maintained by :
  - Extracellular buffer (HCO_3 from kidney).
  - Intracellular buffer (Protein , Po4).
  - Alveolar regulation of PCO_2 .

Metabolic acidosis :

(PH < 7.34 HCO_3 < 18).

- Anion gab (maintained by renal excretion of anions).

AG : Na – (CL + HCO_3) = 10 -12 MEq/L.

I.e calculate the unmeasured anions.

1) MA with normal AG :

- Loss of HCO_3
  - GI (loss of HCO_3). like diarrhea
  - Renal (failure to reabsorb HCO_3) .

    e.g RTA. or bartter syndrome

diadia

2) MA with high AG

- Exogenous like aspirin toxicity

- Over production of acid (↑anions of these acids).

  e.g

  - DM.
  - Lactic acidosis (sepsis , inborn error of metabolism).
  - Renal failure↑ Po_4 (buffer) .

    hyperphosphatemia

Management : $NaHCO_3$.

Metabolic Alkalosis:

- Gain of base (alkali Administration).
- Loss of acid (loss of HCl). pyloric stenosis
- Cl resistant alkalosis   e.g Bartter syndrome.
- 2^{o} Hyperaldosteronism.

Management : Treat underlying condition.

Respiratory alkalosis is very rare in children

Thank you