FLUID THERAPY

a practical seminar
Topics

I. Fluid and electrolyte need
   – Symptoms of dehydration
II. Enteral rehydration
III. Parenteral rehydration
   – Solutions for intravenous use
   – Fluid plan
   – Strategies, rules
+ Practical excercises

most important stuff in framing
I. How much fluid input is ideal for a child?

Healthy:
exactly as much as desired

Daily fluid plan =
maintenance + deficit + future losses
Maintenance fluid (Holliday-Segar method)

- Metabolizing 1 kcal ≈ 1 ml water
- **1-10 kgs:** 100 mL/kg/day (100 kcal/kg)
- **11-20 kgs:** 1000 mL (kcal) + 50 mL/kg/d (50 kcal/kg) for wt 11-20kgs
- **> 20 kgs:** 1500 mL (kcal) + 20 mL/kg/d (20 kcal/kg) for wt above 20kgs
Exceptions

• Neonate, day 1: 60-80 mLs/kg/day
• Over a week it gradually increases to 150mLs/kg/day, this stays the approximate usual need / oral input throughout infancy

• Fever: extra 10% need for each °C above normal (use average temp. for the day).
EXERCISE -1: maintenance fluid

Girl, 32 kgs, being prepared for GI endoscopy.
What should be the daily iv fluid input?
EXERCISE -2: maintenance fluid

Boy 15 kg, awaits surgery for a hernia repair. There are delays in the theatre list. How much fluid shall we prescribe?
Fluid therapy in special scenarios

- Hyperhydration for e.g. tumour lysis syndrome or for certain toxicology cases:
  2 → 3 → 4 → max. 5 L/m²/d
polyuric renal failure, diabetes insipidus: to compensate losses, no upper limit of fluid input

- Fluid restriction e.g.
in pneumonia, maintenance at 80%,
in certain cardiac malformations: 80-70-60%
renal failure with oliguria: as per diuresis,
anuria: 400 mL/m² (insensible losses)
How accurate calculations are needed?

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Daily electrolyte requirement

- Na: 3-5 mmols/kg/day
- K: 2 mmols/kg/day
- Cl: 2 mmols/kg/day
- Ca, Mg, P: abundant in own stores
- Bicarbonate: usually not needed

As smaller children need less water per kg body weight, their usual maintenance fluids are more diluted sodium solutions.
<table>
<thead>
<tr>
<th>Signs of dehydration</th>
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<tr>
<td><strong>MILD</strong></td>
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<tr>
<td>Body weight</td>
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<tr>
<td>Tongue</td>
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<td>Fontanel</td>
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<td>Eyes</td>
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<td>Skin</td>
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<td>UO (ml/kg/hr)</td>
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<td>HR</td>
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<td>BP</td>
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<td>CRT</td>
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<td>Behaviour</td>
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(children, adults) [some sign but well] (infants) [shock or near shock]
Signs of dehydration

Further practical points

- coated tongue: aspecific
- lack of tears point to severe or at least moderate dehydration
- lack of cry on venopuncture is a severe worrying sign
- altered consciousness only occurs in the most severe forms shock.
- acetonic breath, Kussmaul-breathing
- history is very important (e.g. fluid input)
Example – estimation of losses

Boy, 12 years, 45 kgs
Suboptimal fluid intake because of viral gastroenteritis and vomiting. No fever, good general condition, dry mucosal membranes, HR 85/min, BP 100/55 mmHg, CRT < 2 sec, skin turgor norm. Last urine: 1 hour ago, previously 4hrs ago

Please calculate an estimated fluid deficit!
II. Oral rehydration

- Contraindications are very rare: acute surgical abdomen, severe dehydration/shock
- Safer than iv rehydration
- First approach: any fluid is good whatever the child accepts.
- Sodium (e.g. salty sticks), potassium (fruits) to give in case of ongoing losses.
- Oral rehydration solutions: most beneficial when ongoing substantial losses, especially diarrhoea
Oral rehydration solutions (ORS):

- Ingradiants: NaCl, KCl, glucose, (bicarb, citrate), isoosmotic
- **Dosing-1**, „fluid challenge” in vomiting children: 5-10 mL each 5-10 mins for 2-4 hrs.
- **Dosing-2**, in diarrhoea: 50-100 mL or 10mL/kg after each stool passed.
- **Dosing-3**, rapid enteral rehydration: full deficit (even 100 mL/kg) over 4 hrs – standard of care in many western countries. (The enteral epithelial cells make better calculations than us)
III. Parenteral rehydration

I.v. solutions, examples

- Normal Saline, 0.9% ≈150mM NaCl
- 5% or 10% glucose solution
- 0.45% NaCl + 5% glucose solution
- 0.3% NaCl + 10% glucose solution
- These above with added KCl, either manufactured so or added later
- 5% (or 4.5%) human albumin
- Hydroxyethyl-starch (HES) solutions
- 3% NaCl solution

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Comparison of i.v. infusions

Total fluid space 50 L in an adult

ICF

60% = 30 L

4/8

Cell membrane

ECF

Interst. 15 L

3/4

1/4

3/8

1/8

endothel

IV 5 L

1/1

Colloid

0.9% NaCl

5% G
Usual maintenance fluids

- Newborn: 5 or 10% glucose (dextrose)
- Infant, toddler: 0.3% NaCl, 10% glucose
  + 10 mmol KCl / 500mLs
- Child: 0.45% NaCl, 5% glucose
  + 10 mmol KCl / 500mLs
- Adult: 0.9% NaCl solution 10 mmol KCl/500mLs

Others suggest we should not give lower sodium containing solutions even to infants – danger of quickly infused hypoosmotic fluids.

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Isotonic fluids

Salsol
- Na\(^+\): 154
- K\(^+\): 5.4
- Ca\(^{++}\): 1.84
- Cl\(^-\): 154
- pH: 4.5-7
- Ozm: 278

Ringer lactate
- Na\(^+\): 130.9
- K\(^+\): 5.4
- Ca\(^{++}\): 1.84
- Cl\(^-\): 111.7
- Lactate: 28.3
- pH: 5.0-7.0
- Ozm: 278

Ringerfundin
- Na\(^+\): 140
- K\(^+\): 4.0
- Ca\(^{++}\): 2.5
- Cl\(^-\): 127.0
- Mg\(^{++}\): 1.0
- Acetate: 24.0
- Malate: 5.0
- pH: 4.6-5.4
- Ozm: 304

Isonyte
- Na\(^+\): 137.0
- K\(^+\): 4.0
- Cl\(^-\): 110.0
- Mg\(^{++}\): 1.5
- Acetate: 34.0
- pH: 6.9-7.9
- Ozm: 286.5

Balanced solutions
- Used mostly at surgical wards

i.v. bolus OK
- 5% albumin, HES

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Fluid bolus

- **10-20 mls/kg**, in adults 500-1000 mL
- As fast as possible in severe shock
- Less severe cases: over 10-20 min
Thumb rules in i.v. hydration

For fluid boluses (large volumes to infuse fast) only isoosmotic, potassium and sugar free (max. equal to the normal plasma concentrations) solutions are allowed!
Thumb rules in i.v. hydration

Potassium: maximum 80 mmol/L is allowed i.v. Some more strict guidelines advise max. 40 mmol/l for peripheral veins!
You must assess renal functions before giving potassium!

- Na, Ca, Mg, P, bicarbonate: more concentrated solutions can be given in slow bolus.
- Glucose: max 12,5% into peripheral veins, max 20% into central veins in children.

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Practical rules for iv hydration

• Do not administer hypoosmotic fluids parenterally!

• Into peripheral veins: fluids with osmotic pressure over 2.5 times that of the plasma allowed

• Into central canulae: more concentrated solutions are also OK.

• If a patient is on exclusive parenteral hydration, electrolytes have to be checked daily.

• Parenteral hydration for over 5 days warrants parenteral nutrition.
Practical points

- For initial correction and for replacement of losses choose isotonic solutions
- Subsequent fluids: usually the maintenance fluids we discussed above
- First day of iv. fluid therapy, if dehydrated: the first half of the 24-hour plan is given over 8 hours, the second half over 16 hours
- Maintenance potassium: 10 mmol / 500 mL bag.

Plan = maintenance + deficit + estimated future losses
EXERCISE / 4 – i.v. rehydration

Girl 5ys, 20 kgs, gets admitted for 2-day history of gastroenteritis. Afebrile, mucosae dry, eyes bit sunken, HR 130/min, BP 86/50 mmHg, CRT < 2 sec, weak but appropriate in behaviour.
Lab results arrive:
Na 138 mM; K 3,0 mM, creat 50 umol/L
EXERCISE / 5 – i.v. rehydration

Baby boy, 8 mo, 8 kg arrives with gastroenteritis. Afebrile, pale, apathic, dry mucosae, eyes sunken, fontanel sunken, skin tourgor markedly decreased, HR 180/min, BP 70/25 mmHg, CRT 4-5 sec.
Following 2 boluses (160 mLs + 80 mLs) plus 300 mLs of iv infusions, lab results arrive: Na 139 mmol/l, K 5.2 mmol/l, creat 72 umol/L
Perioperative fluid therapy

Before procedure:
100% maintenance
usually Ringer lactate

After surgery:
• Decreased fluid need:
  80% maintenance
• Increased Na input needed:
  typically 0.9% NaCl +/- KCl
Not discussed but important

- hypoosmotic (hyponatraemic) and
- hyperosmotic (hypernatraemic) dehydration
Test questions

• Calculate maintenance fluid, fluid plan
• Sings of dehydration, estimation of losses
• Which solutions can be given as iv bolus
• What fluids can be given as iv infusion