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FLUID THERAPY

a practical seminar

2018-19 / 1st semester

Topics

I. Fluid and electrolyte need

- Symptoms of dehydration

II. Enteral rehydration

III. Parenteral rehydration

- Solutions for intravenous use
- Fluid plan
- Strategies, rules

+ Practical exercises

most important stuff in framing

I. How much fluid input is ideal for a child?

- For the healthy?
- For infants / toddlers / children?
- Those with fever?
- Those dehydrated from diarrhoea?
- In renal failure?
- After surgery?

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 \approx 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

origin, accuracy, alternatives...

2/3 of above is also enough to prevent dehydration

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

Fluid restriction e.g.

in pneumonia, maintenance at 80%,

in certain cardiac malformations: 80-70-60%

renal failure with oliguria: as per diuresis,

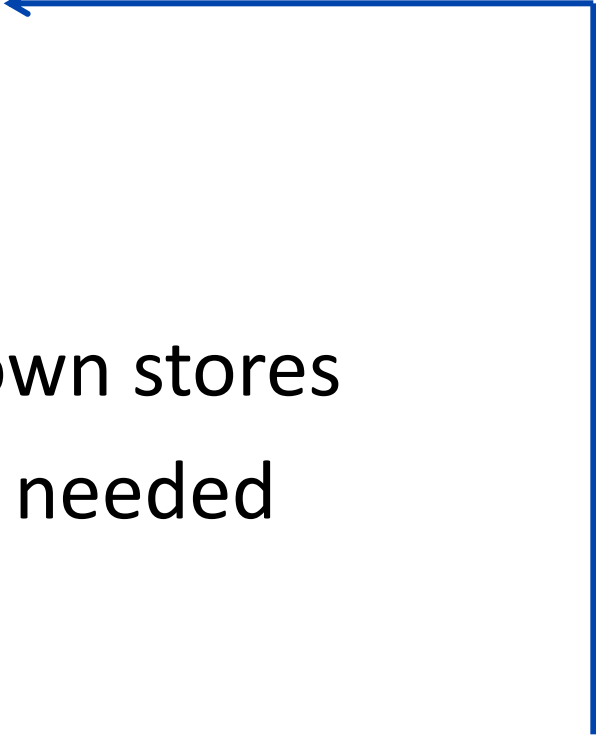
anuria: 400 mL/m² (insensible losses)

How accurate calculations are needed?

- Otherwise healthy, not critically unwell child: +50% or -25% deviation will probably not cause trouble.
- Fluid therapy errors in renal failure, cardiac failure or in the critically unwell: pulmonary oedema or shock may result soon.

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 more water per kg body weight, the traditional maintenance fluids were more diluted sodium solutions. However, in practice, this may result in hyponatraemia.

Signs of dehydration

| | children, adults | infants | | |
|---------------|------------------------|---------|--------------------|------------------------------|
| | | | MILD | MODERATE |
| Body weight ↓ | 3-5 % | | 6-10 % | 9-15 % of body weight |
| Tongue | <u>moist or dry</u> | | dry | dry |
| Fontanel | <u>norm. or sunken</u> | | sunken | sunken |
| Eyes | norm. | | <u>sunken</u> | very much sunken |
| Turgour | norm. | | norm. | ↓ |
| Skin | warm | | warm/cool | <u>cold</u> |
| UO (ml/kg/hr) | >1 | | <u>0,5-1</u> | <u><0,5</u> |
| HR | <u>norm. or mild ↑</u> | | <u>tachycardia</u> | tachy, pulse thready |
| BP | norm. | | norm. | ↓ |
| CRT | < 2 sec | | < 2 sec | <u>> 2 sec</u> |
| Behaviour | norm. | | irritability | lethargy |

[some sign but well]

[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

Oralrehydration solutions **ORS** :

- Ingradiants: NaCl, KCl, glucose, (bicarb, citrate), isoozmotic
- 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 defecit (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% \approx 150mM NaCl
- 5% or 10% glucose solution
- Balanced solutions
- 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

what is this for?

„Isodex”, isoosmotic in some way, not in other...

Used mostly at surgical wards

Isotonic fluids examples

Salsol

Na⁺ 154

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

Isolyte

Na⁺ 137,0

K⁺ 4,0

Cl⁻ 110,0

Mg⁺⁺ 1,5

Acetate

34,0

pH 6,9 - 7,9

Ozm 286,5

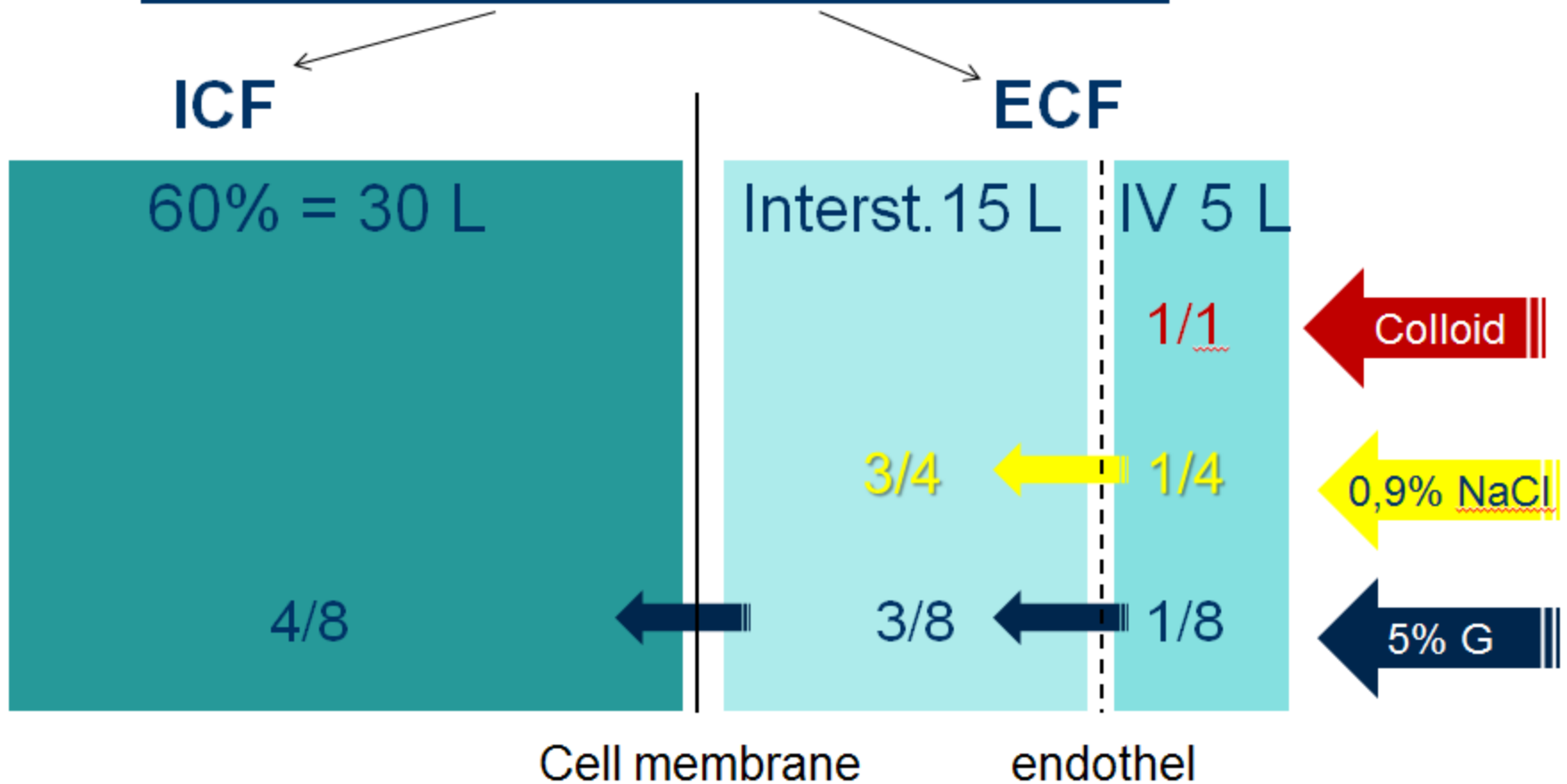
i.v. bolus

5% albumin, HES

Balanced solutions

Comparison of i.v. infusions

Total fluid space 50 L in an adult



Usual maintenance fluids

- New born: 5% or 10% glucose (dextrose)
- Infant, toddler, child, adult:
0.9% NaCl + 10 mmol KCl / 500mLs or
balanced solutions; with 2.5-10% glucose

„maintenance” potassium

Earlier, more diluted sodium solutions were suggested for children:

- 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

„one third”

„half saline”

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. E.g. 10% Ca-gluconate and 4,2% bicarbonate can be given neat.
- Glucose: max 12,5% into peripheral veins, max 20% into central veins in children.

Practical rules for iv hydration

- Do not administer real hypoosmotic fluids parenterally!
- Into peripheral veins: fluids with osmotic pressure ≤ 2.5 times that of the plasma are advisable. 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 even if you plan to use more diluted saline solutions for maintenance
- 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

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 88/50 mmHg, CRT < 2 sec, weak but appropriate in behaviour

Lab results arrive:

Na 138 mM; K 3,0 mM, creat 50 μ mol/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 turgor markedly decreased, HR 180/min, BP 70/25 mmHg, CRT 4-5 sec.

...

Na 139 mmol/l, K 5.2 mmol/l, creat 72 μ mol/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
- Signs of dehydration, estimation of losses
- Which solutions can be given as iv bolus
- What fluids can be given as iv infusion