

Dehydration in children

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- Symptoms
- Differential diagnoses, Anamnesis, Physical examination
- Dehydration
- Lab tests
- Treatment

Physical examination

- behavior: apatia or excitation, thirst
- skin: colour, turgor
- head: fontanella maior, eyes, mucosa, lips
- heart: tachycardia
- abdomen: pain, resistance, peristalsis, hepatosplenomegaly
- limbs: pulsation

Dehydration degree

- Mild
 - home treatment
- Medium
 - hospitalization?
- Severe
 - ICU!!!

Mild dehydration

- weight loss $< 5\%$
 - Neonates with 4 kg, weight loss $< 200\text{g}$
 - adult with 60kg, weight loss $< 3\text{kg}$
- thirst
- oliguria



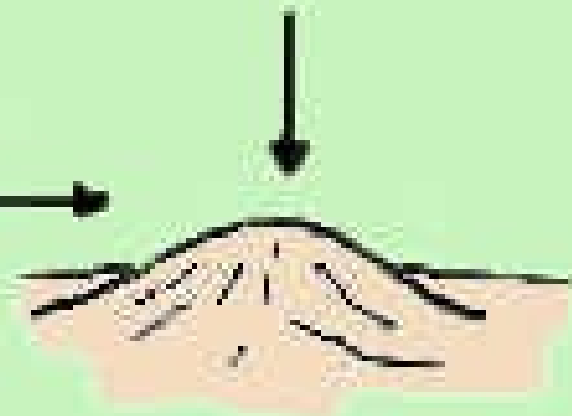
Medium dehydration

- weight loss 5-10%
- + visible sign
 - behavioral changes- apatia/irritability
 - dry or sticky mucous membrane
 - tears missing
 - sunken eyes (endophtalmus)
 - lower fontanelle
 - lower skin turgor (loss of skin elasticity)
- tachycardia





Pinched skin



goes down slowly.

Severe dehydration

- weight loss $>10\%$
- signs of hypovolemic shock
 - cold acral parts
 - cyanosis
 - thready pulse
 - difficult breathing
 - rapid breathing
 - lethargy
 - coma



Why laboratory tests?

- ASTRUP
- ESR
- Complete blood count
- Blood chemistry
- Urine
- Coagulation

ASTRUP



↓ Hydrochlorid acid

↓
Alkalosis

?

pH



↓ Bicarbonate

↓
Acidosis

ASTRUP

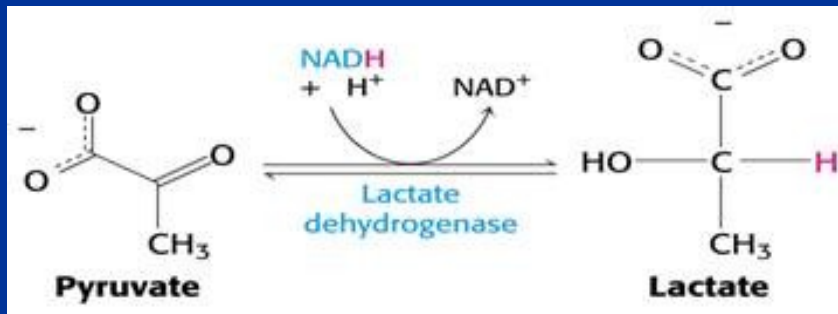
Metabolic acidosis

$$([\text{Na}^+] + [\text{K}^+]) - ([\text{Cl}^-] + [\text{HCO}_3^-])$$

Normal anion gap



High anion gap



- Lactate (tissue hypoperfusion, liver dysfunction)
- Keto acids (starving, DM)
- Paraprotein (malignancies)
- Toxins (ethanol, methanol, ethylene glycol)
- Renal failure – decreased excretion of acids + decreased HCO₃⁻ reabsorption

Erythrocyte sedimentation rate

- non-specific measure of inflammation
- indirectly measures the degree of inflammation



Blood Count

- Degree of inflammation
 - Leukocytosis
- Type of inflammation
 - >Neutrophils – drum sticks or immature forms, toxic granulations
 - >Lymphocytes – viral
 - Eosinophils (normal to 5%), more – allergy, parasites (tissue helminths), cleaning after disease
 - Monocytes (normal to 10%), more – EBV ?
 - **Neutrophil to lymphocyte count ratio - NLCR**
 - ✓ early parameter of systemic inflammation and stress in critically ill
 - ✓ **>10 systemic bacterial infection** (condition: neutrophilia and lymphocytopeny)

Blood Count

- dehydration
 - ↑hemoglobin and hematocrit
- anemia, bleeding
 - ↓hemoglobin, hematocrit
- degree of inflammation
 - ↓PLT

Blood chemistry

CRP

X

PCT

Blood chemistry

CRP

- protein of acute phase, norm <8 mg/ml
- hepatic origin (NO in liver failure!)
- inflammatory condition, malignancy → ↑IL-6 → synthesis of CRP
 - marker of inflammation, not only infection
- binds to phosphocholine expressed
 - on the dead or dying cells → ↑ necrosis (heart attack, multiple trauma)
 - some bacteria → ↑ bacterial infection
- dynamics
 - first level: 4 – 6 h
 - peak: 36 – 48 h
 - elimination half-life time: 18 hours
- diagnostic use:
 - determining disease progress or the effectiveness of treatments

Blood chemistry

PCT

- production
 - normal: parafollicular cells of the thyroid (precursor of the calcitonin)
 - inflammation: somatic cells (**protein of acute phase**, norm < 0,05 ng/l)
 - dynamics
 - first level: 2 - 3h
 - peak: 6 – 12 h
 - elimination half-time: 24 - 30 hours
 - diagnostic use
 - differential diagnosis of infectious and non-infectious process
 - greatest sensitivity and specificity for the differential diagnosis of infectious and non-infectious SIRS
 - 2x negative in first 12 h → exclusion of sepsis
- **marker of infection (bacterial)**

Blood chemistry

- plasma osmolality (275 – 295 mmol/kg)
 - electrolyte-water balance
 - Na (ECF volume regulation), gluc, urea...
 - hyper-,izo- , hypo-
- Ions
 - Na, K, Cl, Ca
 - + Mg, P - seizures
- urea, creatinine – kidneys function
- glycaemia
 - ↑Glc - stress, DM screening
 - ↓Glc – apatia, acetonemic vomiting, seizures
- Lactate
 - tissue hypoperfusion, liver dysfunction →MAC with high anion gap
 - prognostic tool (dynamic changes)

Urine

- Urinary infection
 - leu, erc, proeinuria
- Disorder of kidney function
 - proteinuria, glycosuria
- Starvation
 - ketones
- Dehydration:
 - ↑urine osmolality

Coagulation

- Bleeding
- Liver function (short elimination half-time of coagulation parameters)
- Severe conditions (sepsis)

Therapy

Rehydration – step by step

- Dehydration degree
- Calculation of overall volume
- Fluid management

Calculation of overall volume

- **Basal intake of fluid:**
 - Less than 10 kg = 100 ml/kg
 - 10-20 kg = 1000 + 50 ml/kg for each kg over 10 kg
 - Greater than 20 kg = 1500 + 20 ml/kg for each kg over 20 kg
- **Estimated loss of fluids**
 - <1 year: severe 100ml/kg, medium and mild: 50 ml/kg
 - >1 year: severe 50ml/kg, medium and mild 20 ml/kg
- **Ongoing pathological losses + ions, glucose and acidobasic correction**
 - + 12% of basal intake for every 1°C of body temperature
 - + 50 - 150 ml for every vomiting or stool

IV rehydration

Calculate:

e.g.

Boy, 20 kg, 5-year-old, estimated weight loss to 10 %
(medium dehydration)

basal intake: ?

estimated loss: ?

(ongoing losses)

Calculation of overall volume

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Calculation of overall volume

Calculate:

e.g.

Boy, 20 kg, estimated weigh loss 5 - 10 % (medium dehydration)

basal intake:

$$1000 + (50 \times 10) = 1500 \text{ ml}$$

estimated loss:

$$20 \times 20 = 400 \text{ ml}$$

(ongoing losses)

- $1500 \text{ ml} + 400 \text{ ml} \dots = 1900 \text{ ml}$

Fluid management

Calculated volume in next 24 hours (boy, 20 kg):

1900 ml

- 1/2 in first 8 h: 950 ml (first hour 10 – 20 ml/kg)
 - 1. hour: speed 200 ml/h
 - next 7 hours: 750 ml ...speed of infusion 107 ml/h
- 2/2 in next 16 h: 950 ml

+ add ongoing pathol. losses (in next hours)

+ ongoing ions and acidobasic correction
(blood test results...in first 2 hours)

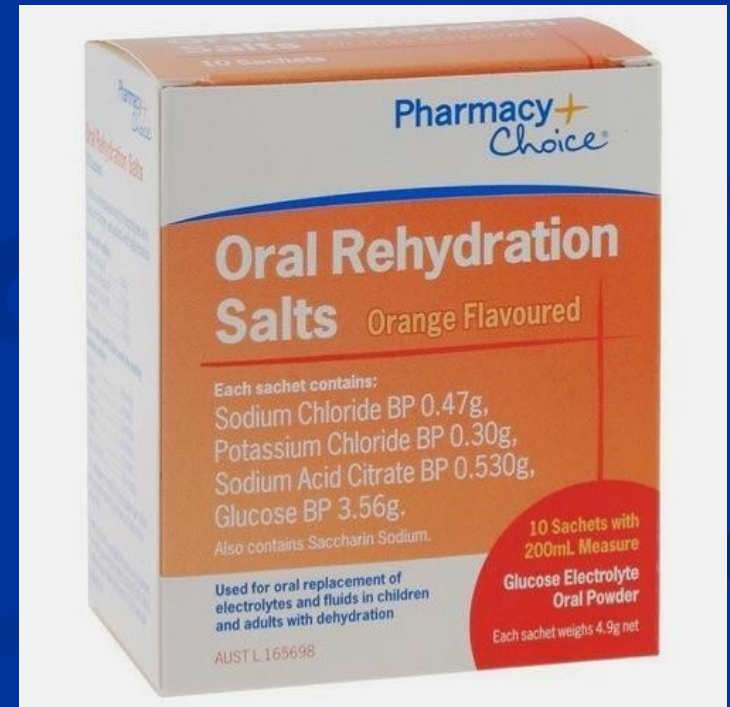
IV rehydration II - fluid management

Monitor for signs and symptoms

- state of consciousness
- urine output
- skin turgor
- tachycardia

Oral rehydration

- mild dehydration
 - peroral rehydration fluid (water, Na, K, Glc) – WHO defined
 - rice water, mineral still water



IV solutions

- Crystalloids – small molecules
 - about 25 % remain in vascular space
 - Isotonic – 0.9 % NaCl, Ringer fundin, Ringer lactate, Plasmalyte
 - Hypotonic - 5 % Gluc, 0,45 % NaCl
 - Hypertonic – 10 % Gluc, Plasmalyte + 5 % Gluc...
- Colloids - large molecules
 - →severe dehydration?
 - remain in vascular space
 - E.g. Hydroxyethyl starch (HES) – max. safety dose – 25 ml/kg/day
 - ↑ price
 - AE: anaphylactoid reactions, coagulopathy
- (Blood products) – NO: for volume expansion!

Isotonic solutions

- concentration of electrolytes is similar to that of plasma
- inicial treatment of dehydration (if we don't know parameters of ions and acid-base balance)
- 0.9 % NaCl
 - I: MAC high anion gap (lactate, ketoacids), renal impairment (absence of K^+)
- Plasmalyte: electrolyte concentrations, osmolality and pH mimic plasma

	Na	K	Cl	Ca	Mg	laktát	acetát	glukonát	osmo
1/1 FR	154	0	154	0	0	0	0	0	308
Ringer	147	4	157	3	0	0	0	0	309
Hartmann	131	5	111	2	0	29	0	0	278
Plasmalyte	140	5	98	0	1,5	0	27	23	295

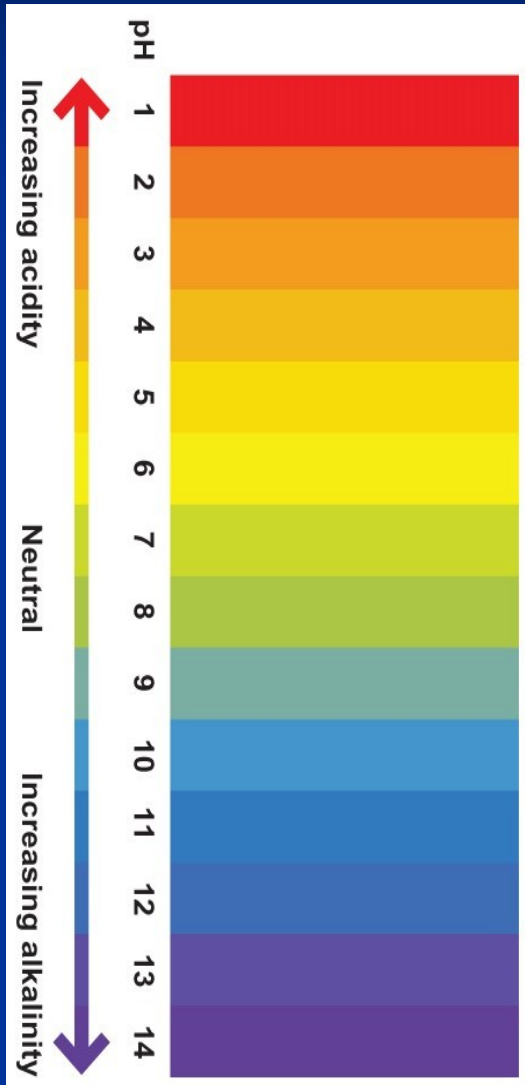
Hypotonic solutions

- Lower concentration of electrolytes or tonicity compared to plasma
- <250 mmol/l \rightarrow shift to cells
- **NO**
 - hypernatremic dehydration (>150 mmol/l)
 - patient at risk for increased ICP
 - liver disease, trauma, burns (depletion of intravascular volume)
 - \rightarrow **cerebral edema**
 - hyponatremic dehydration (<130 mmol/l)
 - \rightarrow **deeper hyponatremia \rightarrow cerebral edema**
- **YES**
 - ongoing pathological losses (e.g. hypoglycemia)

Hypertonic solutions

- Higher concentration of electrolytes or tonicity compared to plasma
- ≥ 375 mmol/l \rightarrow ECF – volume expander
- E.g. Plasmalyte + 5 % gluc (572 Osmol/l), 10 % Gluc (556 mmol/l), 3% NaCl, 10 % NaCl, 7.5 % KCl...
- **NO**
 - replacement of volume (\uparrow Osmol)
 - high speed ! - phlebitis, fluid volume overload \rightarrow pulmonary edema
- **YES**
 - glucose and ion correction (e.g. 3% NaCl in symptom. hyponatremic. dehydration)
 - Correction of MAL (NaCl)

pH



- **correction of MAC <7,1**
- 4,2 %/8,4 % NaHCO₃
- Add 1/3 -1/2 of calculated amount

- Ringer fundin (pH 5.1 – 5.4)
- Ringer lactate (pH 6.5)
- Plasmalyte (pH 7.4)

- **correction of MAL >7,45**
- ↓CL: NaCl, KCl, NH₄Cl...

Thank you for your patience

