Fluid & electrolytes - II

22nd May 2011

Treatment of hyponatremia
- Treatment of underlying condition
- Water intoxication/Shydradipsia:
  - Fluid restriction: 1000ml/day
  - Diuretics
  - Hypertonic saline 3%, 5% NaCl
- Sodium supplement:
  - Na deficit = 0.6 x lean body weight x (130 - serum sodium) (mmol) (Kg) (mmol/L)
  - Na should be increased less than 12 mmol/L over 24 hour (<0.5 mmol/L per hour)
  - In acute hyponatremia (<48 hours) rapid correction @1-2 mmol/hour can be done.
  - Rapid correction: central pontine demyelination

Hypernatremia
- Causes:
  - Infusion of hypertonic solution eg saline, NaHCO3,
  - DI
  - Chronic renal failure
  - Mineralocorticoid excess
- CF:
  - Lethargy, weakness, irritability, seizure, coma
- T/t:
  - correction of water deficit
  - Oral water
  - 5% dextrose, hypotonic saline 0.45%, 0.18% NaCl etc.

Potassium
- Major intracellular cation
- Serum level: 3.5 - 5 mmol/L
- Daily intake: 1 mmol/Kg daily
- Excreted in urine.

Hypokalemia
- Causes:
  - GI losses: diarrhoea, vomiting, NG aspiration
  - Renal losses: diuretics, fluid mobilization
  - Cutaneous loss: burn
  - Insulin excess,
  - Aldosterone excess,
  - Villous adenoma of rectum
- CF:
  - Weakness
  - Cardiovascular: ECG changes—ectopy, T-wave depression, prominent U wave, arrhythmia

Hypokalemia...

Treatment:
- In mild case—oral replacement
- Parenteral infusion: should not exceed 20 mmol/hour
Hyperkalemia

Causes:
- Rhabdomyolysis
- Insulin deficiency
- Beta blocker
- Digitalis intoxication
- Reperfusion syndrome
- Renal failure

CF:
- ECG changes—tall tented T wave, reduced p wave, wide QRS complex.
- Cardiac asystole

Hyperkalemia...

Treatment:
- Mild hyperkalemia: decrease K intake, loop diuretics—frusemide
- Severe hyperkalemia:
  - NaHCO3 8.4% --- 1mmol/kg
  - Glucose with insulin: 0.5gm/kg body wt.
  - Infused B-agonist: salbutamol, albuterol as nebuliser
  - Calcium gluconate 10%: 10ml over 10 min
  - Dialysis

Calcium

- Normal: 8.9 – 10.3 gm/dl
  - Ionized: <45%
  - Protein bound—40%
  - Complexed to other compounds—15%
- Ionized one is physiologically active
- Daily intake: 500mg-1000mg

Regulation:
- PTH, vit D

Hypocalcemia

Causes:
- Ca sequestration: acute pancreatitis, rhabdomyolysis, massive blood transfusion
- Vit D deficiency
- Total thyroidectomy, hypoparathyroidism
- Hypoalbuminemia: 1gm/dl decrease in albumin----- 0.8mg/dl decrease in serum Ca
- Associated with Mg deficiency

CF:
- Perioral numbness & tingling
- Tetany---- Chvostek’s sign (facial muscle spasm on tapping over the branches of facial nerve
  Trousseau’s sign
- Laryngeal spasm, seizure
- ECG changes: ventricular arrhythmia, QT- interval prolongation

Hypocalcemia...

Treatment:
- Oral therapy: calcium salts—Ca carbonate, Ca gluconate
  - in chronic case, vitamin D also added
- Parenteral therapy: calcium gluconate 10% 10 – 20ml over 90 minutes bolus then infusion @ 1-2 mg/kg elemental Ca per hour Calcium chloride

Calcium...

Hypocalcemia

Causes:
- Hyperthyroidism
- Malignancy
- Hyperparathyroidism
- Vitamin D intoxication
- Long term bed ridden patients
- Long term TPN
- Thiazide diuretics

CF:
- Weakness, altered mental status, dehydration, nausea & vomiting, intestinal colic, constipation, bone pain, renal stones.
Hypercalcemia...

- Treatment:
  - Restriction of Ca intake
  - Treatment of underlying disorder
  - Correct dehydration
  - Severe cases: NaCl 0.95 & loop diuretics
  - Calcitonin
  - Pamidronate
  - Bisphosphonate
  - Plicamycin

Magnesium

Composition of crystalloid & colloid solutions (mM/L)

<table>
<thead>
<tr>
<th>Solution</th>
<th>Na</th>
<th>K</th>
<th>Ca</th>
<th>Cl</th>
<th>Lactate</th>
<th>Colloid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hartmann’s</td>
<td>130</td>
<td>4</td>
<td>2.7</td>
<td>109</td>
<td>28</td>
<td>~</td>
</tr>
<tr>
<td>Normal saline</td>
<td>154</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>5%/5% Dextrose</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Dextrose saline</td>
<td>30</td>
<td>--</td>
<td>--</td>
<td>30</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Gelofusine</td>
<td>150</td>
<td>&lt;1</td>
<td>150</td>
<td>--</td>
<td>--</td>
<td>Gelatine6%</td>
</tr>
<tr>
<td>Haemaccel</td>
<td>145</td>
<td>5.1</td>
<td>6.26</td>
<td>145</td>
<td>--</td>
<td>Polygelin75gL</td>
</tr>
<tr>
<td>Haemaccel</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>Hydroxethyl starch 0%</td>
</tr>
</tbody>
</table>

Composition of GI secretions (mM/L)

<table>
<thead>
<tr>
<th>Fluids</th>
<th>Volume m/24 hr</th>
<th>Na</th>
<th>K</th>
<th>Cl</th>
<th>HC03</th>
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<tbody>
<tr>
<td>Saliva</td>
<td>1500</td>
<td>10</td>
<td>25</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>Stomach</td>
<td>1500</td>
<td>50</td>
<td>15</td>
<td>110</td>
<td>--</td>
</tr>
<tr>
<td>Duodenum</td>
<td>1000</td>
<td>140</td>
<td>5</td>
<td>100</td>
<td>--</td>
</tr>
<tr>
<td>Ileum</td>
<td>3000</td>
<td>140</td>
<td>5</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td>Colon</td>
<td>800</td>
<td>60</td>
<td>30</td>
<td>40</td>
<td>--</td>
</tr>
<tr>
<td>Pancreas</td>
<td>1000</td>
<td>140</td>
<td>5</td>
<td>75</td>
<td>115</td>
</tr>
<tr>
<td>Bile</td>
<td>800</td>
<td>140</td>
<td>5</td>
<td>100</td>
<td>35</td>
</tr>
</tbody>
</table>

Acid-base balance

- pH = 7.36 – 7.44
- Buffer system: HC03 buffer system
- HC03: H2CO3
  - CO2 removed by lungs, acid & base (H & HC03) removed by kidney
  - Normal ratio 20:1
- PCO2: 35-45 mmHg
- PO2: 80-110 mmHg
- HC03: 32-35 mmol/L.
- Anion gap: undetermined or unmeasured anions in blood.
  - 10-16 mmol/L
  - Anion gap = (Na + K) – (HCO3+ Cl)
  - Increased in metabolic acidosis like lactic acidosis, boric acidosis, salicylate poisoning.