Fluid and Electrolyte Management

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Volume and Electrolytes

- Normal requirements
- Pre-existing deficits of excesses
- Ongoing losses or gains

Question

- 70 Kg otherwise healthy male – NPO
- Appropriate 24 hour fluid/electrolyte regimen
  - D5W @ 125ml/hr
  - NS @ 125cc/hr
  - D5W + NS @ 150ml/hr
  - D5W + ½ NS @ 125ml/hr √
  - LR @ 125ml/hr

Why 125ml?

- Intern said so
- Chief resident asked me to
- Attending ordered me to
- That is the normal requirement √

‘Normal’ fluid requirement

<table>
<thead>
<tr>
<th>Kg</th>
<th>per hour</th>
<th>per 24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>First 10 Kg</td>
<td>4ml</td>
<td>100ml</td>
</tr>
<tr>
<td>Second 10 Kg</td>
<td>2ml</td>
<td>50ml</td>
</tr>
<tr>
<td>Subsequent Kg</td>
<td>1ml</td>
<td>25ml</td>
</tr>
</tbody>
</table>

‘Normal’ losses

- Sensible losses
  - urine
  - feces
- Insensible losses
  - skin
  - lung
## Sensible losses
- **Minimum urine volume**
  - ~400 ml
    - normal kidneys
    - maximally concentrating urine
- **Adequate urine volume**
  - ½ ml/Kg (30 ml/hr)
    - higher for children
  - 1000 – 1500 ml
- **Fecal loss**
  - 100 – 300 ml

Total sensible loss = ~ 1800 ml

## Losses
- **Insensible**
  - ambient temperature
  - 600 – 1000 ml
- **Total = sensible + insensible**
  - 1800 + 1000 = 2800 ml

## Calculations
- **24 hour losses** = 2800 ml
- **@125 ml/hr** = 3000 ml/24 hr
- **Formulae (70Kg healthy male)**
  - I 10 Kg: 40 ml/hr 1000 ml/24 hr
  - II 10 Kg: 20 ml/hr 500 ml/24 hr
  - 50 Kg: 50 ml/hr 1250 ml/24 hr
- **Total**
  - 110 ml/hr 2750 ml/24 hr
  - (2640 ml/24 hr)

## Question
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## Sodium
- **Sensible losses**
  - urine – 1500 ml
    - ~150 mEq
  - fecal – 300 ml
    - ~30 mEq
- **Insensible loss – 1000 ml**
  - ~15-30 mEq
- **Formula**
  - 2-4 mEq/Kg

## Fluid and Sodium
- **70Kg healthy male**
  - fluid volume ~3000 ml
  - sodium ~210 mEq
- **Fluid needed for normal requirements**
  - 210 mEq Na+/3L = ~70 mEq/L
- **Available fluid**
  - ½ NS 77 mEq/L
Question?

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Question?

- Why D5W?
  - provide caloric needs
  - something is better than nothing
  - required for body to use sodium
  - prevent catabolism √
  - why?
    - ‘Protein sparing effect’ of glucose

Question?

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Other ions

- Add to fluid as necessary
- Normal requirements

Pre-existing deficits/excesses

- Diagnosis
  - clinical
- Quantification
  - severity of clinical signs
- Treatment
  - deficit: repletion
  - excess: removal
- Ongoing monitoring

Ongoing losses/gains

- Losses
  - GI
  - urinary
  - post-operative (‘third spacing’)
  - increased insensible losses
- Gains
  - medications
  - catabolism
  - resorption of ‘third space’
Sodium

- Sodium concentration
  - determines body fluid osmolality
  - 'manages' water
- Hypo/hyper natremia
  - reflection of body water status
    - hyponatremia: water excess
    - hypernatremia: water deficit
  - rarely true sodium deficit/excess

Hypo/hyper natremia

<table>
<thead>
<tr>
<th></th>
<th>True</th>
<th>Spurious</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyponatremia</td>
<td>$\Delta [Na^+] \times \text{TBW}$ (5% NaCl)</td>
<td>Restrict water (3-5% NaCl)</td>
</tr>
<tr>
<td>Hypernatremia</td>
<td>D5W</td>
<td>D5W</td>
</tr>
</tbody>
</table>

Hypo/hyper natremia

- Initial partial rapid correction
  - alleviate symptoms
- Rapid total correction is extremely dangerous
  - rapid increase: central myelinolysis
  - rapid decrease: convulsions/coma
- Close monitoring

Potassium

- Roles
  - neuromuscular communication
  - cardiac function
  - gut motility
  - acid/base regulation
- Hypokalemia
  - post-operative renal failure
- Hyperkalemia
  - iatrogenic
  - excessive losses

Hyperkalemia

- Presentation
- Dangerous
- Immediate treatment
  - cardioprotection
    - calcium gluconate 1gm as 10% solution
  - encourage cellular uptake
    - dextrose and insulin
    - alkalization
- Removal of potassium
  - exchange resins
  - dialysis

Hypokalemia

- Presentation
- Treatment
  - prevention
  - repletion
    - $<20$ mEq/hr
Calcium

- Neuromuscular stability
- Hypo/hyper calcemia presentation
  - Hypocalcemia
    - Pancreatitis
    - massive infection
    - renal failure
    - pancreatic and GI fistula
    - hypoparathyroidism
  - Hypercalcemia
    - metastatic cancer
    - hyperparathyroidism

Hypo/hypercalcemia

- Hypocalcemia
  - acute
    - IV administration
  - long-term
    - PO calcium + vitamin D
- Hypercalcemia
  - vigorous diuresis
  - PO or IV phosphates
  - steroids and calcitonin
  - plicamycin

Magnesium

- Essential for most enzyme systems
- Hypo/hyper magnesemia presentation
  - Hypomagnesemia
    - starvation
    - malabsorption
    - iatrogenic
    - pancreatitis
    - DKA
    - alcoholism
    - aldostronism
  - Hypermagnesemia
    - renal insufficiency
    - iatrogenic
    - burns
    - massive trauma
    - dehydration
    - acidosis

Hypo/hyper magnesemia

- Hypomagnesemia
  - prevention
  - parenteral administration MgSO₄ or MgCl₂
- Hypermagnesemia
  - calcium gluconate: 5-10mEq
  - correct acidosis and dehydration
  - dialysis

Pre-operative management

- Correct volume and electrolyte abnormalities
  - external losses
  - internal redistribution
- Clinical diagnosis
  - separate entities
  - algebraic sum
- Intensive monitoring

Intra-operative management

- Blood
  - replace with blood for blood loss >500ml
- Fluid requirements (losses)
  - degree of dissection
  - duration of procedure
  - crude guide: 500-1000mL/hr
to max of 2-3L/4hours
- Intensive monitoring
Post-operative ‘third space’
- I phase of healing
  - inflammatory phase
    - capillary leak
- Quantification
  - degree of dissection
- Type of loss
  - extra-cellular fluid
- POD III onwards
  - resorption

Early post-operative period (POD I&II)
- Normal requirements
- Carryover from surgery
- Extra losses/gains
  - third space
  - GI
  - medications
  - catabolism

Late post-operative period (POD III onwards)
- Normal requirements
- Extra losses/gains
  - GI
  - medications
  - resorption of third space
- Other ion replacements

Summary
- Similar for volume and electrolytes
- Normal requirements
  - small amount of glucose
- Pre-existing deficits/excesses
- Ongoing losses/gains
- Evaluation – clinical and limited laboratory
- Signs and symptoms – algebraic sum
- Monitoring