Fluid Balance Case Based Discussion

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Fluid balance

- At birth, approximately 80% of a child's body weight is water
- Falls gradually reaching 60% water by adulthood
- Total body water distributed evenly between intracellular, interstitial & intravascular spaces
- Moves between different compartments depending upon various pressure & osmotic gradients
- In fasting, surgery, illness & injury fluid shifts maybe rapid, with significant consequences

Case 1

2 year old patient presents for removal of metal work from his right arm on the day surgery unit. He is 3rd on the morning list and has been nil by mouth since 19:00 the previous day

Questions

- How long would you allow this patient to have clear fluids?
- What are the metabolic effects of fasting & surgery?
- How would you calculate this patient's maintenance fluids intraoperatively?
- What fluid would you give to this patient if any?

Preoperative fasting in children

- Aim is to reduce the risk of pulmonary aspiration in children (0.07-0.1%)
- Aspiration uncommon and more likely in the emergency rather than elective setting
- However brief fasting prior to surgery has a number of benefits:
  - Improved patient & parental satisfaction
  - Ingestion of calories
  - Decreased risk of hypoglycaemia
  - Decreased lipolysis
  - Improved fluid homeostasis

Should children fast at all?

- National guidelines 2, 4, 6 regimen for clear fluids, breast milk & solids
- Studies in UK & US shown that children fasted for much longer than recommended
- Study 10 015 children allowed clear fluids up until time of surgery showed an incidence of pulmonary aspiration of 0.03%
- Compliance with preopeartive fasting by children & parents is incomplete

Metabolic effects of fasting & surgery

- Metabolism slows, primary source of glucose become hepatic glycogenolysis
- Depletion of hepatic glycogen stores leads to hepatic gluconeogenesis & lipolysis
- Subsequent fatty acid beta oxidation & ketogenesis becoming the main energy sources
- Associations with insulin resistance independent factor for development of postoperative complications & increasing length of hospital stay

Fluid requirements in well, normal children		
Body weight	**Fluid requirement per day (ml/kg)**	**Fluid requirement per hour (ml/kg)**
First 10kg	100	4
Second 10kg	50	2
Subsequent kilograms	20	1

Case 2

6 year old, previous weight 22kg is booked for an appendicectomy. She has been vomiting for 24 hours and is nil by mouth. On taking the history you ascertain that the patient has been unwell for a week unable to eat and drink. The nurses on the ward have weighed the patient and she is now 20 kg.

Questions

- How would you assess this patient for evidence of dehydration or shock?
- You decide that the patient is dehydrated, what would your fluid regimen be for this patient?
- What would your choice of fluid be?
- If the patient was shocked secondary to hypovolaemia how much fluid would you administer?

Signs & symptoms of dehydration & shock

Dehydration

- Appears unwell
- HR - normal or raised
- RR - normal or raised
- Normal pulses
- Normal BP
- Reduced skin turgor
- Reduced urine output
- Sunken eyes
- Depressed fontanelle
- Dry mucous membranes

Shock

- Pale, lethargic, mottled
- HR - raised
- RR - raised
- Weak pulses
- Hypotension
- Decreased urine output
- Altered consciousness
- Cold extremities

Dehydration & Shock

- As a guide a child with dehydration with no signs of shock can be assumed to be 5% dehydrated
- If shock has occurred then 10% dehydration has occurred
- Treatment of shock requires rapid replacement of intravascular volume
- Treatment of dehydration requires gradual replacement of fluids with an electrolyte content that relates to electrolyte losses

Assessment & monitoring

- Can the patient meet their fluid and or electrolytes enterally?
- Use body weight to calculate IV fluid & electrolyte needs
- Is the child at risk of hypoglycaemia?
- Look for signs of clinical dehydration and hypovolaemic shock

Fluid regimen for dehydration

- Weight is the best clinically objective measure of total body fluid changes
- Measure weight loss or percentage dehydration:
  - **5% dehydration = loss of 5ml of fluid per 100g body weight, or 50ml/kg**
  - **10% dehydration = loss of 10ml of fluid per 100g body weight, or 100ml/kg**
- Administer the calculated daily maintenance fluids in addition to the calculated replacement fluids over a 24 hour period
- Monitor therapy at 3-4 hourly intervals using weight as an objective measure
- If oral rehydration is possible this should be the preferred route

Routine Maintenance

- In neonates:
  - Day 1 50-60mls/kg/day
  - Day 2 70-80mls/kg/day
  - Day 3 80-100mls/kg/day
  - Day 4 100-120mls/kg/day
  - Day 5-28 120-150mls/kg/day
  - Use isotonic crystalloids with 5-10% glucose

- In children:
  - Calculate routine maintenance using the Holliday-Segar formula
  - Use isotonic crystalloid with fluid in range of 131-154mmol/litre

Estimated fluid therapy for patient

- Calculated 10% dehydrated
- Estimated fluid therapy over next 24 hours:
  - 100mls/kg for 10% dehydration = 100 x 20 = 2000mls
  - 4:2:1 = 60mls/hr x 24 = 1440mls/day
  - Rehydration + maintenance = 3440mls
  - Infusion to commence at 3440/24 = 143mls/hr

Management of hypovolaemic shock

- Rapid administration of glucose free crystalloid solution
- Contain sodium in the range of 131-154mmol/litre
- 10-20mls/kg < 10 minutes in neonates
- 20mls/kg < 10 minutes (children/young people)
- Reassess after bolus given
- Repeated if there is inadequate response
- Seek expert advice if 40-60ml/kg or more is needed in initial resuscitation (PICU)
- Once shock has been adequately treated, attention can turn to management of hydration

Commonly available crystalloid solutions

Fluid	Na^+	K^+	Cl^-	Energy (kcal/l)	Other
0.9% NaCl	150	0	150	0	0
0.45% NaCl 5% dextrose	75	0	75	200	0
Hartmann's solution	131	5	111	0	Lactate
5% dextrose	0	0	0	200	0
10% dextrose	0	0	0	400	0

Case 3

You are asked to see a 14 year old male presenting to the emergency department with acute kidney injury following a 1 week history of diarrhoea and vomiting. He is diagnosed with gastroenteritis. On examination his creatinine is 112, urea is 15, K^+ 2.5, Na 149. On examination, he is pale, HR 145bpm, BP 75/35, delayed capillary refill and has cool peripheries. His GCS is currently 15.

Questions

- What would your initial fluid management for this patient be?
- What are the principles for treating this patient's hypernatraemia?
- How would you treat the hypokalaemia?

Initial fluid management

- This patient is shocked
- 20mls/kg over less 10 minutes of an isotonic solution repeated as necessary
- Once initially treated estimate required fluid therapy over the next 24 hours (replacement + maintenance)

Principles in managing hyponatraemia

1. Treat shock first
2. Calculate the maintenance fluid and estimate the fluid deficit carefully
3. Aim to lower the sodium at a rate no more than 0.5mmol/h
4. Check other electrolyte levels such as calcium and glucose
5. Monitor electrolytes frequently (4-6 hours in 1st 24 hours)
6. Assess hydration and weigh frequently

Treatment of hypokalaemia

- Rarely an emergency
- Oral administration is preferred route
- Where this is not possible IV administration
- Solutions should not exceed 40mmol/L
- If higher concentrations used require central access and cardiac monitoring

Summary

- Increasing evidence that preoperative fasting is not desirable let alone advantageous
- Good evidence that gastric emptying occurs well within the 2 hour guidance
- Clinical assessment is important when calculating degree of fluid administration
- NICE guidance recommends the use of isotonic fluids containing sodium in the range of 131-154mmol/l