430 Surgery Team

Principles of fluid and electrolyte balance in surgical patients

CASES

Case 1:

- A 62 year old man is 2 days post-colectomy. He is euvolaemic, and is allowed to drink 500ml. His urine output is 63 ml/hour:
  How much IV fluid does he need today ?
  What type of IV fluid does he need ?

This man has normal total body water content (uvolaemic), and you aim is to maintain that.
A urine output of 63 ml / hr gives him a total daily urine loss of 1.5 litres. His insensible losses are likely to be 500 ml. He therefore needs a total fluid intake of 2 litres to balance his losses. He is only allowed to drink 500 ml.
He therefore needs 1.5 litres of fluid IV today.
As he is euvolaemic, this man does not need resuscitation, so he should only receive crystalloid. His losses will include water and electrolytes. Giving him just 5% dextrose will cause osmolality to fall and hyponatraemia to follow. Giving him just 0.9% saline will cause gradual hypernatraemia and hypertonicity.
This man needs a mixture of crystalloids. He is getting water orally which might help to offset the sodium load of saline. Even so, it is reasonable to use saline and dextrose in a 2:1 ratio; this proportion can be changed in response to changes in his clinical state and serum sodium.

Case 2:

- 3 days after her admission, a 43 year old woman with diabetic ketoacidosis has a blood pressure of 88/46 mmHg & pulse of 110 bpm. Her charts show that her urine output over the last 3 days was 26.5 litres, whilst her total intake was 18 litres:

1. How much fluid does she need to regain a normal BP ?
2. What fluids would you use ?

The hyperglycaemia of diabetic ketoacidosis causes glycosuria which results in an osmotic diuresis. This causes high losses of water and dehydration occurs if fluid balance is not attended to.
In this case, the lady has lost 26.5 litres of urine plus at least 1.5 litres insensible losses over the last 3 days; her input has been 18 litres. This equals a deficit of 10 litres, and it is not suprising that she appears to be hypovolaemic with hypotension and tachycardia.
Assuming that she was euvolaemic to start with, she needs to gain 10 litres in order to regain a normal BP.
As she has a low BP, we can assume that her blood volume is low, and that organ perfusion is at risk. She therefore needs to be resuscitated. The initial fluids to use would be colloid in order to normalise BP and pulse. There is no need to use only colloid; indeed, this would cause intravascular overload and heart failure.
After using perhaps 1 or 2 litres of colloid, her remaining fluids should be crystalloid. As she has lost mainly water, a large part of this should be dextrose, and serum [Na+] should be monitored in order to assess the need for IV saline.

Case 3:

- An 85 year old man receives IV fluids for 3 days following a stroke; he is not allowed to eat. He has ankle oedema and a JVP of +5 cms; his charts reveal a total input of 9 l and a urine output of 6 litres over these 3 days.

1. How much excess fluid does he carry ?
2. What would you do with his IV fluids ?

This man has become hypervolaemic with interstitial oedema and intravscular excess, becuase he has received 3 litres more fluid than he has passed out in his urine. Remember however that he loses 500 ml / day (and for 3 days which means it's 1.5L) insensible losses. His total fluid excess is therefore around 1.5 litres. Although he is not drinking, he is overloaded and his IV fluids should be stopped. After a day without IV fluids, he should be euvolaemic, and IV fluids can be recommenced at 2.5 litres a day without overloading him.

Case 4:

- 5 days after a liver transplant, a 48 year old man has a pyrexia of 40.8°C. His charts for the last 24 hours reveal:

input:	blood transfusion:	2 units (350 ml each)
	IV crystalloid:	2.5 litres
	oral fluids:	500 ml
Output:	urine output:	2.7 litres
	drain output:	525 ml
	nasogastric output:	1.475 litres

On examination he is tachycardic; his supine BP is OK, but you can't sit him up to check his erect BP. His serum [Na+] is 140 mmol/l.
How much IV fluid does he need ?
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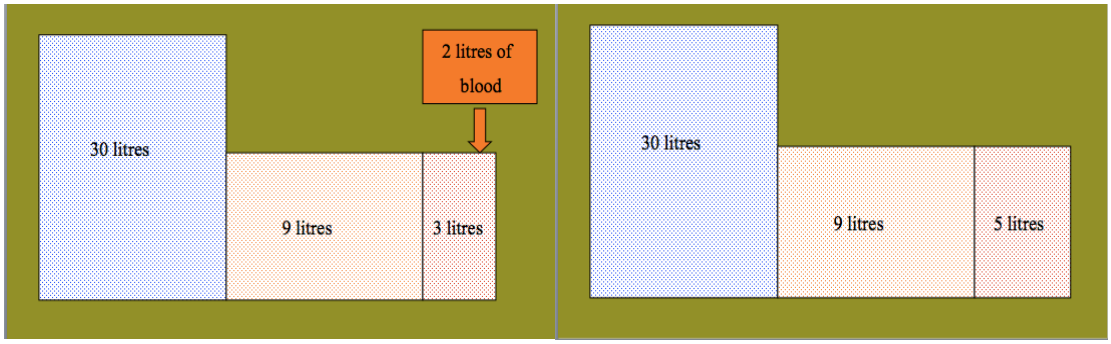
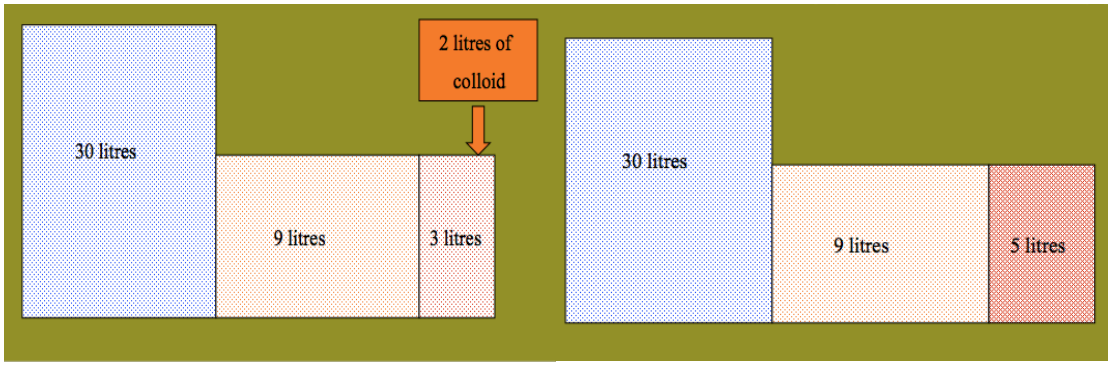
This is a bit more complex !
As is often the case with complex surgical patients, this man has multiple sources of fluid loss. In each case, urine, drain or tube, the fluid lost will be a mixture of fluid and solutes. Indeed, drain fluid will have electrolyte content very similar to plasma. His obvious losses (urine + drain + NG tube) total 4.7 litres.
His insensible losses are higher than normal because of his fever, and will be about 800 ml, giving a total loss of 5.5 litres.
His total intake was 3.7 litres, and he is therefore deficient by 1.8 litres.
Assuming that his total losses for this day are similar to those of the day before, he will need about 7.3 litres in order to become euvolaemic.

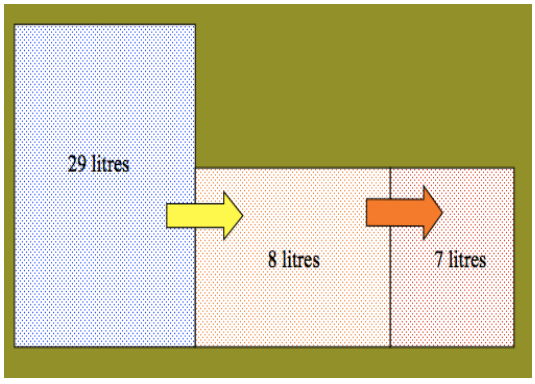
He will almost undoubtedly need a mixture of fluids. He will need colloid or further blood in order to fill the intravascular compartment and maintain organ perfusion. He will need saline to replace water and solute losses, and will need some dextrose in order to prevent hypernatraemia.

Crystalloids & colloids

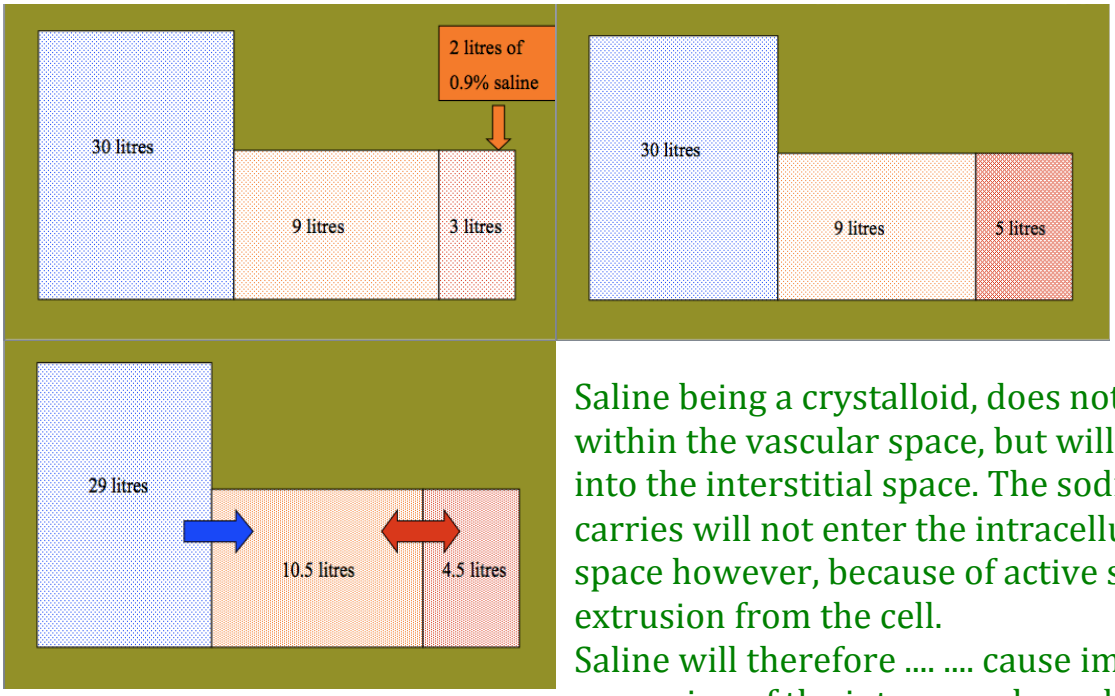


Giving 2 litres of blood to someone will expand their intravascular compartment by 2 litres. None of this fluid will escape across the blood vessel walls (in the short term at least) and the other compartments are unaffected.
This is the right treatment for blood loss.

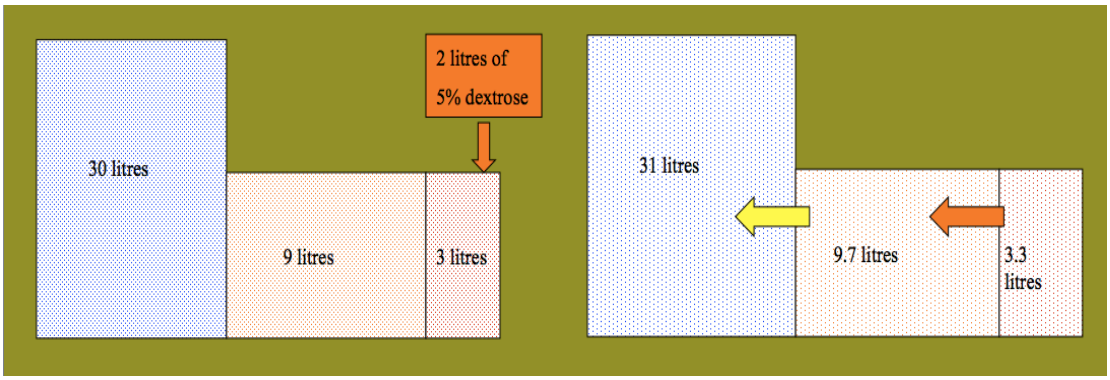




Giving colloid into the vascular space results in an immediate expansion of the intravscular compartment by 2 litres, as does blood. Colloid does not escape from the vascular space, but does increase oncotic pressure markedly .... causing water to be drawn into the vascular space from the interstitial and intracellular reservoirs. Giving colloid therefore not only expands the vascular space itself, but does so by moving water from other spaces.



Saline being a crystalloid, does not remain within the vascular space, but will diffuse into the interstitial space. The sodium it carries will not enter the intracellular space however, because of active sodium extrusion from the cell.
Saline will therefore .... cause immediate expansion of the intravsacular volume, followed by
.... equilibration between the vascular and interstitial spaces, the osmolality of which are equal, but are now slightly greater than that of the intracellular space, due to the increased sodium load. This results in water movement from the intracellular space in order to equalise osmolality throughout all three compartments.



5 Dextrose is isotonic to plasma. Giving 2 litres of 5% dextrose will cause the immediate expansion of the vascular compartment ....
.... but, as its glucose content is rapidly metabolised, the remaining water will distribute itself between all compartments and very little will remain within the blood space. For this simple reason, dextrose is not a fluid of resuscitation.