Management of Fluid Balance

The management of a patient's fluid balance is a key part of treatment. Nearly all patients admitted for critical care will have some form of fluid balance problem or be at significant risk of a fluid balance problem. Many patients may be unable to take a normal fluid intake as a consequence of their illness, while others may be suffering the consequences of fluid overload. It is, however, far more common for patients to be dehydrated and hypovolaemic than fluid-overloaded at the time of critical care admission. Therefore, nearly all patients will require intravenous fluid administration, at least until fluids and nutrition can be administered enterally.

Maintenance Fluid

If the gut works use it! In other words, establish enteral feeding as soon as practically possible. Patients will the receive their maintenance fluid requirements as part and parcel of their enteral feed. However, if this is not possible or until such time as it becomes possible, patients will require intravenous maintenance fluid. The appropriate choice of fluid type and rate of administration has been the subject of considerable debate over the years amongst the Critical Care consultants, senior nursing staff, pharmacists and dieticians.

The standard maintenance fluid for patients in adult Critical Care is Hartmann's solution. The rate of administration is such as to give the patient a total of 1 ml/kg/hour of fluid. Therefore, account needs to be taken of all fluids that the patient is receiving, including drugs and enteral feed. THIS IS A GUIDE ONLY. This, therefore, does not include fluid given during resuscitation and there will be many circumstances in which the rate of fluid administration may need to be altered and occasionally the type of fluid may need changing. For example, a patient with additional fluid losses from a pyrexia or abdominal drain losses will need to have this taken into account. There are, of course, many other situations that require additional fluid to be given as part of therapy – by definition, such fluids are not "maintenance" fluids.

Resuscitation fluids

The subject of resuscitation fluids remains controversial. The crystalloid-colloid debate still rages, and sub-debates about which crystalloid or which colloid should be used still continue. As for maintenance fluids, the consultant staff have spent a great deal of time in respect of fluid choice for resuscitation. The study "A Comparison of Albumin and Saline for Fluid Resuscitation in the Intensive Care Unit", published in the New England Journal of Medicine in May 2004, showed that the "traditional" volume equivalence of crystalloid to colloid appeared to be significantly less than previously quoted, at only 1.3:1. It is therefore possible to adequately fluid resuscitate patients without using colloids. Given that the cost of crystalloids is also considerably cheaper than for colloids, the rationale to use colloids for volume resuscitation has disappeared.

The standard resuscitation fluid for patients in adult Critical Care is Hartmann's solution.
Gelofusine or an equivalent gelatine-based colloid will remain available for use on consultant authority only. Hartmann's is preferred to 0.9% saline as it has a far greater lower risk of producing a hyperchloraemic metabolic acidosis and hypernatraemia.

Other fluids

Glucose (Dextrose) solutions are available in 5%, 10%, 20% and 50%. 5% glucose may be used to treat water deficit, e.g. hypernatraemia. The stronger solutions may be used to treat hypoglycaemia, e.g. acute liver failure or relative insulin overdose.
A solution of 4% glucose/0.18% saline (traditionally called "dextrose/saline") is also available. It may play a role in maintenance fluid therapy in patients who are not critically ill, but there is little (if any) indication for its use in Critical Care.
0.9% saline may occasionally be used as maintenance or resuscitation fluid, but is second choice to Hartmann's solution as discussed above.
5% saline may be used in the treatment of raised intracranial pressure. See the section of raised intracranial pressure for further information
Mannitol 20% may also be used to treat a raised intracranial pressure. See the section of raised intracranial pressure for further information
Sodium bicarbonate is available in 1.4%, 4.2% and 8.4% strengths. The 1.4% solution may be given peripherally, the others should be administered through a central venous catheter. Mainly used for treating metabolic acidosis, particularly hyperchloraemic or to buy some time in a renal metabolic acidosis. Generally best avoided when possible.
Phosphates may be given to treat significant hypophosphataemia if the enteral route is unavailable. Caution because of high potassium content and very high sodium content.
Albumin solutions are used following drainage of ascites in patients with cirrhosis (20% solution, "salt-poor" albumin) or as part of a plasma exchange recipe (4.5%)
Potassium chloride is commonly pre-mixed into saline and dextrose solutions. It may be necessary to add additional potassium to these fluids or to Hartmann's solution to prevent or treat hypokalaemia. If the patient has a central venous catheter, potassium chloride may be given by diluting 20 ml of potassium chloride (40 mmol) into 100ml of 0.9% saline or 5% glucose and infusing over 1 hour with ECG monitoring. Patients fed enterally may have 40 mmol of potassium chloride added to each 500ml bottle of feed.

A summary of the electrolyte contents of fluids is given in the table below:-

FLUID	Sodium mEq/l	Potassium mEq/l	Chloride mEq/l	Lactate mEq/l	Bicarbonate mEq/l	Osmolarity mOsm/l
Hartmann's	131	4	110	27		275
Sodium chloride 0.9%	154		154			308
5% dextrose						278
NaHCO3 4.2%	500				500	1000

NaHCO3 8.4%	1000				1000	2000
Gelofusine	154		120			
5% Human Albumin	140		140			308
20% Human Albumin	140		140			1500

Fluid output.

In order to assess fluid balance we need to measure what comes out of the patient as well as what goes in. Unfortunately, it is difficult in routine clinical practice to measure a number of sources of fluid loss, such as sweat and faeces – insensible losses. You therefore need to allow for this in patient assessment and prescribe fluids accordingly.

What can be easily measured are fluid losses such as from surgical drains and of course the biggest source of fluid loss for most patients is urine. All critically ill patients should have their urine output assessed by a urinary catheter with hourly measurements unless known to have chronic renal failure with little or no native urine output. Urinary catheters should be inserted and cared for in accordance with the Urinary Catheter Care Bundle (hyperlink).

One of the commonest problems encountered in critically ill patients is oliguria, defined as a urine output of less than 0.5 ml/kg/hour for two consecutive hours. It is a normal defence mechanism of the body to attempt to conserve fluid and sodium in the face of a low circulating blood volume by activation of the rennin-angiotensin-aldosterone system. The result is that the patient will pass small volumes of concentrated urine. Oliguria therefore represents an appropriate response to relative fluid depletion. The correct treatment is therefore fluid resuscitation until happy that the patient is no longer volume-depleted. DO NOT GIVE DIURETICS – you will only make the situation worse.

Judging the adequacy of fluid input can be difficult, particularly during a resuscitation process. Traditional clinical examination (skin turgor, mucous membranes, jugular venous pressure) is generally unreliable, although it may still be useful as part of patient assessment to assess capillary refill time (should be 2 seconds or less). As explained in the section on cardiovascular system management, CVP is also of limited value. Surrogate markers of the adequacy of resuscitation may be of some help, for example lactate. PiCCO and LiDCO systems enable cardiac output monitoring and stroke volume variation (only useful in ventilated patients in sinus rhythm). PiCCO also allows measurement of ITBVI. However, the most useful indicator is the urine output. The kidneys normally receive 25% of the cardiac output – healthy kidneys are therefore able to compensate for significant changes in fluid, electrolyte and acid-base status over a relatively short time-scale. Typically, urine output is 1 – 2 ml/kg/hr. The minimum acceptable urine output is 0.5 ml/kg/hr - less than this is classed as oliguria. An adequately fluid-resuscitated patient should pass at least 1 ml/kg/hr of urine unless

there is another reason not to do so, such as low blood pressure despite fluid, established renal failure, obstructive uropathy.

Fluid Balance

Ideally, once resuscitated the patient's daily fluid balance should be around zero. Of course, we cannot measure insensible losses, so it is not unreasonable to see patients with a small positive fluid balance to allow for this. Most patients admitted to critical care will develop a positive fluid balance during the initial phase of their illness as they usually receive a large quantity of resuscitation fluid, particularly those with sepsis or other inflammatory process. It is not uncommon for patients in such situations to develop oedema, both peripheral and pulmonary. As the patient's condition stabilises and improves, there is usually a transition from a positive to a negative fluid balance, commonly recognised by the development of a spontaneous diuresis. Failure to progress to this stage is usually associated with a poor outcome.