

Fluid Management in Critical Care

Aim To provide guidance on fluid maintenance and resuscitation in Critical Care

Scope All adult patients in Critical Care

Assess fluid status and requirements

Hydration & total body water

- History and thirst
- Drug and fluid charts
- Weight, oedema & clinical status
- Evidence of continuing losses

Vascular volume status

- CVS clinical parameters
- Arterial trace, cardiac output & echo
- Fluid challenge or leg-raise test
- Na, Cl, K, Lactate, Hb, Venous Sats, Urinary Na

Maintenance (hydration) fluid

Standard maintenance for Critical Care is
4% Glucose + 0.18% NaCl
+/- 20-40 mmol⁻¹ KCl

1. Set target total fluid intake

<50kg	1500ml/day
50-80kg	2000ml/day
>80kg	2500ml/day

2. Subtract other intake

- Drug fluids (including diabetes infusions)
- Nutritional fluids
- Oral fluid intake

3. Give residual free water requirement as continuous infusion over 24 hours

Resuscitation (replacement) fluid

Standard resuscitation fluid for Critical Care is Hartmann's Solution

Give Hartmann's as bolus (eg 250ml) or short infusion to replace:

- Existing hypovolaemia
- Gut: diarrhoea or fistula losses
- Renal: excess losses
- Skin: excess insensible loss from sweat
- Inflammation: capillary leak

Special Circumstances

- Give blood when Hb below threshold
- Give blood & products when major bleed (massive transfusion guideline)

Consider different fluids in:

- Brain injury
- Diabetes and DKA
- Renal impairment
- Abnormal sodium states
- Malnourished, elderly or low-body weight patients

Reassess based on end-points

- Even fluid balance
- Adequate hydration
- Minimal symptoms of thirst

Reassess based on end-points

- Euvolaemia
- Optimised preload and cardiac output
- Clearance of lactate

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Management of Oliguria

Normal urine output is ≥ 30 ml/hr or 0.3 ml/kg/hr

Assess whether oliguria is pathological or physiological

Consider:

- previous fluid balance
- input of nutrition, drugs and free water
- current vascular volume and cellular hydration
- urine osmolality and sodium

Ensure catheter is not blocked – consider flushing or ultrasound scan

Pre-Renal Failure (hypovolaemia)

Consider:

- fluid challenge eg. Hartmann's 250ml

Acute Renal Failure

Consider:

- fluid restriction
- haemofiltration

Obstructive Uropathy

Consider:

- ultrasound to confirm diagnosis
- catheter change
- percutaneous drainage

Physiological Fluid Retention

eg. postoperative stress response:

- observation only
- resuscitation fluids are not required

Before giving a fluid bolus consider:

1. What is the indication?
2. What is today's fluid balance target?
3. What is the goal of this fluid bolus?
4. What physiological end-point am I targeting?

Explanatory Notes

The stress response of illness and surgery

- Sick patients and perioperative patients and have a **stress response** which involves hormonal changes to maintain vascular volume.
- Water and sodium are retained and hence urine output is modest or low.
- The ability to efficiently eliminate fluids and sodium is impaired so fluid is retained, producing weight gain and oedema.
- The **oliguric** of the perioperative patient is thus physiological and not pathological. Oliguria cannot be used (*by itself*) as an indicator of hypovolaemia.

Water and hydration

- We do not normally add salt to our tea and coffee or orange juice – so it is not logical to use high salt content solutions (saline or Hartmann's solutions) for normal fluid **maintenance**.
- Usual water needs should be met with (1) water or (2) low sodium fluids e.g, dextrose or dextrose 4% and 0.18% saline (dextrose-saline) or (3) modest nutrition fluid enterally.
- Enteral (tube) feeds contain a normal proportion of sodium and potassium, pro rata.
- Because of the stress (fluid retaining) response, the required fluid maintenance is actually less than normal. It is noteworthy that in paediatric practice this means prescribing 75% of normal fluid requirements in the perioperative period.

Excess free water

- Too much free water, in the face of a fluid (water) retaining milieu, may lead to water intoxication and **hyponatraemia**.
- Patients should not receive more than 2500 ml of water or low sodium solutions daily unless there is good reason – such as hypernatraemic dehydration.

Patient-controlled-oral-fluids

- Patients should resume normal oral fluids and nutrition as soon as reasonably practicable after an illness. *Drips should only be used if this is not possible.*
- Patients do not need full IV maintenance fluids (at target fluid intake) in addition to a full diet of 3 square meals and 3 litres of tea, coffee, orange juice!

Fluid losses

- Excess losses of blood, raw surface ooze, bowel fluids, fistulae etc are losses (or temporary sequestration) of fluid *and electrolytes*. These fluids have high concentration of electrolytes, often similar to plasma values, i.e. tending towards sodium 140 mmol/l and chloride 95-100 mmol/l.
- If such losses are significant, these should be replaced with a balanced solution of electrolytes of similar composition, high in sodium. **Hartmann's solution** has comparable electrolyte composition and is the preferred crystalloid.
- Colloids should be avoided.
- Though the sodium of normal saline is only 10% above the 140 mmol/l of plasma, the chloride content is 50% above the normal plasma value, hence saline solutions deliver a chloride load. This is unnecessary, may influence renal electrolyte handling, causes hyperchloraemia and a hyperchloraemic acidosis. Even in health our ability to eliminate a saline load is much slower than the elimination of a similar volume of water (or beer!) and in sick or perioperative patients it is vastly prolonged.
- Two litres of saline administered to a normal person, causes some nausea and abdominal pain as well as the above hyperchloraemic problems. However, saline can be used for gastric fluid losses and may have roles in dysnatraemic states and head injury management.

Lean body mass

The water content and water turnover of adipose tissue is low and thus an obese patient does not require a proportionate increase in normal water needs. So we should work on **lean body mass**, not absolute mass. However, since this is complicated and it is simpler to categorise patients into small, medium and large patients.

Baseline fluid requirements

Target Fluid Intake = baseline water needs = hydration fluid, maintenance (water) =

Small person	<50 kg	≈ 1500 ml/24 hrs	= max 60 ml/hr*
Average person	50-80 kg	≈ 2000 ml/24 hrs	= max 80 ml/hr*
Large person	>80 kg	≈ 2500 ml/24 hrs	= max 100 ml/hr*

*These represent max fluid infusion rates if IV fluids are the only fluid intake of the patient.

Subtract from Target Fluid Intake:

1. Drug fluids
 - fluids necessarily used for drug administration
 - including fluids for diabetes management
2. Nutritional fluid intake
 - enteral feed, oral sip feeds, TPN volume
3. Drinks

This leaves the residual fluid needed to reach the Target Fluid Intake
= fluid given over 24 hrs
= infusion rate/hr

$$\text{Target fluid Intake} \\ = \text{Drug fluids} + \text{Nutritional fluids} + \text{Drinks} + \text{Residual Maintenance}$$

Hence

$$\text{Residual Maintenance Fluid Infusion rate} \\ = \text{Target Fluid Intake} - \text{Drug fluids} - \text{Nutritional fluids} - \text{Drinks}$$

Deficits and continuing losses

Existing deficit

Replacement = high sodium content fluids, Hartmann's

Continuing losses

Replacement = high sodium content fluids, Hartmann's

Electrolyte content of various body fluids can be found in the table in the GIFTASUP document and textbooks. To evaluate the net losses, it may be simpler to measure the total volumes lost and measure the sodium and potassium content of an aliquot of the fluids lost. Measure the U&Es of sick, complex patients, regularly.

Urine output requires:

Pressure – blood pressure

- Hypotensive patients do not pass urine normally
- Hypotension associated with an epidural; if a modest fluid bolus does not solve the hypotension, a vasopressor infusion may be needed on SHCU or Critical Care.
- Do not let patients remain hypotensive, especially elderly and vascular patients

Volume – adequate preload and hydration

- A dry man in the desert does not pass much urine - he is as dry as a chip!

Flow – adequate cardiac output and organ perfusion

- Low cardiac output states, e.g. cardiogenic shock (after an acute coronary syndrome) or pulmonary embolism will impair urine output.

And may be influenced by:

- Abdominal compartment syndrome – high abdominal pressure will impair urine production.
- Hormonal milieu: anti-diuretic and sodium conserving mineralocorticoid influences, reduce urine output e.g. perioperative stress response
- Obstructive uropathy
- Intrinsic renal failure – stop nephrotoxins especially NSAIs, aminoglycosides

Dehydration versus hypovolaemia

There is a difference between hypovolaemia and dehydration:

Hypovolaemia - a well patient who bleeds acutely:

- Becomes hypovolaemic but his cells are *initially* well (normally) hydrated.
- He has lost blood and needs vascular volume replenishing with a high sodium containing fluid Hartmann's or blood (when blood loss is significant and Hb has fallen)
- He needs normal water requirements, 60-100 ml/hr, 1500-2500 ml/day by an appropriate route, initially.

Dehydration - by the end of a very hot day, a person may be very thirsty:

- And is dehydrated, with cells depleted of water
- The physiological response is to try to maintain vascular volume, which is thus only mildly reduced (relatively euvolaemic). The cells are very dehydrated.
- Needs are for orange juice or water, not normal saline