University Hospitals of Derby and Burton NHS Foundation Trust

Fluids - Intravenous Postoperative - SDU - Full Clinical Guideline

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Contents

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Version 3 Dec 2023 Dr Paul Marval

Summary

Prescribe maintenance fluids;

- At a rate of 1.0 - 1.5ml kg^{-1} hr^{-1} alternating 1l bags of Hartmann's solution with 4% Glucose/0.18% NaCl with 20 or 40 mmol KCl L^{-1} up to max 100mls/hr,
- In hypokalaemic patients ($K^+ \leq 3.5$ mmol L^{-1}), use 4% Glucose/0.18% NaCl with 20 or 40 mmol KCl L^{-1}
- It is rarely necessary to prescribe more than 100ml hr^{-1} of maintenance fluid (NICE CG 174) even in obese subjects (BMI ≥35)
- Use 0.9% NaCl with 20 or 40 mmol KCl L^{-1} when plasma sodium ≤ 130 mmol L^{-1} AND plasma potassium ≤ 3.5 mmol L^{-1}

Manage oliguria (< 0.5ml kg^{-1} hr^{-1}) with;

- 250ml bolus of Hartmann's solution given over 10-15 minutes, repeated PRN
- Do not use furosemide to treat oliguria in postoperative surgical patients even if there is a positive fluid balance
- Do not manage oliguria by simply increasing the hourly rate of infusion. Omitting fluid boluses is a strategy that is unacceptable on SDU as it may result in organ damage

Replace fluid losses with;

- Hartmann's solution for most fluid losses
- 0.9% NaCl with 20 or 40 mmol L^{-1} KCl for losses from nasogastric drainage or vomiting

Transfuse packed red cells when;

- Hb concentration < 70 g L^{-1} or when there is ongoing bleeding with Hb ≤ 100 g L^{-1}
- To maintain Hb between 70 – 90 g L^{-1} in patients who are critically ill or undergoing surgery
- In patients with ischaemic heart disease it ***may*** be safer to maintain Hb between 90 – 100 g L^{-1}

Vasoconstrictor solutions may be required;

- In patients receiving epidural analgesia once hypovolaemia is excluded
- In septic patients awaiting transfer to ICU

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Aim and Scope

These guidelines aim to produce information which will guide the rational prescription of intravenous fluids to adult patients (≥ 16 years-old) in the postoperative period in order to limit the complications of this vital therapy. This document has been modified to reflect NICE guideline 174 published December 2013.

1. Introduction

Intravenous fluid therapy is often misunderstood and poor practice can be a cause of postoperative morbidity. The consequences of poor management include;

- hypovolaemia with inadequate tissue perfusion
- fluid overload resulting in cardiac and respiratory morbidity, excess oedema and poor healing
- electrolyte / acid-base disturbances

It is recognized that 0.9% NaCl solutions can induce a state of hyperchloraemic acidosis when used inappropriately and this solution is colloquially known as “abnormal saline”. It has been shown that use of this fluid in the critically ill results in a higher requirement for renal replacement therapy (RRT). It is not yet known whether such acidosis and the need for RRT adversely affects mortality or outcomes, however it is reasonable to avoid acidaemia where possible.

It is also recognized that central venous pressure measurements are of limited utility in determining volume status and fluid administration and will not be considered in this document.

This document reflects the national consensus opinion on fluid management as outlined in “Intravenous fluid therapy in adults in hospital” and published as NICE CG 174 in December 2013. http://pathways.nice.org.uk/pathways/intravenous-fluid-therapy-in-adults-in-hospital#content=view-index

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2. The postoperative patient

The anaesthetist endeavours to replace all pre-operative deficits and intraoperative losses by the end of surgery and ensures that adequate urine volumes are flowing. In other words the patient is 'in balance' at this time.

However the body has primitive responses to stimuli such as trauma, sepsis and surgery and especially to any associated pain. These are known collectively as the “stress response” and involve the activation of pro-coagulant mechanisms, and numerous neuro-hormonal axes which alter catabolism and fluid homeostasis. As a consequence, prescribing intravenous fluid for the postoperative patient differs in several ways from prescribing for a patient who cannot eat or drink.

For a surgical patient the magnitude of the stress response is proportional to the magnitude of the surgical insult. The list below shows the severity and duration of the response generated by the surgical sub-specialties in descending order;

- cardiac surgery involving cardiopulmonary bypass
- thoracotomy
- upper abdominal surgery
- loin surgery
- lower abdominal surgery

The stress response usually lasts between 48 - 72 hours but may be vary depending on the type of surgery and any complications that result.

The purpose of this primitive response is to enable the injured organism to survive by utilizing its own protein as fuel and by conserving fluids. In the postoperative period this will result in changes listed below.

Increased Hormone Level	*Change*
Epinephrine & Norepinephrine	*"Fright & Flight" response* *increased sympathetic activity* *Increased gluconeogenesis* *Mobilization of fatty acids* *Release of adreno-cortical hormones*
Anti-diuretic Hormone (ADH) ***Renin-Angiotensin-Aldosterone***	*Water and Sodium retention &* *Potassium excretion*

In the postoperative patient the "inflammatory response" to surgery also produces an effect on fluid balance. The magnitude of this response is similarly dependent on the type of surgery and the amount of tissue handling that occurs. Fluid leaks out of traumatized capillaries and accumulates in the interstitium as the "third space" loss. The composition of this 'lost' fluid is similar to that of plasma, and may contain protein depending on the degree of capillary 'leakiness'. This loss may amount to an extra litre or more per day in the early postoperative period and must be taken into account when fluids are prescribed.

As a consequence of the stress and inflammatory responses, it is usual for the postoperative patient to develop a positive fluid balance and exhibit oedema in dependent parts of the body. It must be remembered that this excess fluid is not in the intravascular compartment and that additional fluid may still be required to ensure adequate blood volume and tissue perfusion.

The stress and inflammatory responses subside as healing begins to take place. The extra fluid which has accumulated in the tissues is returned to the circulation as capillary homeostatic mechanisms normalize. This results in an increased urine output and therefore a negative fluid

balance, approximately 3 - 5 days postoperatively. Such a negative balance should not result in increased fluid prescription unless cardiovascular instability occurs. Normally it is an excellent clinical sign that the patient is beginning to get well. ***Back to contents***

3. Prescribing for the postoperative patient

Postoperative prescribing must take into account maintenance fluids and on-going losses. The goal of postoperative fluid therapy is to provide appropriate fluid and electrolytes for the patient's needs. Inappropriate management may result in (a) hypovolaemia with inadequate tissue perfusion, (b) hypervolaemia with consequent cardiorespiratory embarrassment, excessive oedema, poor wound healing, or (c) electrolyte imbalance. Ultimately the best approach is to re-establish oral fluid intake as soon as is feasible. Thirsty can be a poor sign of hypovolaemia in a post-operative pt. Excess IV sodium administration can cause the patient to be hyperosmotic, which stimulates thirst. This is despite pts being euvolaemic. Use low IV sodium containing fluids in this circumstance. ***Back to contents***

3.1 Maintenance fluids

Patients require;

- Water – 1.0 - 1.5ml kg^{-1} $hour^{-1}$
- Sodium - 1-2 mmol kg^{-1} day^{-1}
- Potassium - 1-2 mmol kg^{-1} day^{-1}

These figures relate to lean body mass rather than actual body mass. It is rarely necessary to prescribe > 100 ml hr^{-1} of intravenous maintenance fluid (NICE guidance CG 174). Care must be taken that excessive fluid volumes are not prescribed to the obese using the formula above. Additional fluid can always be given as boluses where oliguria is observed. An ideal body mass can be calculated by re-arranging the BMI equation: Ideal Body Mass = 25 x height in $metres^2$. A more sophisticated weight can be input into fluid and drug requirement calculations as Input Weight = Ideal + 0.4 x (Actual-Ideal).

NICE recently suggested that an appropriate maintenance fluid for adult patients is 4% Glucose/0.18% NaCl with KCl additives. However experience on the SDU has demonstrated that this regime is attended by an unacceptable incidence of hyponatraemia.

Therefore a suitable maintenance regimen for a 70 kg patient is as follows;

- ✓ Hartmann's solution @ 70ml hr^{-1} alternating 1L bags with 70ml hr^{-1} Glucose/0.18% NaCl with KCl additives

The daily prescription should be for two or three 1 litre bags to ensure continuous fluid for the day.

It must be remembered that Hartmann's solution contains only 5 mmol KCl L^{-1} and that hypokalaemia may result unless additional supplements are given orally (which is preferred when practicable) or intravenously. If the patient's plasma potassium is less than 3.5 mmol L^{-1} it is reasonable to substitute one or two litre bags of 4% Glucose/0.18% NaCl with 20 or 40 mmol L^{-1}

KCl for Hartmann's solution. If the patient's plasma sodium is less than 130 mmol L^{-1} it is appropriate to substitute 0.9% saline for Hartmann's solution. Use 0.9% saline with 20 or 40 mmol KCl L^{-1} when plasma sodium ≤ 130 mmol L^{-1} AND plasma potassium ≤ 3.5 mmol L^{-1}.

Historically potassium replacement was omitted for the first 24 hours postoperatively on the assumption that tissue breakdown would release potassium into the plasma. However it is better to administer potassium orally or intravenously at the lower daily rate and make adjustments guided by serum measurements than to let the patient become significantly hypokalaemic.

After some operations fluid overload is thought to be particularly deleterious e.g. thoracotomy and it is prudent to restrict maintenance fluids to 1 litre per day (≈ 42ml hr^{-1}).

The surgical patient has increased sodium losses in the postoperative period to drainage and the third space. However these are usually replenished by the sodium-containing fluids given to manage any associated oliguria (see below) and during antibiotic / drug administration. It is rarely necessary (and usually undesirable) to prescribe 0.9% NaCl as maintenance fluid. ***Back to contents***

3.2 Replacement of on-going losses

Fluid prescription needs to replace on-going losses in addition to maintenance fluid volumes. Replacement should be with an IV solution of comparable composition to the fluid lost. It should be remembered that some GI drainage losses impart an acid-base disturbance on the patient, and that arterial / venous blood gas analysis will be required to confirm appropriate replacement.

Loss	*Replacement*
Third space loss	*Hartmann's solution*
Nasogastric tube	***0.9% NaCl with 20/40 mmol L^{-1} KCl***
T-tube	*Hartmann's solution*
Ileostomy	*Hartmann's solution*
Fistulae	*Hartmann's solution*
Diarrhoea	*Hartmann's solution*
Drains	*Hartmann's solution*

If losses are large, replacement will be required on a 4 hourly basis rather than waiting for a 24 hour total to be determined. For example, if a patient has lost 1 litre of nasogastric drainage in the previous four hours, this should be replaced at 250ml per hour of 0.9% NaCl with KCl over the next four hours.

Concealed losses are much more difficult to measure than external losses. Clinical signs of intravascular volume, a rise in heart rate and a decrease in blood pressure and urine output may follow. ***Back to contents***

3.3 Blood Loss (see section 5)

- In general, blood loss must be replaced with packed cell units when Hb < 70 g L^{-1}
- If ongoing blood loss is suspected it is appropriate to transfuse at Hb < 100 g L^{-1}
- Maintain Hb between 7.0 – 9.0 g dL^{-1} in patients who are critically ill or undergoing surgery
- For those with evidence of ischaemic heart disease it ***may*** be safer to maintain Hb between 9.0 – 10.0 g dL^{-1}
- A Hb concentration of ≤ 10.0 g dL^{-1} is appropriate for patients with free-flap tissue grafts

Before prescribing blood, consider the effect of dilution by previous fluid boluses when interpreting a low Hb concentration.

Diuretics are rarely required when administering blood products to a postoperative surgical patient. In fact it is usually necessary to give a colloid with the packed cells when replacing significant blood loss to ensure that the RBCs can "float" in the circulation.

The need for coagulation products and platelets should be guided by laboratory investigations and advice from a Haematologist. ***Back to contents***

3.4 Management of Oliguria

Treating oliguria with furosemide is the incorrect management in most postoperative surgical patients even when there is a positive fluid balance

Clinical signs of inadequate tissue perfusion are difficult to detect, and an adverse change in acid-base balance is a very late and often terminal sign. A urine output of less than 0.5ml kg^{-1} hr^{-1} is considered to be a useful surrogate indicator of inadequate tissue perfusion. Before actively managing oliguria it is important to exclude blockage of the urinary catheter by flushing the device with sterile water.

Managing oliguria by omitting the administration of fluid boluses and simply increasing the hourly rate of infusion is a strategy that could result in organ injury and is therefore unacceptable on SDU

The initial assessment of the oliguric patient should be in an A/B/C/D/E manner as per Acute Illness Management principles. Having established that A & B are satisfactory the possibilities for C are;

- ***Physiological effect of the "Stress Response" in a euvolaemic subject***
- ***Cardiac pump failure***
- ***Dilated vascular system (i.e. sepsis/Systemic Inflammatory Response Syndrome, "SIRS")***
- ***Empty vascular system***

When oliguria is secondary to the effect of the "Stress Response" in a euvolaemic subject it is reasonable to accept a lower urine output target e.g. 0.3ml kg^{-1} hr^{-1}. However this decision should only be made after discussion with the supervising consultant. When this discussion is not possible, continue to manage the patient as outlined below.

History and examination will help in determining which problem is most likely in an individual patient. Occasionally a CXR/ECG will be needed – do these on SDU.

Comparison of clinical features

Problem	*Capillary Refill*	*Systolic BP*	*Diastolic BP*	*Cold & Clammy*	*Peripheral Cyanosis & Mottled*	*Tachycardia*	*External Jugular Vein*
Pump failure	▼	▼	▲	*√*	*√*	*√ or X*	▲
Dilated System	▼	▼	▼	*X*	*X*	*√*	▼
Empty System	▼	▼	▲	*√*	*√*	*√*	▼

The effect of simple manoeuvres (such as placing the patient head-down or elevating the legs) upon HR/BP, heart sounds and RR can aid diagnosis;

- Cardiac pump failure – worsening SOB, ↑RR, additional heart sound
- Dilated vascular system – little or no effect on HR/BP/RR
- Empty vascular system – some improvement in HR/BP

➢ *Cardiac pump failure*

Sitting the patient up and giving sub-lingual GTN is an effective, rapid and controllable way of managing pulmonary oedema and preventing it becoming pink and frothing. Begin the MONA regime if myocardial ischaemia is confirmed by the history and 12 lead ECG. Cardiac pump failure will often require management on the HDU/ICU with CPAP and/or inotropes. Ask for help from senior colleagues.

- ***Dilated vascular system***

In sepsis and SIRS, the effective volume of the vascular system can become limitless and fluid challenges rarely help. It is vital to recognize this situation as early as possible and commence vasoconstrictors whilst awaiting admission to HDU/ICU for continued inotropic support. Ask for help from senior colleagues. Refer to **sepsis screening and management guidance** on the hospital intranet or SDU guidelines.

- ***Empty vascular system***

A decreased urine output due to relative hypovolaemia is a common occurrence early in the postoperative period and is managed by fluid challenges.

A fluid challenge with 250ml of Hartmann's solution given over 10-15 minutes may restore urine output. A colloid should be used in documented hypoalbuminaemia. If this challenge does not result in an adequate urine output, further boluses may be necessary up to a maximum of 2 litres. It is important to re-assess the patient after each bolus to ensure a diagnosis of pump failure has not been missed.

If urine output is still inadequate after two fluid challenges, further assessment is necessary. The question to ask is "where is the fluid going?" A surgical opinion +/- imaging may be required to determine if concealed haemorrhage or other complication has occurred. Continue with additional fluid challenges whilst waiting for this opinion and ensure the patient has had a 'Group and Save' sample sent to Haematology. ***Back to contents***

3.5 Patients receiving epidural analgesia

Maintenance fluids for these patients are prescribed according to the guidance above, but when managing oliguria further considerations must be taken into account. One side effect of epidural bupivacaine is hypotension secondary to reduction of endovascular tone resulting from blockade of sympathetic nerves. The effect is akin to mild sepsis/SIRS.

Patients with working epidural analgesia are often oliguric due to a mixture of hypovolaemia and vasodilatation resulting in hypotension but it can be difficult to decide the relative contribution of each, especially in patients who were treated for hypertension pre-operatively.

Start by noting the patient's mean arterial pressure (MAP) and compare it to the value recorded by the preoperative nurse (MAP=diastolic + (systolic-diastolic)／3).

Administer two 250ml boluses of Hartmann's solution over 10-15 minutes each, and note the MAP after the second bolus. Ensure that the patient has been properly examined to exclude a diagnosis of pump failure or concealed haemorrhage, and that a negative fluid balance has not been missed / miscalculated on the daily charts.

If the MAP after two boluses is either, (a) < 70mm Hg, or (b) < MAP noted at pre-operative clinic and oliguria persists, an infusion of phenylephrine or norepinephrine may be required (see SDU vasoconstrictor guidance). Discussion should take place with the consultant supervising SDU before starting a vasoconstrictor infusion for "epidural" hypotension.

Once MAP has satisfied either of the above criteria, continue fluid challenges as per "management of oliguria" above. ***Back to contents***

3.6 Nutrition

The composition of fluid used in enteral or parenteral nutrition is determined in consultation with the Nutrition Team and Pharmacist, but most regimes involve the administration of 2-2.5 litres of fluid per 24 hours.

It is important to remember that these regimes constitute the patient's maintenance fluid and that the volume of all other infusions must be reduced accordingly – see section 3.7. Commence oral administration of drugs once enteral feeding is established.

The aim should be to re-establish normal oral food intake as soon as feasible. ***Back to contents***

3.7 Other fluid sources

It is easy to overlook the volumes and composition of IV fluids given to patients in order to administer drugs – for example 400ml for QDS paracetamol.

Maintenance fluids should be prescribed after subtraction of the daily or hourly fluid load for IV drugs. Care must be taken with drugs that are solubilized in large volumes of 5% dextrose (e.g. amiodarone and vancomycin) and Hartmann's solution or 0.9% NaCl used to balance the total 24 hour prescription. ***Back to contents***

3.8 Insulin sliding scale therapy

Many diabetic patients are "nil by mouth" postoperatively and require management by insulin sliding scale irrespective of their normal therapy until oral feeding is possible.

Hospital protocol mandates the concurrent infusion of 4% Dextrose 0.18% NaCl with 20mmol KCl L^{-1} with insulin infusions. However with persistent hyperglycaemia Hartmann's solution may be more appropriate, with potassium monitoring. This must be considered when prescribing an overall fluid regime and careful observation for the development of hyponatraemia must be undertaken. ***Back to contents***

4. Electrolyte replacement

Please refer to the dedicated SDU "Managing Electrolyte Disturbances" guideline.

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5. *Composition of intravenous fluids*

Adapted from Anaesthesia UK website - http://www.frca.co.uk

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	Na	K	Ca	Cl	Other	pH	Osmolarity mosm L^{-1}	
Crystalloids								
0.9 % NaCl	154	-	-	154	-	5.0	308**	
4% Dextrose /0.18% saline	30	-	-	30	Dextrose 40 g	4.0	284**	
5% Dextrose	-	-	-	-	Dextrose 50 g	4.0	278**	
Hartmann's	131	5	2	111	Lactate 29	6.5	278	
Bicarbonate 8.4%	1000	-	-	-	HCO_3 1000	8		
Colloids								**COP mmHg**
Gelofusine	154	<0.4	<0.4	125	Gelatin 40 g	7.4	274	34
Voluven	154	-	-	154	Starch 60 g	4.0 - 5.5	310	31
Albumin 4.5%	<160	<2	-	136	Albumin 45 g	7.4	290	19

**Using KCl containing crystalloids increases osmolarity by approximately twice the concentration added (ie 40 or 80 mosm L^{-1})

Normal plasma colloid osmotic pressure (COP) ≈ 25 mmHg

Documentation Controls

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