

Supplementary materials

1. *The guidelines used in NHS Fife.* This is printed on a single double sided varnished sheet, 15 x 42 cm, that is folded into a booklet so that it can be read in a logical sequence. The outer cover is formed by the last two pages: The front is the title, and the back is the fluid challenge algorithm

2. *Additional patient data:*

- a) Study population details
- b) Incidence of AKI in patient groups, before and after guideline introduction.
- c) 30 day mortality by patient group

3. Copies of the *Prescription chart and the Intake and Output chart.* These are printed on two sides of a single sheet of paper.

Basic physiology of sick patients

It is easy to give an excess of salt and water but very difficult to remove them. Serum sodium may fall due to excess water load. Inadequate filling may lead to poor organ perfusion.

In sick patients with leaky capillaries fluid retention contributes to complications such as ileus, peripheral oedema, pressure sores, poor mobility, pulmonary oedema, poor wound healing and anastomotic breakdown.

Urine output naturally decreases during illness or after trauma such as surgery due to increased sodium retention by the kidney. Too much intravenous fluid makes this worse. Cellular dysfunction and potassium loss result. Excess chloride leads to renal vasoconstriction and increased sodium and water retention. **Urine output is a poor guide to fluid requirements in sick patients and oliguria does not always require fluid therapy (full assessment is required).**

Maintenance requirement: 30ml/kg/24hrs of 'water'

It is vital that sick patients receive **THE RIGHT AMOUNT OF THE RIGHT FLUID AT THE RIGHT TIME.**

Questions to ask before prescribing fluid:

1. Is my patient euvolaemic, hypovolaemic or hypervolaemic?
2. Does my patient need IV fluid? Why?
3. How much?
4. What type(s) of fluid does my patient need?

1. Assess the patient

Euvolaemic: veins are well filled, extremities are warm, blood pressure and heart rate are normal.

Hypovolaemic: Patient may have cool peripheries, respiratory rate > 20, systolic BP < 100 mmHg, NEWS \geq 5, HR > 90 bpm, postural hypotension, oliguria and confusion. History of fluid loss or low intake. May respond to 90° passive leg raise. Consider urinary catheter in sick patients. However signs of hypovolaemia may be unreliable in elderly patients.

Hypervolaemic: Patient is oedematous, may have inspiratory crackles, high JVP and history/charts showing fluid overload.

2. Does my patient need IV fluid?

NO: he may be drinking adequately, may be receiving adequate fluid via NG feed or TPN, or may be receiving large volumes with drugs or drug infusions or a combination..

Hypervolaemic: may need fluid restriction or gentle diuresis.

YES: not drinking, has lost, or is losing fluid.

ALLOW PATIENTS TO EAT AND DRINK IF POSSIBLE.

So WHY does the patient need IV fluid?

Maintenance fluid only – patient does not have excess losses above insensible loss/urine. If no other intake he needs approximately **30ml/kg/24hrs**. He may only need **part** of this if receiving other fluid. Patients having to fast for over 8 hours should be started on IV maintenance fluid.

Replacement of losses, either previous or current. If losses are predicted it is best to replace these later rather than give extra fluid in anticipation of losses which may not occur. This fluid is **in addition** to maintenance fluid. Check blood gases.

Resuscitation: The patient is hypovolaemic as a result of dehydration, blood loss or sepsis and requires urgent correction of intravascular depletion to correct the deficit.

3. How much fluid does my patient need?

- Obtain weight (estimate if required). **Maintenance fluid requirement approximately 30ml/kg/24hours.** (Table 1).
See note on next page regarding the elderly.
- Review recent U&Es, other electrolytes and Hb.
- Recent history – e.g. fasting, input/output, sepsis, operations, **fluid overload**. Check fluid balance charts. Calculate how much loss has to be replaced and work out which type of fluid has been lost: e.g. gastro-intestinal (GI) secretions, blood, inflammatory losses.

Note: urine does not need to be replaced unless excessive (diabetes insipidus, recovering renal failure). **Post-op:** high urine output may be due to excess fluid; low urine output is common and may be normal due to anti-diuretic hormone release.

Assess fully before giving extra fluid.

4. What type of fluid does my patient need?

MAINTENANCE FLUID

IV fluid should be given via volumetric pump

Always prescribe as ml/hr not 'x hourly' bags.

Never give maintenance fluids at more than 100ml/hour.

Do not 'speed up bags'; rather give replacement for losses.

Weight kg	Fluid Requirement in mls/24hrs	Rate in ml/hour
35-44	1200	50
45-54	1500	65
55-64	1800	75
65-74	2100	85
≥75	2400	100 (max)

Preferred maintenance fluids: 0.18% NaCl/4% Glucose with or without added KCl (40 mmol) in 1000ml. Use litre bags in preference to bags with 20mmol/500ml. This fluid **if given at the correct rate (Table 1)** provides all water and Na⁺/K⁺ requirements until the patient can eat and drink or be fed. Excess volumes of this fluid (or any fluid) may cause hyponatraemia.

IF SERUM SODIUM IS \leq 132mmol/l USE PL148 FOR MAINTENANCE.

For the frail elderly, patients with renal impairment or cardiac failure and patients who are malnourished or at risk of refeeding syndrome consider giving less fluid: 20-25ml/kg/day (NICE guidelines) Consult a senior doctor for fluid advice. If serum potassium is above 5mmol/l or rising quickly do not give extra potassium. Give Pabrinex IV if refeeding risk.

Diabetes: use 0.18% NaCl/4% Glucose/KCl with intravenous insulin at maintenance rates.

Electrolyte requirements

Sodium **1mmol/kg/24hrs**

Potassium **1 mmol/kg/24hrs (give 40mmolKCL/1000ml)**

Calories: 50-100g glucose in 24 hours to prevent starvation ketosis. Consult diettitian if patient is malnourished.

Magnesium, calcium and phosphate may fall in sick patients – monitor and replace as required.

REPLACEMENT FLUID

Fluid losses may be due to diarrhoea, vomiting, fistulae, drain output, bile leaks, high stoma output, ileus, blood loss, excess sweating or excess urine. Inflammatory losses ('redistribution') in the tissues are hard to quantify and are common in pancreatitis, sepsis, burns and abdominal emergencies. It is vital to replace high GI losses. Patients may otherwise develop severe metabolic derangement with acidosis or alkalosis and hypokalaemia. Hypochloraemia may occur with upper GI

losses. Check blood gases in these patients and request chloride with U&Es.

Hyponatraemia is common: in the absence of large GI losses, causes are too much fluid, SIADH or chronic diuretic use. Treatment of hyponatraemia is complex and requires senior input. A sodium of <125mmol/l is dangerous. 0.9%NaCl or fluid restriction are first line treatments and frequent U&Es are required. [See Hyponatraemia Guideline on Intranet.](#)

Potassium replacement:

A normal potassium level does not mean that there is no total body potassium deficit. Give potassium in maintenance fluid. Only in critical care areas give up to 40mmol in 100ml bags via a central line at 25-50ml/hr. Ensure IV cannulae are patent and clean. Potassium-containing fluids **must** be given via a pump. Give Kay-Cee-L/ Sando-K orally if possible.

Estimate replacement fluid/electrolyte requirements by adding up all the losses over the previous 24 hours and give this volume as PlasmaLyte 148 (PL148). Use 0.9% NaCl with KCl for upper GI or bile loss (high NaCl content). **Otherwise avoid it as it causes fluid retention.** Diarrhoea may lead to potassium loss. Plasma osmolality is approx 285-295mosm/l.

Fluid/Content/l	Na	K	Cl	Mg	Ca	Other	Dsm.
0.9%NaCl	154	0	154	0	0	0	308
0.18%NaCl 4%glucose +/-K	30	0	30	0	0	Gluc40g/l	284
0.45%NaCl 5%glucose	77	0	77	0	0	Gluc50g/l	406
Gelaspan	151	4	103	1	1	Acetate24	284
PlasmaLyte148(PL148)	140	5	98	1.5	0	Acetate27	297
5%glucose	0	0	0	0	0	Gluc50g/l	278

RESUSCITATION FLUID

For severe dehydration, sepsis or haemorrhage leading to hypovolaemia and hypotension. For urgent resuscitation use PlasmaLyte 148 (PL148). PL148 is a balanced electrolyte solution and is better handled by the body than 0.9%NaCl. Give Albumin only in severe sepsis.

[See Fluid Challenge Algorithm](#)

Priorities: Stop the bleeding: consider surgery/endoscopy. Use Major Haemorrhage Protocol. Treat sepsis.

CALL FOR HELP!

For severe **blood loss** initially PL148 until blood/clotting factors arrive. Consider gelatine use. Use O Negative blood for torrential bleeding. Severely **septic** patients with circulatory collapse may need inotropic support in a critical care area. Blood pressure may not respond to large volumes of fluid; **infact excessive volumes may be detrimental.**

IN SUMMARY: assess, why, how much, which fluid?

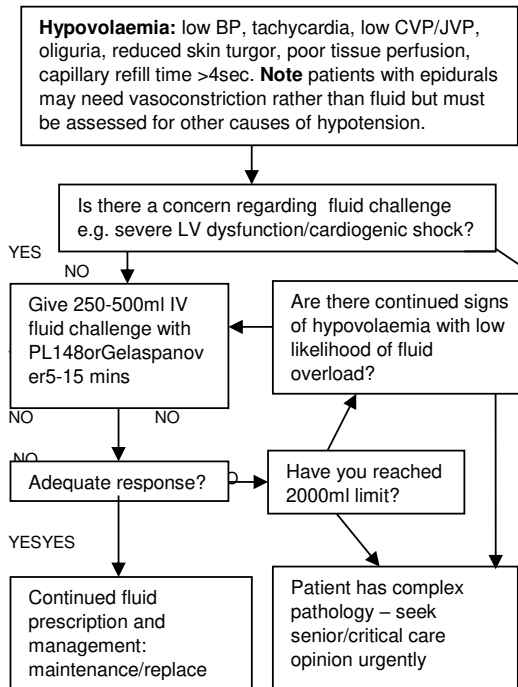
- **Take time and consult senior if you are unsure.**
- **Patients on IV fluids need regular blood tests.**
- **Patients should be allowed food and drink ASAP**

Consider Critical Care Referral if:

- GCS \leq 8 or falling from higher levels
- O₂ saturation < 90% on 60% O₂ or higher
- PaCO₂ > 7kPa unresponsive to NIV
- Persistent hypotension and/or oliguria unresponsive to 2000ml fluid or concern over cardiac function
- Metabolic acidosis: base deficit -8 or worse, bicarbonate < 18mmol/l, lactate > 3mmol/l and not improving in 2 hours
- Aggressive/agitated patients whose treatment (e.g. oxygen/IV therapy) is compromised due to agitation.

Referral is not always appropriate –consult senior doctor.

Fluid Challenge Algorithm



References: Southampton Fluid Guidance 2009
NICE Intravenous Therapy in Adults in Hospital, Guideline 174 Dec 2013



GUIDELINES FOR INTRAVENOUS FLUID AND ELECTROLYTE PRESCRIPTION IN ADULTS

Fluid prescriptions are very important. Prescribing the wrong type or amount of fluid can do serious harm. Assessment of fluid requirements needs care and attention, with adjustment for the individual patient. This is as important as safe prescribing of medications.

FLUIDS ARE DRUGS.

Try to prescribe fluids during daytime ward rounds for patients you know rather than leaving it to the night teams. However, complex patients need review of fluid requirements more than once a day.

Exclusion: Children under 16: consult paediatrician.

Special Circumstances: Principles remain the same

Burns: use established protocols for burns.

Diabetics: use diabetic ketoacidosis(DKA) or hyperosmolar hyperglycaemic state protocols
0.18%NaCl/4%glucose/40mmolKCl in 1000ml with IV insulin.

Obstetrics: consult senior for complex patients.

Head injury: avoid fluids containing glucose.

Renal/liver failure patients: consult senior doctor.

Produced by the Fluid Prescription Working Group
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2. Additional patient details

a. Study population overall details

Study population details	Medical emergencies	Surgical Emergencies	Surgical Elective	Orthopaedic Elective	Orthopaedic Emergencies
Number of admissions	9136	4824	2888	6326	3562
Age (yr) mean,SD)	73 (14)	62 (19)	65 (14)	70 (10)	78 (15)
Gender Male, n, (%)	4224 (46)	2298 (47)	1557 (54)	2556 (40)	1022 (29)
Number studied for AKI	8377	4170	2151	5511	3194

b. Incidence of AKI in patient groups, before and after guideline introduction.

		Medical emergencies	Surgical Emergencies	Surgical Elective	Orthopaedic Emergency	Orthopaedic Elective
Before	Total cases	3311	2159	993	1403	2675
	AKI 1	209	141	104	164	89
	AKI 2	75	22	12	19	23
	AKI 3	111	24	3	11	2
After	Total cases	5066	2011	1158	1791	2836
	AKI 1	365	222 ¹	124	220	229 ³
	AKI 2	128	41 ²	19	40	80 ⁴
	AKI 3	158	21	11	19	22 ⁵


1. increase from 6.5% to 11.0%, difference 4.5 (CI 2.7,6.2)%, $P < 0.0002$
2. increase from 1.0% to 2.0%, difference 1.0 (CI 0.2,1.8)%, $P < 0.007$
3. increase from 3.3% to 8.1%, difference 4.7 (CI 3.5,6)%, $P < 0.0002$
4. increase from 0.9% to 2.8%, difference 2.0 (CI 1.2,2.7)%, $P < 0.0002$
5. cannot calculate statistics because numbers too small

c. 30 day mortality by patient group

			Medical emergencies	General Surgical		Orthopaedic	
				Emergencies	Elective	Elective	Emergencies
Absolute values	before	30 day m	807	113	13	10	87
		admissions	4070	2813	1448	3490	1771
	after	30 day m	878	70	15	12	94
		admissions	5066	2011	1440	2836	1791
% Incidence	Before		19.8	4.0	0.9	0.3	4.9
	After		17.3	3.5	1.0	0.4	5.2
	difference		-2.5*	0.54	0.14	0.31	0.34
	95% CI		-0.9, -4.1	-0.6, 1.6	-0.7, 1.0	-0.1, 0.8	-1.2, 1.8

*P = 0.002

4. Prescription chart



DAILY ADULT INTRAVENOUS/SUBCUTANEOUS FLUID PRESCRIPTION CHART
 Prescribe fluids for a maximum of 24 hours on this chart – N.B. NOT FOR PAEDIATRICS

Affix Patient Label Name: CHI: Date of Birth:	Date: Ward: Patient Weight: Maintenance Goal Today (including oral intake) 30ml/kg/24hrs (20-25ml/kg/24hrs in frail elderly) _____ Latest U&Es/Hb checked (circle): Yes / No
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1. Assess patient	Hypovolaemic (reassess regularly)		Euvolaemic (fasting >8hrs)	Hypervolaemic (overloaded)	Special cases Consult senior
2. Why give fluid?	Resuscitation	Replacement	Maintenance	Restriction _____ ml	Cardiac dysfunction Renal / Liver failure Obstetrics Head Injury
3. How much? Look at history, weight, U&Es, other fluid intake e.g. IV antibiotics	Fluid challenge 250-500ml over 5-15mins & reassess	Estimate losses in past 24 hrs. Give replacement before maintenance.	30ml/kg/24hrs Subtract other intake Today's IV needs: = _____ ml	Fluid restrict. Consider diuresis. Ensure patient receives fluid goal.	*Give 40mmol KCl/litre in maintenance unless K is \geq 5.3 or renal function deteriorating
4. Which fluid?	PlasmaLyte148 (PL148) / colloid / Blood on BTS chart	PL148 0.9%NaCl+KCl for upper GI loss	0.18%NaCl/ 4%Glucose +/- KCl * If Na \leq 132 use PL148	Consult Senior.	


<p>*Never give 0.18%NaCl/4%Glucose/KCl at over 100ml/hr: RISK OF HYPONATRAEMIA</p> <p>Diabetes: for patients on intravenous insulin use 0.18%NaCl/4%Glucose/KCl</p> <p>**Subcutaneous fluids– see S/C guidance</p>	Weight (kg)	Maintenance Requirement /24hr (30ml/kg/24hrs)	Rate (ml/hr)	PLEASE PRESCRIBE IN ml/hr FOR MAINTENANCE FLUIDS
	35-44	1200 ml	50	
	45-54	1500 ml	65	
	55-64	1800 ml	75	
	65-74	2100 ml	85	
	\geq75	2400 ml (max)	100 (max)	

Resuscitation / Replacement Fluid in this box Still hypotensive after 2000ml of resuscitation fluid? D/w with senior/ICU.							
Fluid +/- Additions e.g. KCl / MgSO ₄	Vol ml	Rate ml/hr	After this bag	Prescribed by (Sign/Print)	Date	Start Time	Given by / Checked by
			Stop Review				
			Stop Review				
			Stop Review				
			Stop Review				
			Stop Review				
			Stop Review				
			Stop Review				

Maintenance Fluid (Max 100ml/hr) includes fluid for patients receiving IV insulin or subcutaneous fluids**							
			Continue				
			Stop Review				
			Continue				
			Stop Review				
			Continue				
			Stop Review				
			Continue				
			Stop Review				

The Fife Guidance for Intravenous Fluid and Electrolyte Prescribing, Guidelines for Diabetes Emergencies, **Hyponatraemia Guideline and Subcutaneous (Hypodermoclysis) Fluid Guidelines are available on the Intranet.

Intake output chart



Intake Output Chart

Date: _____ **Ward:** _____ **Patient weight:** _____
Previous Day's Intake: _____ **Output:** _____
Reason for chart (use Criteria for Fluid Chart): _____
Maintenance Goal Today: _____ ml

Affix Patient Label

Name: _____

CHI: _____

Date of Birth: _____

Time	Intake					Output				
	Oral	Oral Type	Enteral	IV	IV Type	Urine	Stool / Stoma	Vomit / Aspirate	Drain / Fistulae	Blood
01:00										
02:00										
03:00										
04:00										
05:00										
06:00										
07:00										
08:00										
09:00										
10:00										
11:00										
12:00										
13:00										
14:00										
Subtotal										
Stop and Check	Intake (Oral/Enteral + IV) less than 500ml?					Yes	No	If Yes to any question or if any concern inform nurse in charge		
	Urine less than 300ml?					Yes	No			
	Other losses more than 500ml?					Yes	No			
15:00										
16:00										
17:00										
18:00										
00:00-18:00 Total										
19:00										
20:00										
21:00										
22:00										
23:00										
00:00										
24 hr Totals										
Total Intake					Total Output					
Fluid Balance					(Total Intake minus Total Output)					

V12 October 2019 Use a volumetric pump to administer IV fluids