IV Fluids – NICE Guidelines

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Draft for consultation

Intravenous fluid therapy

Intravenous fluid therapy in adults in hospital

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Content

• Background
• Problems with current evidence
• Whistle-stop Guidance Tour
• Learning from mistakes
• Future research
Background

Claude Bernard (1813-1878)

‘La fixité du milieu intérieur est la condition de la vie libre;’

Preservation of cellular environment

Fluid and electrolyte homeostasis

Sea Water

Na$^+$ 133 mmol/L
K$^+$ 2.8 mmol/L
Cl$^-$ 92 mmol/L
Ca$^{++}$ 2.9 mmol/L
Perhaps, due to the fact that our physiology has evolved in an environment with wide variations in water availability but a relative paucity of salt, the response to a low sodium intake is both rapid and efficient.

In contrast, we have not been exposed to excessive salt intake or infusion until recent times, so that the response to sodium excess is sluggish and even normal subjects are slow to excrete an excess sodium load.
Effects of 2000 mL acute fluid loading in 10 volunteers. Blind cross over trial (Lobo et al Br J Surg 2001)

Weight gain following 2L Saline or Dextrose in normal subjects

![Graph showing weight gain over time for Saline and Dextrose](image)
Effects of 2000 mL acute fluid loading in 10 volunteers. Blind cross over trial (Lobo et al Br J Surg 2001)
Chloride-Dependent Vasoconstriction

• Critical range of vasoconstriction (50-100%) lies in the physiological Cl⁻ range of 80-110 mmol/L

Hansen et al, Hypertension 1998
Factors influencing salt and water retention in patients

- Injury/illness responses (ADH/Renin – angiotensin – aldosterone/Corticosteroids)
- Capillary permeability
- Catabolic solute load + reduced capacity to produce concentrated or dilute urine.
- K depletion
Potassium depletion in illness and injury

- Aldosterone and cortisol

- Catabolic loss of intracellular –ve charge

- GI losses

- Sick-cell pump failure

- Malnutrition +/- refeeding uptake

- Recovery uptake
Iatrogenic problems

– Lack of junior knowledge and poor senior review

– Large fluid volumes +/- saline during anaesthesia/resuscitation for sepsis

– Antibiotics and other drugs with high sodium and fluid content

– Poor fluid balance charts and ‘vicious cycle’

– MEWs
Drowning in the brine of an inadequate knowledge base

(Lobo et al Clinical Nutrition 2001;20:125-130)

Telephone survey 100 HOs in 25 DGH & Teaching Hospitals:

HOs did 89% the fluid and electrolyte prescribing

27% did not know minimum urine 24h output

76% did not know Na & Cl content of 0.9% saline

82% did not know Na$^+$ daily requirements

98% did not know Na & Cl content of gelofusine

26% prescribed > 2L 0.9% saline/day (4 x need)
Problems of Na, Cl + Fluid Excess

- Left ventricular failure
- Oedema
- Skin breakdown
- Hyperchloraemic acidosis
- Renal perfusion
- GI
  - Ileus especially post op
  - Post op anastamotic and wound dehiscence
  - Post op PN requirement
Iatrogenic salt and water overload: A prospective RCT involving 20 post op surgical patients.

Lobo DN et al. Lancet, May 2002

<table>
<thead>
<tr>
<th>CONTROL</th>
<th>INTERVENTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Fluid Regimen</td>
<td>Restricted Fluid Regimen</td>
</tr>
<tr>
<td>- Vol 3L</td>
<td>- Vol 2L</td>
</tr>
<tr>
<td>- Na(^+) 154 mmol</td>
<td>- Na(^+) 77mmol</td>
</tr>
<tr>
<td>- K(^+) 40-60 mmol</td>
<td>- K(^+) 40-60 mmol</td>
</tr>
<tr>
<td>• n=10</td>
<td>• n=10</td>
</tr>
<tr>
<td>Endpoints</td>
<td>Standard group (n=10)</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Day on which flatus first passed</td>
<td>4.0 (4.0–5.0)</td>
</tr>
<tr>
<td>Day on which stool first passed</td>
<td>6.5 (5.8–8.0)</td>
</tr>
<tr>
<td>Day on which intravenous infusion discontinued</td>
<td>6.0 (4.8–6.3)</td>
</tr>
<tr>
<td>Day on which solid food intake resumed</td>
<td>6.5 (5.5–7.0)</td>
</tr>
<tr>
<td>Postoperative hospital stay (days)</td>
<td>9.0 (7.8–14.3)</td>
</tr>
</tbody>
</table>

Values are median (IQR). Mann Whitney U test applied.

Table 3: Secondary endpoints
A Medical ‘Case’

Saturday afternoon:
• 85 yr old woman found in bed in morning by daughter. Usually lives alone. Last spoke on Wednesday.
• No other Hx available. No known PMH but ‘takes water tablet’

OE
• T 38C, P95AF, BP 100/60, JVP low, poor capillary refill, skin turgor decreased, HS normal, chest clear, abdo soft.
• WBC 13.6, Na 132, K 4.7, Cr 198, Ur 13.2, Urine dipstick protein ++, CXR normal, ECG normal. Urine and blood to micro

• Diagnosis – Probable UTI. Admitted AMU.
• Rx – Antibiotics, IV fluids – 2L N Saline over 4 hrs each
• Transferred to ward Saturday evening
Monday a.m ward round
- Patient very SOB
- JVP raised, P115, BP105/70, HS – psm + gallop
- Crackles to mid zone
- LVF

Review of IVs and fluid balance:
- 2 L saline from AMU – Saturday
- 1L saline + 2L dextrose prescribed 01.00 Sunday
- 1L saline prescribed 02.00 Monday (bag empty)
Catheter inserted Saturday night after arrival on ward 450 ml Sunday + 300 ml

Patient weight approx 52 kg

Given diuretics
Thursday a.m ward round
• Patient very SOB
• Pyrexial, p 130AF
• Course generalized crackles
• Pneumonia in CXR
• Admitted to ITU

Following Monday
   Deteriorating with multi-organ failure

Thursday
Dies
Problems with evidence

Wanted – volunteers for randomized, placebo controlled trial

Patients with an undoubted need for fluid support cannot be randomized
Problems with evidence

Historical drivers of customary usage

Trials in heterogenous groups which vary type, volume and timing of fluid with varied outcome measures (compared to drug trials)

No immediate resuscitation trials so reliance on ITU trials (delayed intervention +/- inotropes) and anaesthetic/surgical hypovolaemia
Whistle stop tour – Key recommendations:

All IV fluid prescribers should understand the principles of fluid balance in health and disease

All hospitals should organize appropriate training

All hospitals should monitor adverse, IV fluid related events

Standardised approach to prescribing
The 5Rs are a cornerstone of the guideline and a recommended change in practice, as described in section 1; these five concepts should form the basis of fluid therapy protocols and IV fluid management plans.
4.2.1 Algorithms for IV fluid therapy

Algorithm 1: Assessment

Does the patient need fluid resuscitation?
Assess volume status taking into account clinical examination, trends, and context. Possible indicators include: systolic BP < 100 mmHg; capillary refill > 2s; and peripheries are cold to touch; heart rate > 90 bpm; respiratory rate > 20 per min; NEWS > 5/6; 45° passive leg raising test positive.

Yes

Algorithm 2: Resuscitation

Initiate treatment
- Give high-flow oxygen.
- Secure large bore IV access.
- Identify cause of deficit and respond.

Give a fluid bolus of 600 ml of crystalloid

Assess the patient's likely fluid and electrolyte needs
- History: previous limited intake, abnormal losses, comorbidities.
- Clinical examination: pulse, BP, capillary refill, JVP, oedema, postural hypotension.
- Clinical monitoring: NEWS, fluid balance charts, weight.
- Laboratory assessments: FBC, urea, creatinine, and electrolytes.

Yes

No

Can the patient meet their fluid and/or electrolyte needs orally or enterally?

Yes

Ensure nutrition and fluid needs are met. Refer NICE guidance on Nutrition support.

No

Algorithm 3: Routine Maintenance

Give maintenance IV fluids
Normal daily fluid and electrolyte requirements:
- 25-30 ml/kg of water
- 1 mmol/kg/day sodium, potassium, chloride
- 50-100 g/kg/day glucose (eg glucose 5% contains 50g/100ml)

Reassess and monitor the patient
- Stop IV fluids when no longer an appropriate indicator.
- Nasogastric fluids or enteral feeding are preferable when maintenance needs are > 3 days

Yes

No

Seek expert help urgently

Give a further fluid bolus of 250-600 ml of crystalloid

No

Algorithm 4: Replacement and Redistribution

Are there existing fluid and/or electrolyte deficits or excesses?
Check for:
- Dehydration
- Fluid overload
- Hyperkalaemia/ hypokalaemia

Yes

Estimate deficits or excesses and add to or subtract from normal daily maintenance requirements.

No

Are there any ongoing abnormal fluid or electrolyte losses?

Yes

Prescribe for routine maintenance requirement plus additional fluid and electrolyte supplements to replace the measured abnormal "on-going" losses.

No

Are there other complex issues?
Check if allowance required for:
- Gross oedema
- Severe sepsis
- Pseudohyponatraemia/ hypernatraemia
- Renal, liver and/or cardiac impairment

Yes

Seek expert help promptly

No

Check for:
- Vomiting and nasogastric tube loss
- Bilary drainage loss
- High/low volume ileal stoma loss
- Diarrhoea/colostomy loss
- Ongoing blood loss e.g. melena
- Sweating/febrile hydration
- Pancreatic/jejunal fistula/stoma loss
- Urinary loss e.g. post AKI polyuria
Algorithm 1 - Assessment

Does the patient need fluid resuscitation?

Can the patient meet fluid and electrolyte needs orally or enterally?

Assess fluid and electrolyte needs from Hx, examination, monitoring, lab values

Does patient have replacement or redistribution issues?
Algorithm 2
Resuscitation

Initiate treatment
- Give high-flow oxygen.
- Secure large bore IV access.
- Identify cause of deficit and respond.

Give a fluid bolus of 600 ml of crystalloid

Reassess the patient using the ABCDE approach (Airway, Breathing, Circulation, Disability, Exposure)

Does the patient still need fluid resuscitation?

Yes
Does the patient have signs of shock?

Yes
Assess patient’s likely fluid and electrolyte needs (Algorithm 1, Box 3)

No
Given > 2000 ml given

No
Seek expert help urgently

Yes
Give a further fluid bolus of 260–500 ml of crystalloid

No
NICE review - Fluids for Resuscitation

Comparison of:
- NaCl 0.9%, Ringers, Hartmanns
- Gelatins, HES and albumin
- NOT dextrans or HMW penta- and hexa-starches

Gelatins had no advantage over other colloids or crystalloids

Tetrastarch had no advantage and 3 large ICU studies suggested increased AKI (1 increased mortality)

Albumin 4% had no advantage but decreased mortality in 1 study examining its use in a pre-defined sepsis subgroup

No studies compared colloids in balanced physiological solutions to those in sodium chloride 0.9%.
NICE - Resuscitation Recommendations

Use crystalloids that contain sodium 130-154 mmol/l, with a bolus of 500 ml over less than 15 minutes

Do not use tetrastach

Consider albumin 4-5% in severe sepsis
Algorithm 3: Routine Maintenance

Give maintenance IV fluids
Normal daily fluid and electrolyte requirements:
- 25–30 ml/kg/d water
- 1 mmol/kg/day sodium, potassium, chloride
- 50–100 g/day glucose (e.g. glucose 5% contains 5g/100ml).

Reassess and monitor the patient
- Stop IV fluids when no longer an appropriate indication.
- Nasogastric fluids or enteral feeding are preferable when maintenance needs are >3 days.
NICE Review - Fluids for Routine Maintenance

No studies simply compared different maintenance fluids

4 RCTs compared ‘restricted’ IV fluid regimens (lower NaCl and less fluid) with ‘standard’ regimens

2 less mortality and shorter LOS
2 same mortality with 1 prolonged LOS

BUT ‘restricted’ given fluid 1.5 - 2.5 l/d vs 2.0 - 4.0 l/d
and NaCl 62 - 231 mmols/d vs. to 154 - 231 mmol/d.
NICE recommendation for maintenance

Initial prescription approx: 25–30 ml/kg/day water
1 mmol/kg/day of potassium, sodium and chloride; and 50–100 g/day of glucose.

Can be achieved using 25–30 ml/kg/day of NaCl 0.18% in 4% glucose with 27 mmol/l potassium

Explicitly warned about hyponatraemia (risks small if <2.5 l/d) and these are initial prescriptions with further prescribing to be guided by monitoring.

Do not exceed 30ml/kg/d and give less fluid (e.g 20–25 ml/kg/day) in elderly/frail, renal impairment, cardiac failure or malnutrition.
Algorithm 4: Replacement and Redistribution

1. Are there existing fluid and/or electrolyte deficits or excesses? Check for:
   - Dehydration
   - Fluid overload
   - Hyperkalaemia/hypokalaemia

   - Yes  (Estimate deficits or excesses and add to or subtract from normal daily maintenance requirements)
     - Check for:
       - Vomiting and nasogastric tube loss
       - Bilary drainage loss
       - High/low volume ileal stoma loss
       - Diarrhoeal/colostomy loss
       - Ongoing blood loss e.g. melena
       - Sweating/fever/dehydration
       - Pancreaticjejunal fistula/stoma loss
       - Urinary loss e.g. post AKI polyuria

   - No

2. Are there any ongoing abnormal fluid or electrolyte losses?
   - Yes (Prescribe for routine maintenance requirement plus additional fluid and electrolyte supplements to replace the 'measured' abnormal 'ongoing' losses)
   - No

3. Are there other complex issues? Check if allowance required for:
   - Gross oedema
   - Severe sepsis
   - Hypernatraemia/hyponatraemia
   - Renal, liver and/or cardiac impairment.

   - Yes (Seek expert help promptly)
   - No

4. Monitor and reassess fluid and biochemical status by clinical and laboratory monitoring.
Replacement & redistribution

Add or subtract from maintenance estimates to account for existing fluid and/or electrolyte deficits or excesses, ongoing losses or abnormal distribution.

See expert help if patients have complex fluid and/or electrolyte redistribution issues or imbalance, or significant comorbidity e.g. gross oedema, severe sepsis, hypo- or hypernatraemia, renal, liver, cardiac impairment.
Replacement - ongoing losses

- Vomiting and nasogastric tube loss
  - Gastric fluid contains:
    - 25–80 mmol Na+/l
    - 14 mmol K+/l
    - 140 mmol/lt Cr/l
    - 60–80 mmol HCl/l
  - Excessive loss causes a hyperchloremic (hypokalemic), metabolic acidosis. Correction requires supplemental K+ and Cr+.

- ‘Pure’ water loss (e.g. fever, dehydration, hyperventilation)
  - Mainly insensible water loss (i.e. relatively low electrolyte content), results in potential hypovolemia.

- Biliary drainage loss
  - 145 mmol Na+/l
  - 5 mmol K+/l
  - 55 mmol Cl-/l
  - 30 mmol HCO3-/l

- Diarrhoea or excess colostomy loss
  - 50–140 mmol Na+/l
  - 30–70 mmol K+/l
  - 25–60 mmol HCO3-/l

- Jejunal loss via stoma or fistula
  - 140 mmol Na+/l
  - 5 mmol K+/l
  - 135 mmol Cl-/l
  - 85 mmol HCO3-/l

- High volume ileal loss via new stoma, high stoma or fistula
  - 100–140 mmol Na+/l
  - 4–5 mmol K+/l
  - 75–125 mmol Cl-/l
  - 9–30 mmol HCO3-/l

- Low volume ileal loss via established stoma or low fistula
  - 50–100 mmol Na+/l
  - 4–5 mmol K+/l
  - 25–75 mmol Cl-/l
  - 9–30 mmol HCO3-/l

- Inappropriate urinary loss (e.g. polyuria)
  - Na+/l and K+/l very variable, so monitor serum electrolytes closely. Match hourly urine output (minus 50 ml) to avoid intravascular depletion.

- Ongoing blood loss
  - (e.g. melena)
Reassessment

Patients receiving IV fluids with Cl>120 mmol/l should have chloride monitoring
- If hyperchloraemic assess acid-base and review prescription

Reassess fluid status and plan if changing location

Clear incidents of fluid mismanagement should be reported as critical incidents – learning from mistakes
<table>
<thead>
<tr>
<th>Consequence of fluid mismanagement</th>
<th>Identifying features</th>
<th>Time frame of identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dehydration</td>
<td>Patient’s fluid needs not met by oral or enteral intake and Features of dehydration on clinical examination Low urine output or concentrated urine Biochemical indicators, such as more than 50% increase in urea or creatinine with no other identifiable cause</td>
<td>Before and during IV fluid therapy</td>
</tr>
<tr>
<td>Pulmonary oedema (breathlessness during infusion)</td>
<td>No other obvious cause identified (for example, pneumonia, pulmonary embolus or asthma) Features of pulmonary oedema on clinical examination Features of pulmonary oedema on X-ray</td>
<td>During IV fluid therapy or within 6 hours of stopping IV fluids</td>
</tr>
<tr>
<td>Hyponatraemia</td>
<td>Serum sodium less than 130 mmol No other likely cause of hyponatraemia identified</td>
<td>During IV fluid therapy or within 24 hours of stopping IV fluids</td>
</tr>
<tr>
<td>Hypernatraemia</td>
<td>Serum sodium 155 mmol/l or more Baseline sodium normal or low IV fluid regimen included 0.9% sodium chloride No other likely cause of hypernatraemia identified</td>
<td>During IV fluid therapy or within 24 hours of stopping IV fluids</td>
</tr>
<tr>
<td>Peripheral oedema</td>
<td>Pitting oedema in extremities and/or lumbar sacral area No other obvious cause identified (for example, nephrotic syndrome or known cardiac failure)</td>
<td>During IV fluid therapy or within 24 hours of stopping IV fluids</td>
</tr>
<tr>
<td>Hyperkalaemia</td>
<td>Serum potassium more than 5.5 mmol</td>
<td>During IV fluid therapy or within 24 hours of stopping IV fluids</td>
</tr>
<tr>
<td>Hypokalaemia</td>
<td>Serum potassium less than 3.0 likely to be due to infusion of fluids without adequate potassium provision No other obvious cause (for example, potassium-wasting diuretics, re-feeding syndrome)</td>
<td>During IV fluid therapy or within 24 hours of stopping IV fluids</td>
</tr>
</tbody>
</table>
Training – Who takes responsibility?

Hospitals must train prescribers of IV fluids in:

- Physiology of fluid and electrolyte balance in health and disease
- Assessment of needs – 5Rs
- Prescribing and administering IV fluids
- Monitoring patient responses
- Recognising complications
- Documenting needs and changes
- Taking appropriate actions

Hospitals should have IV fluids lead
http://elearning.nice.org.uk
4.3 Key research recommendations

1. What is the incidence of complications during, and as a consequence of, IV fluid therapy?

2. Are balanced solutions superior to sodium chloride 0.9% for the resuscitation of patients with acute shock?

3. Are balanced crystalloids superior to a combination of a balanced crystalloid and a gelatin suspended in a balanced solution for the resuscitation of patients with acute shock?

4. Does a higher sodium content IV fluid regimen for maintenance reduce the risk of developing hyponatraemia and volume depletion without increasing the risk of volume overload in hospitalised adults?

5. Does the introduction of hospital systems that ensure:
   - all hospital healthcare professionals involved in prescribing and delivering IV fluid therapy are appropriately trained in the principles of fluid prescribing; and
   - all IV fluid therapy related complications are reported;
lead to a reduction in fluid-related complications and associated healthcare costs?