Australian Commission on **Safety and Quality** in Health Care

Intravenous fluid therapy: Principles for safe, appropriate and sustainable use

Guiding principles for intravenous (IV) fluid therapy, supporting safe, appropriate and sustainable care.

Key messages

- IV fluid therapy is a complex, high risk clinical intervention and requires deliberate, ongoing decision-making throughout the patient journey.
- Inappropriate initiation, administration, monitoring or prolonged use can lead to local and systemic patient harm, including thrombophlebitis, extravasation, fluid overload, infection, electrolyte disturbance and acute kidney injury.
- Decisions to start, stop or switch IV fluid therapy should be guided by indication or clinical intent, patient-specific factors and response to treatment.
- The type and volume of IV fluid administration should be guided by the patient's clinical condition, intravascular volume status and electrolyte levels.
- Continuation of IV fluid therapy should be an active clinical decision based on ongoing assessment and review, not routine practice.
- Clear documentation of indication or clinical intent, as well as criteria for review or cessation in the patient's health care record supports safer IV fluid use.
- Proactive, timely and appropriate transition to oral hydration and/or oral medicines is a component of good clinical care.
- Where possible, patients should be informed and involved in decisions about IV fluid therapy, including hydration and medicines-related treatment options.
- Safe and appropriate IV fluid use relies on coordinated action across the multidisciplinary team. This should be supported by processes and systems that enable review and monitoring of IV fluid use throughout the patient journey.
- Appropriate IV fluid use supports both patient safety and responsible, sustainable use of healthcare resources.

Purpose

This guidance provides a practical framework to support safe, appropriate and sustainable use of IV fluids, focusing on:

- deliberate initiation
- clear documentation
- ongoing review
- timely and appropriate cessation of IV fluid therapy.

These practices are aimed at reducing unnecessary or prolonged IV fluid use, minimising the risk of patient harm, improving continuity of care and supporting sustainable use of healthcare resources.

Scope

This guidance is applicable to public and private health service organisations in the acute sector and the clinicians involved in prescribing, administering, monitoring and reviewing IV fluid therapy. It outlines:

- high-level principles and actions to support safe and appropriate use of IV fluid therapy, including the use of IV fluids as a vehicle for medicine administration
- general considerations for IV fluid selection, including an overview of IV fluid classification, commonly available fluids and considerations for selected patient groups
- how to enable safe IV fluid use through development of systems that support clinical practice.

While this guidance includes general principles for IV fluid selection, it does not provide exhaustive advice for condition-specific fluid regimens or treatment pathways.

> See Guiding principles for initiation, review and cessation of IV fluid therapy.
>
> See General considerations for IV fluid selection for fluid types and properties.
>
> See Role of health service organisations for guidance implementation considerations.
>
> See Appendix A for resources covering specific clinical conditions, patient population groups and specialty settings.

The issue

IV fluid therapy is used for resuscitation, replacement of fluid losses, maintenance or hydration, and administration of medicines when oral or enteral routes are unsuitable. Despite routine prescribing and the availability of clinical guidance, the potential for errors, inappropriate IV fluid use and patient harm remain.

In many clinical contexts, there is no single approach that applies to all patients, and safe management depends on clinical judgement informed by patient specific requirements, the indication or clinical intent, anticipated duration of therapy and evolving clinical needs.[1-3]

Errors and inappropriate IV fluid use are more likely in emergency departments, acute admission units and general medical and surgical wards. In these settings, IV fluid therapy is initiated and recharted under time pressure or with a sense of urgency, often by less experienced clinicians.[1,4-6]

Studies and audits of IV fluid use consistently identify the following errors and contributing factors[4-7]:

- inappropriate fluid or volume selection based on individual physiological requirements
- inconsistent documentation of clinical intent (including the indication or goals of therapy and criteria for cessation)
- limited continuity of decision-making across teams
- failure to proactively and routinely reassess therapy once initiated.

A common pattern across these issues is continuation by default. IV fluids often continue beyond the period of clinical benefit when a clear IV fluid plan has not been documented or communicated. In these situations, particularly out-of-hours or over weekends, IV fluids may be continued in the absence of clear instructions.

Targeted interventions can reduce these issues by strengthening routine review, documentation of clinical decisions and clinician education, [4-7] together with effective communication and shared decision-making with patients and/or their family or carers, where appropriate.

IV fluid therapy – Guiding principles

The intake or administration of fluids is intended to meet the patient's physiological requirements (including water, electrolytes and glucose) and maintain homeostasis. IV fluid therapy may be necessary to meet these requirements, however appropriate fluid selection, administration and duration is important to minimise the risk of complications.

The following guiding principles summarise the core considerations that should underpin all decisions about IV fluid therapy. They emphasise that IV fluid therapy requires deliberate initiation, regular review and timely cessation based on a patient's clinical response.

Guiding principles for IV fluid use

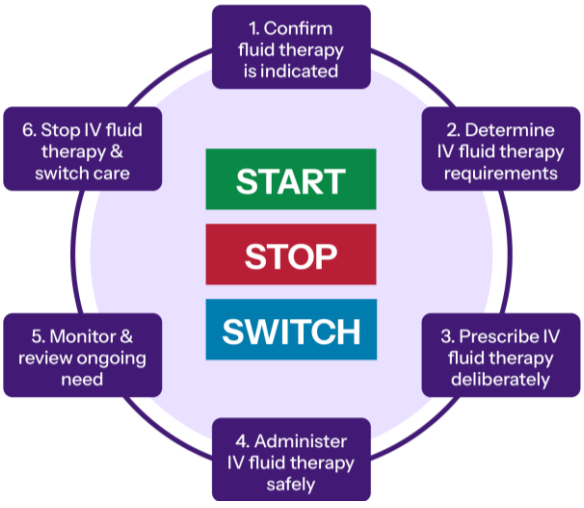
- **Start** appropriate IV fluids only when there is a clear clinical indication.
- **Stop** IV fluids as soon as they are no longer clinically required.
- **Switch** therapies based on clinical response, including modification of IV fluid regimens and timely transition to oral hydration and/or oral medicines as appropriate.

Applying the guiding principles in practice

The three guiding principles translate into six practical actions to support safe and appropriate IV fluid use over time.

Each action described in this section reflects one or more of the guiding principles and is intended to support initiation, ongoing review and appropriate cessation of IV fluid therapy.

These actions are interconnected and may be revisited as a patient's condition or goals of care evolve.



Action 1: Confirm the need for IV fluid therapy

Consider the following when determining whether IV fluid therapy is indicated:

- can oral intake meet hydration or maintenance fluid needs
- the patient's clinical condition, including anticipated fluid and treatment requirements
- where patients are fasting for surgery or procedural sedation, consider strategies to minimise dehydration, for example, the Australian Commission on Safety and Quality in Health Care (the Commission's) 'Sip Til Send' guidance
- where IV fluid therapy is being considered for medicine administration, assess whether an effective and safe oral medicine alternative is available, including situations where oral therapy is bioequivalent or preferred.

Involve the patient (their family and/or carer where appropriate) in decisions about fluid therapy and treatment options, considering clinical urgency and individual circumstances.

> If IV fluid therapy is indicated, undertake an assessment of the patient's fluid requirements (see Action 2).

Action 2: Determine IV fluid therapy requirements

When IV fluid therapy is required, an assessment should consider:

- the clinical indication or goals of therapy (for example, resuscitation, replacement, maintenance, medicine administration)
- clinical status, including haemodynamic stability, anticipated or unexpected losses (for example, blood loss, vomiting or diarrhoea), electrolyte status and the rate of change or trend in these factors (for example, a resolving acute kidney injury)
- all other sources of fluid and electrolyte intake, including any oral or enteral fluids, and/or IV medicines, nutrition, blood and blood products
- other patient-specific factors such as baseline renal function, cardiac and respiratory disease, age, weight, pregnancy and other relevant comorbidities.

Based on this assessment, consider:

- the physiological effects and composition of available IV fluid types (including tonicity and electrolyte content)
- the potential impact of the selected fluid on the status of the patient's fluid balance and electrolyte levels.

If IV fluids are used to deliver medicines, assessment should also include:

- fluid–medicine compatibility
- medicine–IV container / bag compatibility
- medicine–giving set compatibility
- the most appropriate fluid type and volume for medicine administration
- the total volume of IV fluid being administered where multiple IV medicines are prescribed.

Where IV fluids are used to deliver medicines, assessment should be guided by the Australian Injectable Drugs Handbook (AIDH) and relevant manufacturer product-specific information, alongside the considerations for IV fluid therapy outlined under Action 2.

Fluid selection is important, particularly in patients at increased risk of adverse effects and/or those requiring higher cumulative fluid volumes or prolonged duration of therapy.

See General considerations for IV fluid selection for more information on commonly available fluids and considerations for specific patient population groups.

See Appendix A for condition specific resources.

Action 3: Prescribe IV fluids deliberately

IV fluids should be prescribed with the same care and attention as other medicines and based on clear clinical intent, rather than as a routine or 'just in case' measure.

Within the IV fluid prescription, clinicians should clearly specify:

- the fluid type
- dose (volume and rate)
- indication or goal of therapy
- intended duration of therapy, where appropriate.

Prescribers should also document any monitoring requirements and criteria that should prompt reassessment, modification or cessation.

Verbal communication at the time of prescribing supports timely awareness and initiation by nurses and midwives.

Clearly document the IV fluid plan at the time of prescribing. This supports safe monitoring and review, particularly out-of-hours.

Action 4: Administer IV fluid therapy safely

Once the decision to use IV fluid therapy has been made, safe administration is essential to reduce the risk of avoidable harm and support effective clinical care.

Safe administration of IV fluid therapy includes:

- selecting the correct fluid type – some irrigation fluids are packaged in look-alike bags or containers and **are not** suitable for injection or infusion
- adherence to the rights of medicine administration, ensuring the right patient receives the right IV fluid or medicine, at the right dose, at the right time, via the right route, with appropriate documentation, and with the intended clinical response
- use of approved labelling practices, in line with the Commission's National Standard for user-applied labelling of medicines, fluids and lines
- adherence to infection prevention and control principles, including the use of aseptic technique and appropriate management of intravascular access devices during preparation and administration in line with the Australian Guidelines for the Prevention and Control of Infection in Healthcare
- appropriate selection of the vascular access device and insertion site, taking into account the characteristics and duration of therapy, the type of fluid and/or medicine being administered, and patient-specific factors

- monitoring and management of infusion devices and IV access sites to prevent complications, in accordance with organisational guidance and relevant national resources, including the Commission's:
  - Management of Peripheral Intravenous Catheters Clinical Care Standard
  - Safe administration of intravenous fluids: Avoiding venous air embolism fact sheet
- use of IV infusion pumps where possible to improve safety and support accurate delivery through better titration and control of the drip rate
- review of standing IV fluid orders to ensure ongoing appropriateness for the patient's clinical status, in line with local protocols and organisational guidance
- adherence to medicines administration guidance, including the AIDH, manufacturer's product information, and local guidelines on medicine preparation and administration.

> Administer IV fluids and IV medicines in accordance with local, state and national guidance, applying standard medicine safety and infection prevention principles.

Action 5: Monitor and review ongoing need

IV fluid therapy should be reviewed regularly using a multidisciplinary approach, and more frequently in unstable or high-risk patients, when a patient's condition changes, or at transitions of care.

Assessment should include:

- the patient's clinical response to therapy, including assessment of fluid status, review of laboratory parameters and, where clinically appropriate, consideration of fluid responsiveness to inform ongoing IV fluid therapy
- potential signs of harm, such as fluid overload, electrolyte disturbance or IV-access related complications such as phlebitis or thrombosis, in accordance with the National Consensus Statement: Essential elements for recognising and responding to acute physiological deterioration.

At each review, clinicians should determine whether IV fluid therapy should:

- remain unchanged
- be adjusted based on clinical response
- be ceased, with transition to oral route where clinically appropriate.

Any changes to IV fluid therapy should follow the prescribing principles outlined in Action 3.

> IV fluid therapy should be proactively reviewed and adjusted or ceased based on the patient's clinical need and response. Avoid continuation by default.

Action 6: Stop IV fluid therapy and switch care

Following review, when IV fluid therapy is no longer required, clinicians should:

- cease IV fluids promptly
- switch to oral hydration and oral medicines where clinically appropriate
- remove IV access devices as soon as they are no longer required.

Verbal communication when IV fluid orders are changed or ceased supports timely awareness and adjustment or discontinuation by nurses and midwives.

> Cease IV fluid therapy promptly to reduce the risk of potentially avoidable complications associated with ongoing IV access. This supports patient comfort and effective use of healthcare resources.

How the multidisciplinary team supports safe IV fluid therapy

Safe and appropriate IV fluid therapy relies on a coordinated and collaborative approach across the multidisciplinary care team, with patients as partners in decision-making about their care wherever possible. **Table 1** illustrates how different clinicians can contribute to applying the guiding principles and actions for IV fluid use in routine care. Roles may overlap and vary depending on local context, scope of practice, models of care and patient needs.

Table 1 Multidisciplinary contributions to IV fluid therapy

Clinician	Roles
Prescribers	• Consider the patient's needs and preferences • Initiate and review IV fluid therapy • Define goals and stopping criteria • Monitor clinical response and signs of deterioration • Lead IV-to-oral transition • Review and select appropriate vascular access devices where required • Escalate concerns
Nurses and midwives	• Monitor clinical response and signs of deterioration • Document and assess fluid balance and IV access sites • Determine the most appropriate IV fluid for medicine administration (see Action 2) • Administer IV fluid therapy safely (see Action 4) • Support IV-to-oral transition • Escalate concerns
Pharmacists	• Support medicines safety and provide compatibility advice • Support IV-to-oral transition • Monitor clinical response (for example, electrolyte balance) and signs of deterioration • Escalate concerns
Senior medical clinicians (For example, Consultants, Staff Specialists)	• Consider the patient's needs and preferences • Provide oversight, clinical governance and clinical decision support • Define goals and stopping criteria • Monitor clinical response and signs of deterioration • Lead IV-to-oral transition

General considerations for IV fluid selection

IV fluids differ in their composition, intravascular distribution and physiological effects, which influence their suitability for individual patients and clinical situations. In many common clinical contexts, no single IV fluid is universally superior. Fluid selection should therefore be guided

by the indication or clinical intent, intended volume and duration of therapy, and patient-specific factors, with ongoing review of response.

This section outlines general considerations to support safe IV fluid selection in routine care, including broad fluid classifications, properties of commonly available IV fluids and factors relevant to select patient groups. Resources for specific clinical conditions and specialty settings are provided in Appendix A.

Overview of IV fluid classifications

IV fluids are broadly categorised as colloids or crystalloids, based on their composition and intravascular behaviour.

Colloids contain larger molecular weight substances (for example, albumin) that predominantly remain within the intravascular space.

Crystalloids are aqueous solutions of electrolytes and/or glucose. Their clinical effects are influenced by properties such as tonicity and electrolyte composition, which affect fluid distribution and physiological response.

Crystalloids are further classified according to[22]:

- tonicity, relative to plasma (isotonic, hypotonic or hypertonic), which influences the movement of water between the extracellular and intracellular compartments
- electrolyte composition commonly described as balanced or unbalanced solutions.

Balanced solutions have electrolyte profiles that more closely approximate plasma, while unbalanced solutions contain higher chloride concentrations and may be associated with electrolyte or acid–base disturbances when administered in larger volumes or over longer durations.[22]

Commonly available IV fluids and key properties

A range of IV fluids are used in acute care settings. While no single IV fluid is appropriate across all clinical contexts, most clinical indications can be managed with a small range of fluid types.

Table 2 summarises the properties of commonly available IV fluids to support informed fluid selection in routine care.

Table 2 Properties of commonly available IV fluids

IV fluid	Tonicity* [22]	Balance[22]	Key notes
Plasma-Lyte 148 Plasma-Lyte 148 and 5 % glucose Compound sodium lactate (Hartman's solution) Compound sodium lactate (Hartman's solution) and 5% glucose	**Isotonic**	**Balanced**	• Monitor for fluid overload in at-risk patients (e.g. cardiac/renal disease). • Consider potassium content in hyperkalaemia or renal impairment.
0.9% sodium chloride 0.9% sodium chloride and glucose 5%	**Isotonic**	Unbalanced	• Large volumes of 0.9% sodium chloride may cause hyperchloraemia and metabolic acidosis.[16, 17] • Monitor for fluid overload in at-risk patients (e.g. cardiac/renal disease).
5% and 10 % glucose (dextrose)	Hypotonic	Unbalanced	• Primarily used for management of hypoglycaemia and as a glucose source (e.g. in diabetic ketoacidosis protocols). • Once metabolised, these solutions behave as free water and do not contribute to effective intravascular volume expansion. Therefore, they are not generally appropriate for resuscitation.[19] • May precipitate hyponatraemia.[19, 20]
sodium chloride 0.45% and glucose 5% sodium chloride 0.18% and glucose 4%	Hypotonic	Unbalanced	• Primarily used as maintenance fluids in adults where both water and sodium are required. • Remain hypotonic overall and may contribute to hyponatraemia, particularly in children or with prolonged use.[19, 20] • Require careful monitoring of electrolytes and fluid balance.
Hypertonic saline (e.g. sodium chloride 3%)	Hypertonic	Unbalanced	• Mainly used for the treatment of raised intracranial pressure and symptomatic hyponatremia.[15] • Significant risk of harm if inadvertently administered instead of a fluid like sodium chloride 0.9%.
Colloids *Albumin 5%* *Albumin 20%*	–	–	• Colloids have a limited role in routine IV fluid therapy and should be used for specific clinical indications.[2] • Synthetic colloids (e.g. hydroxyethyl starch solutions) are associated with safety concerns and are restricted or not recommended in many settings.[2] • Use in accordance with local formulary or policy and relevant clinical guidelines.

*With reference to cell membrane.

See Appendix B for the electrolyte and glucose concentrations in 1 litre of commonly available IV fluids.

Considerations for specific patient population groups

In clinically stable patients without significant ongoing losses, electrolyte disturbance or comorbidities, short-term use of isotonic crystalloid (including balanced solutions and 0.9% sodium chloride) are often appropriate.[1, 16, 17] Balanced crystalloids may be preferred where larger volumes or prolonged administration are anticipated, given their lower chloride content and reduced risk of metabolic disturbance. [16, 17]

Certain patient population groups are more susceptible to fluid-related harm due to physiological differences that affect fluid distribution, electrolyte balance and organ function. In these patients, IV fluid choice, volume and duration require careful individualisation, with closer monitoring and earlier reassessment.

Table 3 Considerations for specific patient population groups

Population	Considerations
Children and adolescents *(28 days to 18 years of age)*	**Avoid hypotonic fluids in most situations** [18, 19, 20] • Children are at increased risk of electrolyte disturbances, particularly hyponatraemia, due to differences in fluid and electrolyte regulation. • Fluids containing a sodium concentration less than plasma are not recommended for routine use in children. • In most situations, when prescribing glucose-containing fluids, isotonic solutions should be considered in preference to hypotonic solutions.
Patients undergoing surgery	**Avoid fluid deficit and fluid overload** • Patients are at risk of both fluid deficit (e.g. pre-operative fasting and surgical losses) and harm from excessive or prolonged IV fluid therapy. • Individualise IV fluid therapy to the perioperative phase, avoiding both under-replacement and excess, and support early transition to oral intake to promote recovery and reduce reliance on IV fluid therapy.[3] • Where clinically appropriate, avoid unnecessarily prolonged pre-operative fluid fasting (see the Commission's national guidance on 'Sip Til Send').
Adult patients experiencing haemorrhage or major bleeding	**Prioritise haemorrhage control over excessive fluid use** • Where clinically appropriate, a restrictive fluid resuscitation strategy (including permissive hypotension in selected patients) may be considered until definitive haemorrhage control is achieved.[23]
Pregnancy and obstetrics	**Avoid unnecessary IV fluid use and fluid overload** • Physiological changes in pregnancy increase susceptibility to fluid overload and altered fluid distribution. • Prioritise oral hydration where feasible and avoid routine IV fluid administration during labour unless required to meet a specific clinical need. [24]
Patients at higher risk of adverse effects, for example: • Neonates and children • Older adults • Patients with cardiac and/or renal disease	**Use careful and individualised fluid therapy** • Susceptibility to fluid overload or electrolyte disturbance is increased due to differences in fluid distribution, organ function, and physiological response across these patient groups. • In neonates, particularly preterm infants, the risk of fluid overhydration may be increased by hidden fluid sources such as sodium chloride 0.9% (or 'normal saline') flushes.

Role of health service organisations

Health service organisations play an important role in enabling safe, appropriate and sustainable use of IV fluids by:

- establishing and maintaining effective clinical governance
- promoting and supporting access to education, infrastructure and resources that help clinicians deliver high-quality care[25] care in routine practice.

Implementation of this guidance will take time and should be progressive and adapted to the local context, recognising variation in workforce models and system capability (including availability and use of electronic and/or paper-based prescribing systems).

Changes to practice, such as strengthening documentation, supporting regular review and promoting timely and appropriate cessation of IV fluid therapy, may require staged adoption and ongoing reinforcement.

Establishing good clinical governance

Clinical governance is central to providing the best possible outcomes for patients. The 2026 National Model for Clinical Governance (national model) defines clinical governance as the combination of organisational culture, systems and structures that enables everyone in a health service to deliver care that is consistently high quality and improving.

Effective clinical governance means that boards, executives, clinical leaders and the workforce are clearly accountable to patients and the community for providing high-quality care – care that is person-centred, safe, effective, accessible and integrated, provided in a way that is equitable, efficient and sustainable.

Consistent with the principles outlined in the national model health services can apply the six foundations of clinical governance in a way that meets the needs of their organisation. Existing medicines governance structures (such as Medicines/Drug and Therapeutics Committees) can be used to establish good clinical governance of IV fluid therapy. This may include:

- establishing oversight of IV fluid use and product availability within the organisation
- promoting and supporting access to education, guidance and resources for clinicians involved in prescribing, administering and monitoring of IV fluid therapy
- reviewing IV fluid-related incidents and patterns of use to support quality improvement
- reinforcing IV fluids as a clinical therapy requiring proactive, ongoing oversight across the patient journey (consistent with other medicines)
- supporting multidisciplinary stewardship of IV fluids, such as the involvement of nurses and pharmacists in monitoring, review and optimisation of therapy to support timely cessation and appropriate transition to oral forms of hydration and/or medicines.

Systems and infrastructure

Health service organisations can support safe IV fluid use by strengthening systems, processes and ways of working, recognising that improvements may be gradual and adapted to local context, capability and priorities.

This may include:

- implementing or strengthening processes that support proactive review, reassessment and timely cessation of therapy, such as multidisciplinary review rounds, as well as supporting clinicians to escalate concerns (for example, whether there is an ongoing need for IV fluids) in line with the Communicating for Safety Standard and a strong patient safety culture
- ensuring availability of tools that support documentation, communication, review and planning of IV fluid therapy (for example, IV fluid charts and handover tools that support continuity of care)
- leveraging technology, if available, to support standardisation, monitoring, communication and oversight (for example, in-built clinical decision support; real-time monitoring dashboards).

Implementation support

This guidance is supported by resources designed to reinforce key messages and uptake in routine practice.

These include a poster for clinicians and a fact sheet for prescribers.

> Health service organisations should ensure that systems supporting safe IV fluid use are consistent with the National Safety and Quality Health Service (NSQHS) Standards, the National Model for Clinical Governance and implementation guide for the national model.
>
> This includes requirements related to communicating for safety, a strong patient safety culture, recognising and responding to acute deterioration, preventing and controlling infections, and medication safety, alongside broader expectations for clinical governance and partnering with consumers.

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For more information

Please visit: safetyandquality.gov.au/ivfluids

Appendix A: Useful resources

This appendix provides local, national and international resources for reference. Clinical practice should be guided by locally endorsed resources within the relevant health service organisation.

Table 4 Adult resources

Clinical area	Guidelines and resources
General adult inpatients	• National Institute for Health and Care Excellence Guideline: Intravenous Fluid Therapy in Adults in Hospital • Adult Electrolyte Prescribing Guidelines, Queensland Health
Burns	• Burns Management Guidelines, Victorian Adult Burns Service • Emergency Management of Severe Burns (EMSB)
Chronic kidney disease	• Kidney Disease: Improving Global Outcomes (KDIGO) Clinical practice guidelines
Critical care	• Surviving Sepsis Campaign • European Society of Intensive Care Medicine clinical practice guideline on fluid therapy in adult critically ill patients
Diabetes	• Management of Hyperosmolar Hyperglycaemic State (HHS) in Adults: An updated guideline from the Joint British Diabetes Societies (JBDS) for Inpatient Care Group • Developing a Protocol for Management of Euglycemic Diabetic Ketoacidosis
Liver cirrhosis	• European Association for the Study of the Liver Clinical Practice Guidelines on the Management of Ascites in Cirrhosis
Obstetrics	• World Health Organisation (WHO) recommendations: intrapartum care for a positive childbirth experience • Royal Australina and New Zealand College of Obstetricians and Gynaecologists – Care in Labour in the Absence of Pregnancy Complications (C-Obs 31) • Joint British Diabetes Societies (JBDS) 12: Managing diabetes and hyperglycaemia during labour and birth • Society for Maternal-Fetal Medicine Consult Series #67: Maternal sepsis
Palliative / end-of-life care	• Multinational Association of Supportive Care in Cancer (MASCC) expert opinion/guidance on the use of clinically assisted hydration in patients with advanced cancer • End of Life Direction for Aged Care

Clinical area	Guidelines and resources
Perioperative (consensus)	• Enhanced Recovery After Surgery Society Guidelines for Perioperative Care • PeriOperative Quality Initiative Consensus Recommendations on Perioperative Fluid Management
Trauma – General	• European guideline on management of major bleeding and coagulopathy following traumatic injury (6th edition) • Trauma Hemostasis and Oxygenation Research (THOR) Network position paper on hypotensive resuscitation and remote damage control resuscitation
Traumatic brain injury	Fluid therapy in neurointensive care patients: ESICM consensus and clinical practice recommendations

Table 5 Paediatric resources

Clinical area	Guidelines and resources
General paediatrics	• Neonatal Intravenous Fluids Clinical Practice Guideline, The Royal Children's Hospital Melbourne • Australian Neonatal Medicines Formulary • Intravenous Fluids Clinical Practice Guideline, The Royal Children's Hospital Melbourne • Electrolyte Abnormalities, Clinical Practice Guideline, The Royal Children's Hospital Melbourne • Paediatric Injectable Medicines Handbook, The Royal Children's Hospital Melbourne • Fluids Calculator, Maintenance Fluid Requirements, The Royal Children's Hospital Melbourne • National Institute for Health and Care National Institute for Health and Care Excellence Guideline: Intravenous Fluid Therapy in Neonates, Infants, Children and Young People
Perioperative care	• Enhanced Recovery After Surgery – Society Recommendations for Neonatal Perioperative Care
Diabetic ketoacidosis (DKA)	• International Society for Paediatric and Adolescent Diabetes Consensus Guidelines on Diabetic Ketoacidosis and the Hyperglycaemic Hyperosmolar State • British Society for Paediatric Endocrinology and Diabetes Guideline for the Management of Children and Young People with Diabetic Ketoacidosis
Sepsis	• Sepsis assessment and management, Clinical Practice Guideline, The Royal Children's Hospital Melbourne
Trauma & burns	• Emergency Management of Severe Burns (EMSB) • Fluid therapy in neurointensive care patients: ESICM consensus and clinical practice recommendations
Emergency transport	• NSW Newborn and paediatric Emergency Transport Service (NETS) clinical calculator

Appendix B: Composition of commonly used intravenous fluids

Table 6 Electrolyte and glucose concentrations in 1 litre of commonly available IV fluids.* From Myles et al.[3]

Biochemistry	Plasma	0.9% sodium chloride	0.18% sodium chloride / 4% glucose*	5% dextrose**	Hartmann's Compound Sodium Lactate	Lactated Ringer's (USP)	Ringer's acetate	Plasma-Lyte 148
Na^+ (mmol/L)	135-145	154	31	0	131	130	130	140
Cl^- (mmol/L)	95-105	154	31	0	111	109	112	98
$[Na^+]:[Cl^-]$ ratio	~1.37:1	1:1	1:1	-	1.18:1	1.19:1	1.16:1	1.43:1
K^+ (mmol/L)	3.5-5.3	¶	¶	¶	5	4	5	5
HCO^{3-} (mmol/L)	24-32	0	0	0	29 (lactate)#	28 (lactate)#	27 (acetate)	27 (acetate) 23 (gluconate)
Ca^{2+} (mmol/L)	2.2-2.6	0	0	0	2	1.4	1	0
Mg^{2+} (mmol/L)	0.8-1.2	0	0	0	0	0	1	1.5
Glucose (mmol/L)	3.5-5.5	0	222 (40 g)	278 (50 g)	0	0	0	0
Strong ion difference@	30-46	0	0	-	29	28	27	47
pH	7.35-7.45	4.5-7.0	4.5	3.5-5.5	5.0-7.0	6-7.5	6-8	6.5-8.0
Osmolarity (mOsm/L)	275-295	308	284	278	278	273	276	294

* There are slight variations in the composition, as supplied by different manufacturers.
** The term dextrose refers to the d-isomer of glucose and is the only form used in IV fluids; however, IV fluid bags are often labelled as glucose. Glucose–saline combinations now come in at least five different concentrations, and variable potassium content.
¶ These solutions are also available with differing quantities of potassium already added.
# The lactate in Hartmann's solution is a conjugate base, and so because no extra hydrogen ions are added to the body there is no "lactic acidosis" – there may be a transient rise in serum lactate, but not a decrease in blood pH. The lactate anion will absorb a hydrogen ion as it is metabolised, tending to an alkalosis – it does not meaningfully contribute to the strong ion difference. Acetate (and to a lesser extent, gluconate) act similarly as bicarbonate substitutes.
@ An increase in the strong ion difference in solution leads to consumption of hydrogen ions, tending to an alkalosis.