

# ACUTE KIDNEY INJURY: A COMPETENCY FRAMEWORK

DEFINING THE ROLE OF  
THE EXPERT CLINICIAN

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# PREFACE

Acute kidney injury (AKI) has now replaced the term acute renal failure and is characterised by a rapid reduction in kidney function, potentially resulting in a failure to maintain fluid, electrolyte and acid-base homeostasis. Recently it has been recognised that even relatively small rises in serum creatinine in a variety of clinical settings are associated with significant adverse outcomes, including increased mortality and prolonged length of stay.

Collection of precise data on the incidence and prevalence of AKI has been fraught with difficulties because of the varying definitions of the condition, but the reported prevalence from US data ranges from 1% (community-acquired) up to 7.1% (hospital-acquired) of all hospital admissions. The population incidence of AKI from UK data ranges from 172 per million population (pmp) per year from early data up to 486-630 pmp/year from more recent series,

Recognising the frequency and relative serious nature of AKI, NCEPOD surveyed the management of the condition in UK hospitals. The subsequent report (Adding Insult to Injury, NCEPOD, June 2009<sup>1</sup>) identified serious shortcomings in the management of AKI in hospitals.

This framework was commenced under the auspices of the AKI delivery group led by the National Clinical Director for Renal Services, Dr Donal O'Donoghue. The Academy of Medical Royal Colleges has developed the framework to promote better care of patients with, or at risk of, AKI by all members of the clinical team. The working group that developed the competency framework comes from a multi-professional background and has been sponsored by the Royal College of Nursing and the National Outreach Forum. These organisations have supported the framework through its development, as have the Society for Acute Medicine and Renal Association and the Renal Pharmacy Group.

It is anticipated that the framework will be used to promote competence acquisition in the multi-professional team to improve care for patients suffering from AKI, recognising that only by good integrated teamwork can the best results be achieved.



**Dr Sian Finlay**  
Author of the AKI Framework  
Society for Acute Medicine



**Professor Sir Neil Douglass**  
Chairman Academy of Medical Royal  
Colleges



# CONTRIBUTORS WORKING GROUP

**Dr Andrew Lewington (Chairman)**  
UK Renal Association

**Dr Sian Finlay (Author)**  
Society for Acute Medicine

**Dr Mike Jones**  
Society for Acute Medicine

**Dr Timothy Gould**  
Intensive Care Society

**Professor Dileep Lobo**  
Association of Surgeons of Great Britain  
and Ireland

**Dr Mark Thomas**  
UK Renal Association

**Ms Lesley Durham**  
National Outreach Forum

**Dr Isabel Gonzalez**  
National Outreach Forum

**Mrs Caroline Ashley**  
UK Renal Pharmacy Group

**Professor Mark Bellamy**  
Intensive Care Society

**Professor Gordon Carlson**  
Society of Academic and Research Surgery  
Association of Surgeons of Great Britain  
and Ireland

**Professor Charles Thomson**  
UK Renal Association

**Dr Alistair Douglas**  
Society for Acute Medicine

**Ms Sarah Quinton**  
National Outreach Forum



# 1. INTRODUCTION

This document sets out a framework of competencies for prevention, recognition, and management of Acute Kidney Injury. It is targeted primarily at hospital-based staff, but may be adapted for use in other settings. The framework was produced in response to the NCEPOD report *Adding Insult to Injury*<sup>1</sup> which identified serious shortcomings in the management of AKI in hospitals. Its aim is to improve quality of care by providing consistent standards for all staff involved in the care of acutely ill patients, outlining what is expected of both teams and individuals, and improving accountability at all levels.

The competencies framework was produced by a multi-disciplinary working group, with representation from the UK Renal Association, the Society for Acute Medicine, the Intensive Care Society, National Outreach Forum, Royal College of Nursing, Association of Surgeons of Great Britain and Ireland, and the UK Renal Pharmacy Group. The structure is based on the Department of Health framework Competencies for Recognising and Responding to Acutely Ill Patients in Hospital.<sup>2</sup> It defines the knowledge, skills, and behaviours required for safe and effective patient care along the Chain of Response described by NICE.<sup>3</sup> (Figure 1).

**Figure 1: Chain of Response**



Source: NICE (Guideline No. 50), 2007

The Chain of Response reflects escalating levels of intervention in the care of an acutely ill patient, with input from staff with a variety of different backgrounds and skills. The clinical team as a whole must have the competencies to record patient information and vital signs, recognise abnormal values, and institute intervention at a level appropriate to the patient's clinical condition.

There are five tiered levels of competency: Recorder, Recogniser, and Primary, Secondary, and Tertiary Responder. It is assumed that a practitioner at one level of competency will also possess the competencies outlined for all the preceding levels. It is likely that on occasions one staff group or banding will cover more than one role in the chain (e.g. the recogniser may also fulfil the primary responder role).

The five levels of competency are described below:

- **The Recorder** takes designated measurements and records observations and relevant patient information. This role will typically be undertaken by a Healthcare Assistant
- **The Recogniser** monitors the patient's condition, interprets designated measurements and information, and adjusts the frequency of observations if required. In specific circumstances, the Recogniser may initiate immediate management, according to defined protocols (e.g. commencement of oxygen therapy). The Recogniser role will typically be undertaken by a trained staff nurse
- **The Primary Responder** goes beyond recording and observation, by interpreting available information and initiating a clinical management plan. This includes arranging appropriate investigations and prescribing treatment. A Foundation Year 1 doctor, Advanced Nurse Practitioner, or Critical Care Outreach nurse will typically undertake this role
- **The Secondary Responder** assesses the clinical effect of the primary intervention, formulates a diagnosis, refines the management plan, and initiates a secondary response. This individual has the knowledge to recognise when referral to Critical Care is indicated. Training-grade doctors and consultants in non-Nephrology specialties will typically undertake this role
- **The Tertiary Responder** has detailed knowledge about AKI and makes higher level management decisions, including initiation of renal replacement therapy if indicated. This role will usually be undertaken by Nephrology consultants or senior Nephrology trainees.

A core component of the Chain of Response is the ability to recognise and respond to signs of deterioration in the patient, and to escalate care to the next level if indicated. To facilitate this process, this working group recommends the use of a 'Track and Trigger' observation chart for all patients.



## 2. ACUTE KIDNEY INJURY FRAMEWORK

### 2.1 Recorder

#### 2.1.1 Recognition of risk of AKI. Baseline Assessment:

Knowledge	Skills	Behaviours
<p>Blood Pressure (BP)</p> <ul style="list-style-type: none"> <li>• Knows the normal range of BP measurements</li> <li>• Understands the importance of using the correct size of blood pressure cuff for the patient, including a leg cuff when indicated. Understands the effect of incorrect cuff size</li> </ul>	<p>Blood Pressure (BP)</p> <ul style="list-style-type: none"> <li>• Can reliably perform BP measurement using manual and automated sphygmomanometers</li> <li>• Recognises situations when it is necessary to recheck BP using a manual sphygmomanometer (e.g. if unrecordable or if systolic BP &lt; 100mmHg on an automated machine)</li> <li>• Recognises situations when it is necessary to use a leg cuff, and can obtain BP measurement using this technique</li> <li>• Recognises situations when it may be difficult or impossible to obtain a BP measurement e.g. shocked patient, during cardiac arrest</li> </ul>	<p>Blood Pressure (BP)</p> <ul style="list-style-type: none"> <li>• Performs physiological observations with respect for patient's dignity and comfort at all times</li> <li>• Rechecks automated BP readings using a manual sphygmomanometer when indicated</li> <li>• Documents BP on an observation chart</li> <li>• Reports abnormal recordings to a senior colleague immediately</li> </ul>
<p>Urinalysis</p> <ul style="list-style-type: none"> <li>• Can describe the different methods of obtaining a urine specimen</li> <li>• Understands situations when a sterile urine sample is necessary</li> <li>• Knows the appropriate specimen containers for common urine tests</li> </ul>	<p>Urinalysis</p> <ul style="list-style-type: none"> <li>• Can obtain a urine specimen from catheterised and non-catheterised patients</li> <li>• Can perform dipstick urinalysis and recognise abnormal results</li> </ul>	<p>Urinalysis</p> <ul style="list-style-type: none"> <li>• Obtains urine specimen with respect for patient's dignity and comfort at all times</li> <li>• Documents urinalysis results in patient records</li> <li>• Reports abnormal urinalysis to a senior colleague immediately</li> </ul>

### 2.1.2 Recognition of increased risk of AKI during acute illness:

Knowledge	Skills	Behaviours
<p>Physiological Observations</p> <ul style="list-style-type: none"> <li>• Knows that abnormal physiological parameters may be a sign of acute illness</li> <li>• Is familiar with local policy regarding deteriorating 'Track and Trigger' scores</li> </ul>	<p>Physiological Observations</p> <ul style="list-style-type: none"> <li>• Can obtain physiological observations including temperature, pulse rate, BP, respiratory rate, oxygen saturation, and AVPU (Alert/ responsive to Voice/Pain/ Unresponsive) status in an acutely unwell patient.</li> </ul>	<p>Physiological Observations</p> <ul style="list-style-type: none"> <li>• Records physiological observations on observations chart</li> <li>• Follows local policy regarding abnormal or deteriorating 'Track and Trigger' scores.</li> </ul>

### 2.1.3 Recognition and Management of AKI

Knowledge	Skills	Behaviours
<p>Physiological Observations</p> <ul style="list-style-type: none"> <li>• Understands need for physiological monitoring in patient with AKI</li> </ul>	<p>Physiological Observations</p> <ul style="list-style-type: none"> <li>• Can obtain relevant physiological observations including temperature, pulse rate, BP, respiratory rate, oxygen saturation, and AVPU status in a patient with AKI</li> </ul>	<p>Physiological Observations</p> <ul style="list-style-type: none"> <li>• Records and monitors physiological parameters as advised by senior colleagues</li> <li>• Reports deteriorating parameters to senior colleague immediately</li> <li>• Performs urinalysis</li> </ul>
<p>Fluid Balance</p> <ul style="list-style-type: none"> <li>• Understands how to complete a fluid balance chart</li> </ul>	<p>Fluid Balance</p> <ul style="list-style-type: none"> <li>• Can maintain an accurate fluid balance chart</li> <li>• Can recognise abnormally high or low urine output**</li> </ul>	<p>Fluid Balance</p> <ul style="list-style-type: none"> <li>• Maintains an accurate fluid balance chart</li> <li>• Reports both oliguria and polyuria to a senior colleague</li> </ul>

## 2.2 Recogniser

### 2.2.1 Recognition of risk of AKI. Baseline Assessment:

Knowledge	Skills	Behaviours
<p>Risk Factors for AKI</p> <ul style="list-style-type: none"> <li>Has knowledge of common risk factors for AKI. (Appendix A)</li> </ul>	<p>Risk Factors for AKI</p> <ul style="list-style-type: none"> <li>Can elicit relevant history of major risk factors for AKI, including inadequate fluid intake or excessive losses</li> </ul>	<p>Risk Factors for AKI</p> <ul style="list-style-type: none"> <li>Obtains patient history in sympathetic and considerate manner</li> </ul>
<p>Urea &amp; Electrolytes (U&amp;E)</p> <ul style="list-style-type: none"> <li>Recognises that serum biochemistry should be checked on all emergency admissions, as recommended by NCEPOD<sup>1</sup></li> <li>If appropriately trained understands theoretical aspects of venepuncture, including aseptic technique, minimisation of biohazard exposure, and management of immediate complications, including needle stick injury*</li> <li>Understands need to use correct specimen tubes for commonly used blood tests</li> <li>Understands the importance of correct labelling and handling of samples</li> </ul>	<p>Urea &amp; Electrolytes</p> <ul style="list-style-type: none"> <li>If appropriately trained*, can perform venepuncture safely and with minimal discomfort and inconvenience to patient. Can deal with immediate complications arising from venepuncture</li> </ul>	<p>Urea &amp; Electrolytes</p> <ul style="list-style-type: none"> <li>Demonstrates compassion and empathy for the patient while performing venepuncture*</li> <li>Maintains high standards of hygiene</li> <li>Uses appropriate specimen tubes and labels samples correctly</li> </ul>
<p>Urinalysis</p> <ul style="list-style-type: none"> <li>Understands common causes of abnormalities in dipstick urinalysis</li> </ul>	<p>Urinalysis</p> <ul style="list-style-type: none"> <li>Can interpret results of dipstick urinalysis</li> </ul>	<p>Urinalysis</p> <ul style="list-style-type: none"> <li>Reports significantly abnormal urinalysis to a senior colleague immediately</li> </ul>

## 2.2.2 Recognition of increased risk of AKI during acute illness:

Knowledge	Skills	Behaviours
<p>Acute Illness and AKI</p> <ul style="list-style-type: none"> <li>• Understands the importance of monitoring physiological parameters in a patient with AKI</li> <li>• Understands that acute illness increases the risk of AKI even when the serum creatinine is normal</li> <li>• Has knowledge of an 'ABCDE' approach to management of an acutely unwell patient</li> <li>• Understands the importance of responding rapidly</li> </ul>	<p>Acute Illness and AKI</p> <ul style="list-style-type: none"> <li>• Can interpret abnormal physiological parameters and recognise both absolute values and trends indicative of acute illness. Able to recognise situations when it is appropriate to increase the frequency of observations</li> <li>• Can obtain intravenous access in the majority of patients when required*</li> <li>• Recognises the importance of fluid balance recording in patients with acute illness</li> <li>• If appropriately trained, can obtain central venous pressure (CVP) measurements*</li> </ul>	<p>Acute Illness and AKI</p> <ul style="list-style-type: none"> <li>• Uses a 'Track and Trigger' chart and escalates care according to local policy</li> <li>• Obtains intravenous access* and initiates a fluid balance chart in patients with acute illness</li> <li>• Obtains CVP measurements when indicated*</li> </ul>

### 2.2.3 Recognition and Management of AKI

Knowledge	Skills	Behaviours
<p>Physiological Observations</p> <ul style="list-style-type: none"> <li>Understands that a patient with AKI requires frequent monitoring of physiological parameters including urine output</li> </ul>	<p>Physiological Observations</p> <ul style="list-style-type: none"> <li>Able to monitor physiological parameters of a patient with AKI and recognise when it is appropriate to increase the frequency of observations</li> <li>Able to recognise abnormal physiological parameters in a patient with AKI, and take immediate steps to correct them, according to local protocol</li> </ul>	<p>Physiological Observations</p> <ul style="list-style-type: none"> <li>Maintains a 'Track and Trigger' chart and escalates care according to local policy</li> <li>Recognises abnormal physiological parameters in a patient with AKI, and takes immediate steps to correct them, according to local protocol</li> </ul>
<p>Fluid Balance</p> <ul style="list-style-type: none"> <li>Knows important causes of low urine output**, including AKI, response to volume depletion, blocked urinary catheter</li> <li>Knows that urine output is affected by both fluid intake (oral and parenteral) and losses (overt and insensible)</li> </ul>	<p>Fluid Balance</p> <ul style="list-style-type: none"> <li>Able to recognise low urine output**</li> <li>Able to recognise when low urine output is secondary to inadequate fluid intake</li> </ul>	<p>Fluid Balance</p> <ul style="list-style-type: none"> <li>Commences a fluid balance chart if not already done</li> <li>Recognises when urine output is low**, and informs a senior colleague</li> <li>Takes steps to increase patient's oral intake if indicated; discusses with a senior colleague if supplementary fluid is required</li> </ul>
<p>Urethral Catheterisation</p> <ul style="list-style-type: none"> <li>Knows the indications for urethral catheterisation, and its complications</li> </ul>	<p>Urethral Catheterisation</p> <ul style="list-style-type: none"> <li>Can perform male and female urethral catheterisation* using sterile technique</li> </ul>	<p>Urethral Catheterisation</p> <ul style="list-style-type: none"> <li>Performs urethral catheterisation if indicated, using sterile technique.* Seeks senior help if the procedure is technically difficult</li> <li>Demonstrates empathy and respect for the patient's dignity during the procedure</li> </ul>

Knowledge	Skills	Behaviours
<p data-bbox="185 573 501 607">Medicines Management</p> <ul data-bbox="185 645 592 1379" style="list-style-type: none"> <li data-bbox="185 645 592 815">• Understands the importance of prompt administration of prescribed therapy, including fluids and antibiotics</li> <li data-bbox="185 822 592 1025">• Understands that a patient's regular medication may become nephrotoxic, contra-indicated, or require dose adjustment during acute illness</li> <li data-bbox="185 1032 592 1202">• Understands the need for on-going review of prescribed medication in the context of changing physiological parameters</li> <li data-bbox="185 1209 592 1379">• Knows where to obtain information about medication (e.g. ward pharmacist or British National Formulary)</li> </ul>	<p data-bbox="616 573 932 607">Medicines Management</p> <ul data-bbox="616 645 1023 1061" style="list-style-type: none"> <li data-bbox="616 645 1023 781">• Can administer oral and intravenous drugs and fluids safely as prescribed, in a timely manner</li> <li data-bbox="616 788 1023 1061">• Able to recognise some clinical contexts when prescribed medications may be contra-indicated (e.g. diuretics in dehydrated patient), and to discuss queries with senior colleagues</li> </ul>	<p data-bbox="1046 573 1362 607">Medicines Management</p> <ul data-bbox="1046 645 1453 992" style="list-style-type: none"> <li data-bbox="1046 645 1453 815">• Administers therapies as prescribed, including prompt administration of antibiotics in accordance with local policy</li> <li data-bbox="1046 822 1453 992">• In the context of acute illness, discusses appropriateness of prescribed medication with a senior colleague</li> </ul>
<p data-bbox="185 1431 432 1464">Recovery from AKI</p> <ul data-bbox="185 1503 592 1639" style="list-style-type: none"> <li data-bbox="185 1503 592 1639">• Recognises that polyuria may occur during recovery from AKI or following relief of urinary tract obstruction</li> </ul>	<p data-bbox="616 1431 863 1464">Recovery from AKI</p> <ul data-bbox="616 1503 1023 1606" style="list-style-type: none"> <li data-bbox="616 1503 1023 1606">• Able to recognise the development of polyuria during recovery from AKI</li> </ul>	<p data-bbox="1046 1431 1294 1464">Recovery from AKI</p> <ul data-bbox="1046 1503 1453 1673" style="list-style-type: none"> <li data-bbox="1046 1503 1453 1673">• Actively observes patient for the development of polyuria during recovery from AKI, and informs senior colleagues if it occurs</li> </ul>

## 2.3 Primary Responder

### 2.3.1 Recognition of risk of AKI. Baseline Assessment:

Knowledge	Skills	Behaviours
<p>Risk Factors for AKI</p> <ul style="list-style-type: none"> <li>• Can recall common and less common risk factors which may predispose to AKI (Appendix A)</li> <li>• Can list common co-morbidities that can increase risk of AKI</li> <li>• Knows the reference range for U&amp;E results</li> </ul>	<p>Risk Factors for AKI</p> <ul style="list-style-type: none"> <li>• Can obtain history and examine patient for co-morbidities relevant to risk of AKI</li> <li>• Able to elicit relevant physical signs (e.g. JVP, BP, vascular bruits)</li> <li>• Able to recognise abnormal U&amp;E results</li> <li>• Able to interpret patient's serum biochemistry results in context of previous serum analysis and recognise the presence of chronic kidney disease (CKD)</li> </ul>	<p>Risk Factors for AKI</p> <ul style="list-style-type: none"> <li>• Obtains history and conducts examination sensitively and with consideration for the patient at all times</li> <li>• Interprets serum biochemistry results in context of previous serum analysis, and determines if patient is at increased risk of AKI</li> <li>• Reports abnormal U&amp;E results to a senior colleague, having determined the degree of urgency</li> <li>• Arranges frequent monitoring of biochemistry (e.g. daily) in patient identified as being at increased risk of AKI</li> </ul>
<p>Urinalysis</p> <ul style="list-style-type: none"> <li>• Knows that abnormal urinalysis may be indicative of acute or chronic kidney disease</li> </ul>	<p>Urinalysis</p> <ul style="list-style-type: none"> <li>• Able to recognise urinalysis findings typical of significant renal tract disease</li> </ul>	<p>Urinalysis</p> <ul style="list-style-type: none"> <li>• Interprets results and informs senior colleagues if significantly abnormal. Arranges urine culture if indicated</li> </ul>

Knowledge	Skills	Behaviours
<p data-bbox="185 573 501 607">Medicines Management</p> <ul data-bbox="185 645 576 1485" style="list-style-type: none"> <li data-bbox="185 645 544 745">• Recognises medications which are potentially nephrotoxic</li> <li data-bbox="185 752 544 853">• Understands the importance of Medicines Reconciliation</li> <li data-bbox="185 860 576 994">• Understands that dosages of renally-excreted drugs may need to be adjusted in patients with AKI</li> <li data-bbox="185 1001 544 1135">• Recognises the need for continued review of drug doses if renal function changes</li> <li data-bbox="185 1142 544 1344">• Knows that intravenous contrast used for radiological procedures is potentially nephrotoxic, especially in patients with pre-existing CKD</li> <li data-bbox="185 1350 576 1485">• Knows approaches to minimise this risk, including intravenous volume expansion</li> </ul>	<p data-bbox="616 573 932 607">Medicines Management</p> <ul data-bbox="616 645 1023 1373" style="list-style-type: none"> <li data-bbox="616 645 1023 992">• Able to take a detailed medication history, including over-the-counter medicines and herbal remedies, and including medications taken prior to admission or started after it. Recognises medications which may increase the risk of AKI in a specific clinical context</li> <li data-bbox="616 999 1023 1099">• Able to adjust drug dosages appropriately in patients with AKI</li> <li data-bbox="616 1106 1023 1373">• Able to recognise procedures when intravenous contrast is likely to be used. Able to identify patient at high risk of contrast-induced AKI and take steps to minimise this risk</li> </ul>	<p data-bbox="1046 573 1362 607">Medicines Management</p> <ul data-bbox="1046 645 1453 1350" style="list-style-type: none"> <li data-bbox="1046 645 1453 813">• Avoids or discontinues nephrotoxic medications in patients with pre-existing CKD and those at increased risk of AKI</li> <li data-bbox="1046 819 1453 920">• Seeks information from Pharmacist or other source (e.g. BNF) when required</li> <li data-bbox="1046 927 1453 1061">• Prescribes and amends medication doses appropriately in patients with AKI (if a trained prescriber)</li> <li data-bbox="1046 1068 1453 1350">• Informs radiologist (or colleague who will be performing the procedure). Ensures adequate hydration of patient to minimise nephrotoxicity. Monitors renal function post-procedure</li> </ul>

### 2.3.2 Recognition of increased risk of AKI during acute illness:

Knowledge	Skills	Behaviours
<p>Acute Illness and AKI</p> <ul style="list-style-type: none"> <li>• Understands the importance of volume status assessment in patients with acute illness. Is aware of problems associated with both hypo- and hyper-volaemia</li> </ul>	<p>Acute Illness and AKI</p> <ul style="list-style-type: none"> <li>• Able to make a detailed assessment of volume status, including fluid balance, laboratory results, and clinical examination (Appendix B)</li> </ul>	<p>Acute Illness and AKI</p> <ul style="list-style-type: none"> <li>• In patients with acute illness, makes a clinical assessment of volume status and takes steps to optimise fluid balance</li> <li>• Arranges blood tests for serum biochemistry (including serum bicarbonate) and interprets results. Plans on-going monitoring of results</li> </ul>

### 2.3.3 Recognition and Management of AKI

Knowledge	Skills	Behaviours
<p>Urea &amp; Electrolytes</p> <ul style="list-style-type: none"> <li>Recognises that a small rise in serum creatinine concentration may be clinically important. Recognises that trends in serum creatinine concentration may be more significant than absolute values</li> </ul>	<p>Urea &amp; Electrolytes</p> <ul style="list-style-type: none"> <li>Can identify significant trends in U&amp;E results even within the normal range, and recognise when this is indicative of AKI</li> </ul>	<p>Urea &amp; Electrolytes</p> <ul style="list-style-type: none"> <li>Recognises changes in U&amp;E results indicative of AKI at the earliest opportunity and informs a senior colleague</li> </ul>
<p>Fluid Balance</p> <ul style="list-style-type: none"> <li>Recognises that trends in urine output may be significant</li> </ul>	<p>Fluid Balance</p> <ul style="list-style-type: none"> <li>Can identify significant changes in urine output and recognise when this is indicative of AKI</li> </ul>	<p>Fluid Balance</p> <ul style="list-style-type: none"> <li>Recognises changes in urine output indicative of AKI at the earliest opportunity and informs a senior colleague</li> </ul>
<p>Causes of AKI</p> <ul style="list-style-type: none"> <li>Recalls the common causes of AKI, and understands the 'Pre-renal', 'Renal', and 'Post-renal' classification</li> </ul>	<p>Causes of AKI</p> <ul style="list-style-type: none"> <li>Can take a detailed and focused history and conduct examination relevant to AKI</li> </ul>	<p>Causes of AKI</p> <ul style="list-style-type: none"> <li>Takes history and conducts examination with consideration for patient's feelings at all times. Is open with the patient and allays anxieties whenever possible</li> </ul>
<p>Clinical Examination</p> <ul style="list-style-type: none"> <li>Understands the utility and limitations of clinical examination, including assessment of volume status, in evaluating a patient with AKI (Appendix B)</li> </ul>	<p>Clinical Examination</p> <ul style="list-style-type: none"> <li>Can conduct a focused examination relevant to AKI</li> </ul>	<p>Clinical Examination</p> <ul style="list-style-type: none"> <li>Conducts examination sensitively and with consideration for the patient at all times</li> </ul>

Knowledge	Skills	Behaviours
<p data-bbox="132 573 256 607">Urinalysis</p> <ul data-bbox="132 645 539 1061" style="list-style-type: none"> <li data-bbox="132 645 539 853">• Knows that an active urinary sediment (urinalysis strongly positive for haematuria +/- proteinuria) may be indicative of acute glomerulonephritis</li> <li data-bbox="132 853 539 1061">• Is familiar with commonly used estimation of protein excretion, including Albumin:Creatinine Ratio (ACR) and Protein:Creatinine Ratio (PCR)</li> </ul>	<p data-bbox="557 573 681 607">Urinalysis</p> <ul data-bbox="557 645 963 1133" style="list-style-type: none"> <li data-bbox="557 645 963 779">• Can interpret dipstick and laboratory urinalysis and recognise an active urinary sediment</li> <li data-bbox="557 779 963 891">• Able to recognise abnormal PCR results indicative of significant proteinuria</li> <li data-bbox="557 891 963 1133">• Recognises scenarios suggestive of typical renal pathologies, including pre-renal, post-renal, and renal, including drug-induced AKI and acute glomerulonephritis</li> </ul>	<p data-bbox="992 573 1117 607">Urinalysis</p> <ul data-bbox="992 645 1399 887" style="list-style-type: none"> <li data-bbox="992 645 1399 887">• Informs senior colleague of urinalysis results potentially indicative of renal disease. If indicated, arranges blood tests to look for evidence of Rapidly Progressive Glomerulonephritis (RPGN)</li> </ul>

Knowledge	Skills	Behaviours
<p>Investigations and Immediate Management</p> <ul style="list-style-type: none"> <li>• Has understanding of the indications for, and interpretation of, arterial blood gases, ECGs, and basic radiological tests, including chest x rays</li> <li>• Understands the need to repeatedly reassess a patient's response to clinical interventions</li> <li>• Knows that obstruction of the urinary tract must be relieved urgently</li> <li>• Is aware of different methods to achieve this, including urethral and supra-pubic catheterisation, nephrostomy insertion, and retrograde ureteric stenting</li> </ul>	<p>Investigations and Immediate Management</p> <ul style="list-style-type: none"> <li>• Can determine the indications for additional investigations including: <ul style="list-style-type: none"> <li>o Biochemical and Haematological</li> <li>o Microbiological</li> <li>o Immunological</li> <li>o Imaging</li> </ul> </li> <li>• Can interpret the results of additional investigations and construct a management plan</li> <li>• Able to effectively assess patient's response to initial treatment and modify management plan if required. Can seek senior help appropriately</li> </ul>	<p>Investigations and Immediate Management</p> <ul style="list-style-type: none"> <li>• Orders additional investigations as indicated, and interprets the results</li> <li>• Collates all relevant information and constructs a management plan Discusses this plan with senior colleagues.</li> <li>• Assesses need for fluid challenge and administers immediately if indicated (Appendices B &amp; C)</li> <li>• Reviews patient timeously to assess response to initial management. Discusses with seniors. Modifies management plan as required</li> <li>• When indicated, inserts a urethral catheter to relieve urinary tract obstruction and/or accurately monitor urinary output</li> <li>• Recognises when alternative intervention is necessary to relieve obstruction and informs senior colleague immediately</li> </ul>

Knowledge	Skills	Behaviours
<p>Medicines Management</p> <ul style="list-style-type: none"> <li>• Recognises potentially nephrotoxic medications. Understands that a patient's regular medication may become nephrotoxic in a new clinical context</li> <li>• Knows that renally-excreted drugs may accumulate in AKI. Knows where to obtain information about dose reductions</li> </ul>	<p>Medicines Management</p> <ul style="list-style-type: none"> <li>• Able to identify medications which are potentially nephrotoxic in a given clinical context</li> <li>• Able to recognise renally-excreted drugs and reduce dosages if required</li> </ul>	<p>Medicines Management</p> <ul style="list-style-type: none"> <li>• Discontinues potentially nephrotoxic medications and documents the reasons for this. Documents plans for reintroduction of medication at a later date if appropriate</li> <li>• Reduces dosages of renally-excreted drugs and monitors drug levels when appropriate. Discusses with Pharmacist when required.</li> </ul>
<p>Complications of AKI</p> <ul style="list-style-type: none"> <li>• Can outline the potentially life-threatening complications of AKI, including hyperkalaemia, metabolic acidosis, sepsis, and fluid overload</li> <li>• Has knowledge of initial management of such complications and understands that intervention must be immediate</li> <li>• Recognises that the development of complications refractory to immediate medical management is an indication for urgent renal replacement therapy</li> </ul>	<p>Complications of AKI</p> <ul style="list-style-type: none"> <li>• Able to recognise the complications of AKI as soon as they occur</li> <li>• Able to initiate medical management of complications and to seek senior help promptly</li> </ul>	<p>Complications of AKI</p> <ul style="list-style-type: none"> <li>• Actively assesses and monitors patient with AKI for potential complications</li> <li>• Recognises complications at the earliest opportunity. Responds immediately to correct such complications when possible</li> <li>• Seeks senior help promptly</li> </ul>

Knowledge	Skills	Behaviours
<p>Recovery from AKI</p> <ul style="list-style-type: none"> <li>• Understands that patient education may help to reduce the risk of recurrent AKI</li> <li>• Knows that during recovery from AKI, polyuria may result in fluid and electrolyte loss which must be corrected</li> </ul>	<p>Recovery from AKI</p> <ul style="list-style-type: none"> <li>• Able to arrange appropriate follow-up for patients recovering from AKI</li> <li>• Able to advise patients appropriately on steps to reduce their risk of recurrent AKI (e.g. avoidance of nephrotoxins, omission of specific drugs during acute illness)</li> </ul>	<p>Recovery from AKI</p> <ul style="list-style-type: none"> <li>• In a patient with polyuria, monitors fluid and electrolyte loss and replaces both as required</li> <li>• Arranges Nephrology follow-up for patients with incomplete recovery from AKI or with CKD stage 4 or 5 (eGFR <math>\leq</math>30ml/min)</li> </ul>

## 2.4 Secondary Responder

### 2.4.1 Recognition of risk of AKI. Baseline Assessment:

Knowledge	Skills	Behaviours
<p>Risk of AKI</p> <ul style="list-style-type: none"> <li>• Understands that a patient may be at increased risk of AKI as a result of pre-existing renal disease, co-morbidities, current clinical context, or a combination of the above</li> </ul>	<p>Risk of AKI</p> <ul style="list-style-type: none"> <li>• Able to recognise when a patient is at increased risk of AKI and communicate this to others</li> </ul>	<p>Risk of AKI</p> <ul style="list-style-type: none"> <li>• Recognises when a patient is at increased risk of AKI and communicates this to others</li> </ul>
<p>Medicines Management</p> <ul style="list-style-type: none"> <li>• Understands that the dose and method of administration (e.g. because of fluid restriction) of some medications needs to be adjusted in patients with AKI</li> </ul>	<p>Medicines Management</p> <ul style="list-style-type: none"> <li>• Able to review medications prescribed by junior colleagues and modify dosage and methods of administration if required</li> </ul>	<p>Medicines Management</p> <ul style="list-style-type: none"> <li>• Reviews medications prescribed by junior colleagues and modifies if required. Seeks advice from a Pharmacist as necessary</li> </ul>

Knowledge	Skills	Behaviours
<p>Investigations</p> <ul style="list-style-type: none"> <li>Is aware of potential complications of radiological investigations, including contrast-induced AKI and nephrogenic systemic fibrosis, and knows how these conditions typically present</li> </ul>	<p>Investigations</p> <ul style="list-style-type: none"> <li>Able to evaluate the potential risks and benefits of radiological investigations using intravenous contrast or gadolinium and determine whether the procedure is justified</li> <li>Able to have informed discussion with patient of potential risks and benefits of elective procedures</li> </ul>	<p>Investigations</p> <ul style="list-style-type: none"> <li>Discusses risks and benefits of proposed procedure with patient in an open and honest manner</li> </ul>

#### 2.4.2 Recognition of increased risk of AKI during acute illness:

Knowledge	Skills	Behaviours
<p>Acute Illness &amp; AKI</p> <ul style="list-style-type: none"> <li>Understands the pathophysiology of AKI in the context of acute illness</li> </ul>	<p>Acute Illness &amp; AKI</p> <ul style="list-style-type: none"> <li>Able to advise junior colleagues on the frequency of biochemical monitoring during acute illness</li> <li>Able to modify management plan, including prescribed medications, to reduce risk of AKI during acute illness</li> </ul>	<p>Acute Illness &amp; AKI</p> <ul style="list-style-type: none"> <li>Advises junior colleagues on the frequency of biochemical monitoring during acute illness</li> <li>Modifies management plan, including prescribed medications, to reduce risk of AKI during acute illness</li> </ul>

### 2.4.3 Recognition of increased risk of AKI during acute illness:

Knowledge	Skills	Behaviours
<p>Diagnosis of AKI</p> <ul style="list-style-type: none"> <li>• Is familiar with current definitions of AKI</li> </ul>	<p>Diagnosis of AKI</p> <ul style="list-style-type: none"> <li>• Able to recognise and stage AKI</li> </ul>	<p>Diagnosis of AKI</p> <ul style="list-style-type: none"> <li>• Recognises AKI and identifies the probable or suspected cause</li> <li>• Documents this in the patient's case notes</li> </ul>
<p>Fluid Balance</p> <ul style="list-style-type: none"> <li>• Knows the major constituents of all commonly available intravenous fluids (Appendix C)</li> <li>• Understands the indications for central venous catheter insertion, and complications of the procedure</li> </ul>	<p>Fluid Balance</p> <ul style="list-style-type: none"> <li>• Able to make an informed choice about use of specific intravenous fluids in given clinical contexts</li> <li>• Is able to obtain central venous access safely using sterile technique. Is able to recognise and manage complications of the procedure</li> </ul>	<p>Fluid Balance</p> <ul style="list-style-type: none"> <li>• Selects and administers appropriate intravenous fluids in a given clinical context</li> <li>• Assesses need for central venous access, and obtains if indicated. Seeks consent and shows empathy and consideration for the patient throughout the procedure</li> </ul>
<p>Renal Referral</p> <ul style="list-style-type: none"> <li>• Understands the indications for nephrology referral, including need for specialist investigation or advice, need for renal replacement therapy (RRT). Knows the relative and absolute indications for RRT</li> </ul>	<p>Renal Referral</p> <ul style="list-style-type: none"> <li>• Can recognise patients who require nephrology referral +/- RRT</li> </ul>	<p>Renal Referral</p> <ul style="list-style-type: none"> <li>• Involves nephrologists for appropriate patients</li> </ul>
<p>Critical Care Referral</p> <ul style="list-style-type: none"> <li>• Understands indications for referral to other specialties, including critical care</li> </ul>	<p>Critical Care Referral</p> <ul style="list-style-type: none"> <li>• Is able to recognise when a patient fails to respond to initial treatment, and to discuss a deteriorating patient with critical care</li> </ul>	<p>Critical Care Referral</p> <ul style="list-style-type: none"> <li>• Discusses acutely ill or deteriorating patient with critical care if appropriate. Makes referrals to other specialties promptly</li> </ul>

## 2.5 Tertiary Responder

### 2.5.1 Recognition of risk of AKI. Baseline Assessment:

Knowledge	Skills	Behaviours
<p>Risk of AKI</p> <ul style="list-style-type: none"> <li>Aware of different causes of underlying CKD (if identified as a risk factor)</li> </ul>	<p>Risk of AKI</p> <ul style="list-style-type: none"> <li>Able to identify clinical features of pre-existing CKD (if identified as a risk factor)</li> </ul>	<p>Risk of AKI</p> <ul style="list-style-type: none"> <li>Reviews all available information to determine if a patient has evidence of pre-existing CKD</li> <li>Ensures that correctable risk factors have been modified</li> </ul>
<p>Urinalysis</p> <ul style="list-style-type: none"> <li>Understands the distinction between ACR and PCR, and situations in which one may be preferable</li> <li>Recognises that proteinuria is indicative of CKD even if the serum creatinine is normal</li> </ul>	<p>Urinalysis</p> <ul style="list-style-type: none"> <li>Able to interpret ACR and PCR results and recognise microalbuminuria and proteinuria</li> </ul>	<p>Urinalysis</p> <ul style="list-style-type: none"> <li>Interprets ACR and PCR results and documents results in patient records</li> </ul>

## 2.5.2 Recognition and Management of AKI

Knowledge	Skills	Behaviours
<p>Causes of AKI</p> <ul style="list-style-type: none"> <li>Is familiar with both common and uncommon causes of AKI</li> </ul>	<p>Causes of AKI</p> <ul style="list-style-type: none"> <li>Able to recognise both common and esoteric presentations of renal disease</li> </ul>	<p>Causes of AKI</p> <ul style="list-style-type: none"> <li>Reviews all available information and confirms likely cause of AKI</li> <li>Recognises when patient fails to respond to initial management and re-evaluates for additional or alternative diagnosis</li> </ul>
<p>Medicines Management</p> <ul style="list-style-type: none"> <li>Knows the nephrotoxicity profile of commonly used medications, such as aminoglycosides</li> </ul>	<p>Medicines Management</p> <ul style="list-style-type: none"> <li>Can evaluate the risks and benefits of using nephrotoxic drugs in a specific clinical context</li> </ul>	<p>Medicines Management</p> <ul style="list-style-type: none"> <li>Evaluates the risks and benefits of using potentially nephrotoxic drugs in a specific clinical context, and discusses this with the patient where appropriate</li> <li>Takes steps to minimise nephrotoxicity when possible e.g. use of gentamicin nomogram</li> </ul>
<p>Investigations-Kidney Biopsy</p> <ul style="list-style-type: none"> <li>Understands the indications and contra-indications for renal biopsy</li> <li>Knows how to manage complications of renal biopsy, including blood loss</li> </ul>	<p>Investigations-Kidney Biopsy</p> <ul style="list-style-type: none"> <li>Can perform renal biopsy (when trained) under ultrasound guidance. Recognises patients who are high risk for renal biopsy and can evaluate the relative risks and benefits of the procedure</li> <li>Able to obtain diagnostic samples of renal cortex.</li> </ul>	<p>Investigations-Kidney Biopsy</p> <ul style="list-style-type: none"> <li>Discusses risks and benefits of renal biopsy openly with the patient. In high risk patients, discusses with senior colleagues if required</li> <li>Demonstrates empathy and consideration for the patient throughout the procedure</li> </ul>

Knowledge	Skills	Behaviours
<p>Renal Replacement Therapy (RRT)</p> <ul style="list-style-type: none"> <li>• Recognises that renal replacement therapy and critical care may not be appropriate in the context of overwhelming illness or severe co-morbidity</li> <li>• Understands the indications for, and complications of, Continuous Renal Replacement Therapy (CRRT) versus Intermittent Haemodialysis (IHD)</li> <li>• Has knowledge of dialysis regimes, including options for anti-coagulation, fluid removal, and dialysate composition</li> <li>• Understands the concept of the dose of dialysis prescribed and delivered in AKI</li> <li>• Understands the importance of adequate nutrition in patients with AKI</li> </ul>	<p>Renal Replacement Therapy (RRT)</p> <ul style="list-style-type: none"> <li>• Able to take a holistic patient-centred approach to decisions on treatment limitation</li> <li>• Able to recognise the likely prognosis of patients with AKI across the spectrum, and advise accordingly</li> <li>• Able to discuss these issues sensitively with patient and/or relatives</li> <li>• Able to plan and prescribe RRT</li> <li>• Able to communicate dialysis regimes in AKI, including anti-coagulation, fluid removal, and dialysate composition</li> <li>• Able to determine the dose of dialysis delivered for a patient with AKI</li> <li>• Able to prioritise the workload of a dialysis unit in conjunction with Renal Unit staff to ensure optimal use of limited resources</li> <li>• Able to recognise situations when a patient's nutritional intake is inadequate, and involve a Renal Dietician</li> </ul>	<p>Renal Replacement Therapy (RRT)</p> <ul style="list-style-type: none"> <li>• Determines patient's suitability for escalation of treatment to renal replacement therapy (which may include transfer to critical care)</li> <li>• Involves patient and/or relatives in such discussions when possible</li> <li>• Discusses issues sensitively and openly, and puts patient's interests first</li> <li>• Communicates the outcome of these discussions to colleagues involved in the patient's care</li> <li>• Assesses the dose of dialysis delivered in a patient with AKI and adjusts the dialysis prescription if required</li> <li>• Discusses requirement for nutritional support with renal dietician if required</li> </ul>

**Notes:**

*Throughout this document, practical skills (e.g. venepuncture) in which not all individuals within a given level of competency will have received training are marked with an asterisk.*

*\*It is understood that an individual who has not had relevant training, should not undertake the procedure, but must communicate with a competent colleague to ensure it is carried out promptly.*

*\*\*Oliguria and polyuria defined by local protocol e.g. <0.5ml/kg/hr or >150ml/hr respectively.*

# APPENDIX A

## RISK FACTORS FOR AKI

- Age > 75 years
- Hypovolaemia
- Hypotension (Systolic BP <100mmHg or fall of  $\geq 40$  mmHg from known baseline)
- Sepsis
- Nephrotoxic medication
- Chronic Kidney Disease (eGFR < 60ml/min)
- Diabetes Mellitus
- Atherosclerotic Peripheral Vascular Disease
- Cardiac failure
- Jaundice

# APPENDIX B

## CLINICAL ASSESSMENT OF VOLUME STATUS

Physical examination is a useful tool in assessing a patient's volume status, but individual clinical findings are often insensitive and/or non-specific. All of the following may provide relevant information:

- Postural vital signs
- Dry Axillae
- Capillary refill time
- Moistness of mucous membranes
- Moistness of axillae
- Jugular/central venous pressure
- Skin turgor
- Changes in body weight
- Urine output and fluid balance chart
- Evidence of peripheral oedema, pleural effusions, ascites, or pulmonary oedema
- Physiological response to a fluid challenge
- Physiological response to passive leg raising
- Other.

More detailed evidence for the utility of some of these signs is summarised below.

### Postural Vital Signs

Measurement requires a wait of two minutes before obtaining supine vital signs and one minute before obtaining erect vital signs. A meta-analysis<sup>7</sup> summarised 25 studies of 3500 young healthy volunteers, some of whom underwent venesection to reduce blood volume:

**Postural pulse increment** was most useful for detecting blood loss. Increment of over 30beats/min had specificity of 98% (i.e. only occurred in 2% of normovolaemic individuals). The sensitivity for blood loss >630ml was 97%, but only 22% for moderate blood loss (450-630ml), and likely to be lower still in older patients, those on rate-limiting medications etc.

**Postural hypotension** (fall of  $\geq 20$ mmHg on standing) occurred in 10% of normovolaemic people aged under 65, and 11-30% of those aged over 65. Sensitivity for 450-630ml blood loss was low (only 9% in under 65s and 27% in over 65s). After excluding those too dizzy to stand, postural hypotension had no incremental value. There were insufficient data to determine its value after blood loss > 630ml.

**Supine tachycardia** (pulse > 100/min) had only 12% sensitivity, though it was 96% specific for acute blood loss in this context. Specificity would be

likely to be significantly lower in a hospital population with a range of acute illnesses.

**Supine hypotension** (SBP < 95mmHg) was insensitive to both moderate and significant blood loss (13% and 33% respectively), but had 97% specificity for hypovolaemia.

### **Dry Axillae**

Good inter-observer reliability and correlation with measurement of weight gain of tissue paper. Eaton<sup>4</sup> (100 patients aged over 70) showed 82% specificity, but only 50% sensitivity. Positive likelihood ratio of dry axilla was 2.8. Negative likelihood ratio of a moist axilla was 0.6. Another study of 202 patients 6 with acute illnesses found that dry axillae correlated with level of dehydration (p=0.03).

### **Capillary Refill Time**

This is determined by compressing the distal phalanx of the patients' middle finger, positioned level with the heart, for five seconds, and then timing the return of normal colour to the finger. Meta-analysis found that a prolonged capillary refill does not accurately predict 450ml blood loss (only 6% sensitivity, though 93% specificity). Schriger et al<sup>8</sup> showed that prolonged capillary refill had positive likelihood ratio of 6.8 for identifying hypovolaemic patients (however, the study used changes in postural vital signs as the criterion standard, so there may not be any additional diagnostic value). Another study<sup>5</sup> found no predictive value.

### **Skin Turgor**

No studies are available on the normal skin recoil time. Elasticity declines with age. Two studies have found no diagnostic value.<sup>5,6</sup>

### **Physiological Response to fluid challenge**

Fluid challenge is the term used to describe the rapid administration of intravenous fluid over a short time, in order to assess the response to expansion of circulating volume. Changes in physiological parameters, such as mean arterial pressure, heart rate, and central venous pressure, are indicative of fluid responsiveness and suggest the presence of hypovolaemia.<sup>9</sup> This approach is widely used in clinical medicine, but there

is no published data on the optimum technique or its diagnostic reliability.

### **Physiological Response to Passive Leg raising (PLR)**

PLR induces a transient translocation of venous blood from the legs to the intra-thoracic compartment, resulting in an increase in cardiac pre-load. This can be viewed as a 'self- fluid challenge', the effects of which are completely reversible, and the physiological response to the manoeuvre can predict fluid-responsiveness.<sup>8-11</sup> PLR is performed by moving the patient from a semi-recumbent position to a supine position with passive elevation of the legs to 45° above the horizontal. Maximal response is seen within 30-60 seconds of the positional change. The value of the technique in assessing fluid responsiveness has been largely assessed in the intensive care setting, where increases in descending aortic blood flow of  $\geq 10\%$  or echocardiographic subaortic flow of  $\geq 12\%$  are highly sensitive and specific predictors of fluid responsiveness. The utility of PLR outside the critical care environment has not yet been established.

### **Other**

Other includes; dry or furrowed tongue, sunken eyes, non-fluent speech, muscle weakness, confusion.

*None of these are useful in isolation. Most helpful in excluding hypovolaemia are moist mucous membranes, absence of tongue furrows, and absence of sunken eyes.<sup>1</sup> Dry mucous membranes are commonly attributable to other factors, such as mouth breathing or medication, and have low specificity for hypovolaemia.*

*In summary, no single clinical sign is sufficiently sensitive and specific to confirm the diagnosis of hypovolaemia. The most predictive static measurements are a postural pulse increment over 30beats/min and detection of dry axillae. Dynamic tests such as response to fluid challenge and passive leg raising may provide additional information. Clinical assessment of volume status must consider physical findings in the context of a patient's clinical history and relevant laboratory results.*

## APPENDIX C

### TYPICAL PROPERTIES OF COMMONLY USED INTRAVENOUS SOLUTIONS

Type of Fluid*	Sodium mmol/L	Potassium mmol/L	Chloride mmol/L	Osmolarity mosm/L	Weight average Mol Wt kD	Plasma volume expansion duration hrs+
Plasma	136-145	3.5-5.0	98-105	280-300	—	—
5% dextrose	0	0	0	278	—	—
4% dextrose 0.18% saline	30	0	30	283	—	—
0.9% 'normal' saline	154	0	154	308	—	0.2
0.45% 'half normal' saline	77	0	77	154	—	—
Ringer's Lactate	130	4	109	273	—	0.2
Hartmann's	131	5	111	275	—	0.2
Gelatine 4%	145	0	145	290	30,000	1-2
5% albumin	150	0	150	300	68,000	2-4
20% albumin	—	—	—	—	68,000	2-4
HES 6% 130/0.4	154	0	154	308	130,000	4-8
HES 10% 200/0.5	154	0	154	308	200,000	6-12
HES 6% 450/0.6	154	0	154	308	450,000	24-36

*\*The properties of fluids may vary depending on the manufacturer.*

*+ These are approximations only. The duration of clinically effective volume expansion will vary depending on several factors including, how volume expansion is defined, the rate of in vivo degradation and excretion of the fluid and the systemic capillary permeability of the individual patient.*

*Note: most hospitals are trying to reduce or eliminate ward-based additions to intravenous infusions, including potassium. Five percent dextrose, dextrose-saline and 0.9% normal saline solutions are readily available with added potassium and may be required for this purpose. Care must always be taken to balance sodium needs (maintenance and replacement) with the sodium load infused.*

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Academy of Medical Royal Colleges  
10 Dallington Street  
London  
EC1V 0DB

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