

## Acute Kidney Injury

### Definition / Supporting Information

See Acute kidney injury: Prevention, detection and management of acute kidney injury up to the point of renal replacement therapy [[NICE clinical guideline CG169](#), [Sections 1.1 to 1.3](#)].

Acute renal failure is a syndrome of sudden diminution or cessation of kidney function. It can occur in previously healthy children or in those with chronic, underlying conditions.

The change in terminology from acute renal failure to acute kidney injury (AKI) focuses attention on early recognition of kidney insult and interventions to prevent or mitigate effects of significant renal failure.

AKI in children and young people is detected in line with the (paediatric) RIFLE (Risk, Injury, Failure, Loss, End stage renal disease), AKIN (Acute Kidney Injury Network) or KDIGO (Kidney Disease: Improving Global Outcomes) definitions, by using any of the following criteria:

- A fall in urine output to  $< 0.5$  mL/kg/hour for more than 8 hours
- A 25% or greater fall in estimated glomerular filtration rate (eGFR) within the past 7 days

**Keywords / also known as:** renal failure, renal injury, kidney failure, kidney damage, abdominal pain, oedema

### Essential History

Evaluation should progress only after the ABCs (airway, breathing, and circulation) of resuscitation have been addressed.

#### Ask about:

- Risk factors for AKI
  - Acute illness associated with hypovolaemia:
    - Dehydration associated with acute gastrointestinal losses (most common)
    - Haemorrhage
    - Burns
    - Sepsis
    - Trauma
  - Chronic kidney disease or previous history of AKI
  - Congestive heart failure

- Liver disease
- Malignant disease
- Perinatal asphyxia
- Diarrhoea
  - Haemolytic–uraemic syndrome
- Exposure to nephrotoxins, eg:
  - Non-steroidal anti-inflammatory drugs (NSAIDs), aminoglycoside antibiotics, loop diuretics, Angiotensin–converting enzyme inhibitors (ACE inhibitors) and calcineurin inhibitors

## ‘Red Flag’ Symptoms and Signs

### Ask about:

- Symptoms that may be associated with fluid overload
  - Breathing difficulties (see Dyspnoea)
  - Swelling and / or puffiness (see Oedema)
- Headache
- Altered level of consciousness
- Seizures
  - Sudden onset of seizures and other signs of central nervous system dysfunction may be the presenting features of AKI.
- Tremors or tetany
  - Hypocalcaemia
- Reduced urine output
  - Number of wet nappies / 24 hours
  - Normal wet nappy frequency:
    - 1 to 2 days old - 1 to 2 wet nappies a day or more
    - 3 to 4 days old - 3 or more per day
    - 5 to 6 days old - 5 or more per day
    - 7 to 28 days old - 6 or more per day

### Look for:

- Signs of fluid overload
  - Raised jugular venous pressure (JVP)
  - Tachycardia
  - Heart failure
  - Hepatomegaly
  - Hypertension
  - Oedema
  - Rapid excessive weight gain in a neonate

## Differential Diagnosis / Conditions

- Haemolytic–uraemic syndrome
- Glomerulonephritis or vasculitis
- Nephrotoxic drugs
- Pre-existing undiagnosed chronic kidney disease
- Obstructive uropathy

## Investigations

Evaluation should progress only after the ABCs (airway, breathing, and circulation) of resuscitation have been addressed.

To be undertaken by non-specialist practitioners (eg, General Practitioner (GP) Team), or by specialist practitioners (eg, Emergency Department / General Paediatric / Paediatric Nephrology Team(s)):

- Urinalysis (including blood, protein, leucocytes, nitrites, pH, glucose and ketones)
- Refer to specialist practitioner for further evaluation.

To be undertaken by specialist practitioners (eg, Emergency Department / General Paediatric / Paediatric Nephrology Team(s)):

- Urinalysis (including blood, protein, leucocytes, nitrites, pH, glucose and ketones)
- Serum electrolytes, urea and creatinine
- Full blood count and film
  - Consider serum lactate dehydrogenase assay if haemolysis suspected (haemolytic uraemic syndrome)
- Blood gas, blood glucose and lactate levels
- Calcium, phosphate and albumin levels
- Consider urgent renal tract ultrasound if no cause has been identified for the AKI or if urinary tract obstruction is suspected.

## Treatment Approach

See Acute kidney injury: Prevention, detection and management of acute kidney injury up to the point of renal replacement therapy [[NICE clinical guideline CG169, Sections 1.1 to 1.3](#)].

Treatment should progress only after the ABCs (airway, breathing, and circulation) of resuscitation have been addressed.

Advice from a paediatric nephrologist should be sought at the earliest opportunity.

To be undertaken by specialist practitioners (eg, Emergency Department / General Paediatric / Paediatric Nephrology / Paediatric Intensive Care Team(s)):

- Measure urine output
- Record weight twice daily to determine fluid balance
- Maintain fluid balance and prevent or treat metabolic derangements
  - Preserve or restore renal perfusion with appropriate fluid resuscitation and inotropic agents in patients with AKI secondary to hypovolaemia and / or poor perfusion
  - Discuss fluid management with paediatric nephrology / paediatric intensive care team(s)
  - Correct hyperkalaemia
- Loop diuretics
  - Do not offer routinely to treat AKI
  - Consider for treating fluid overload or oedema if:
    - The child or young person is awaiting renal replacement therapy
    - Renal function is recovering in a child or young person not receiving renal replacement therapy
- Minimise exposure to nephrotoxic drugs
- Alter dosage regimens of drugs according to degree of renal dysfunction
  - Reduce dose
  - Prolong dosing interval
  - Or both
- Consider renal replacement therapy if any of the following are not responding to medical management:
  - Hyperkalaemia
  - Metabolic acidosis
  - Symptoms or complications of uraemia (eg, pericarditis or encephalopathy)
  - Fluid overload
  - Pulmonary oedema

## Specific Treatment

### Hyperkalaemia

- Apply 100% oxygen via reservoir mask
  - Unless patient has cardiac lesion requiring low FiO<sub>2</sub>
- Apply electrocardiographic (ECG) monitoring
- Give nebulised salbutamol to shift potassium from extracellular to intracellular spaces
  - Neonate - 18 years: 2.5 mg - 5 mg as a single dose; repeat if necessary.

- If ECG changes are present give calcium gluconate (10%)
  - Dose: 0.5 mL/kg IV over 2–4 minutes (longer if patient is on digoxin due to theoretical risk of arrhythmias)
    - Best given through a central vein (can give undiluted via central line)
    - If giving peripherally be aware of risk of extravasation injuries and dilute to 45 micromol/mL (ie, 1 in 5) with glucose 5% or sodium chloride 0.9%.
- Correct metabolic acidosis with sodium bicarbonate
  - Dose: 1 mmol/kg IV over 20 minutes, or an amount appropriate to the body base deficit.
- Calcium polystyrene sulfonate (anion exchange resin)
  - This is required to actually remove potassium from the body
  - Dose: 0.5–1 g/kg by mouth (max. 60 g/day) or per rectum (max. 30 g/day)
- Insulin with dextrose has been used to treat hyperkalaemia by stimulating the uptake of potassium by cells.
  - Dose: intravenous infusion of soluble insulin (0.3 - 0.6 units/kg/hour in neonates and 0.05 - 0.2 units/kg/hour in children over 1 month)
  - Diluted with glucose 0.5 - 1 g/kg/hour (5 - 10 mL/kg/hour of glucose 10% or 2.5 - 5 mL/kg/hour of glucose 20% via a central venous catheter)
  - Extreme caution is required as renal impairment may be associated with:
    - Reduced insulin requirements
    - Impaired compensatory response to hypoglycaemia
- Nephrostomy or stenting:
  - May be required to treat upper tract urological obstruction resulting from:
    - Pyonephrosis
    - Obstructed solitary kidney
    - Bilateral upper urinary tract obstruction
  - Should be undertaken as soon as possible and within 12 hours of diagnosis

## When to Refer

Refer (arrange emergency transport) a child or young person with any 'red flag' signs or symptoms to specialist practitioners (eg, Emergency Department / General Paediatric / Paediatric Nephrology / Paediatric Intensive Care Team(s)).

Refer to a Paediatric Nephrology Team for:

- Guidance on diagnostic evaluation
- Management of complex fluid, mineral, electrolyte, and blood pressure abnormalities
- Evaluation of dialysis options
- Preparation for and implementation of:
  - Dialysis

- Continuous renal replacement therapy (CRRT)
- Disease-specific management

Refer children and young people with upper tract urological obstruction to a Paediatric Urology Team. Refer immediately when one or more of the following is present:

- Pyonephrosis
- An obstructed solitary kidney
- Bilateral upper urinary tract obstruction
- Complications of acute kidney injury caused by urological obstruction

Immediate referral in any stage of AKI with the following:

- Potassium > 6.5 mmol/L (non-haemolysed sample)
- Oligoanuria and plasma sodium < 125 mmol/L
- Pulmonary oedema or hypertension unresponsive to diuretics
- Plasma urea > 40 mmol/L unresponsive to fluid challenge

## When to Admit

Admit to hospital if:

- AKI is unexplained, rapidly progressive, or oliguric or anuric
- Significant or potentially dangerous fluid or metabolic abnormalities
  - Hyperkalaemia
  - Hypocalcaemia
  - Acidosis
  - Clinical fluid overload
  - Dehydration
- Renal biopsy is required

## 'Safety Netting' Advice

Advise parent or carer to seek urgent medical advice if any 'red flag' signs or symptoms develop.

See Acute kidney injury: Prevention, detection and management of acute kidney injury up to the point of renal replacement therapy [[NICE clinical guideline CG169](#), [Recommendation 1.6](#)].

## Patient / Carer Information

***\*Please note: whilst these resources have been developed to a high standard they may not be specific to children.***

- [Acute Kidney Injury – Overview](#) (Web page), InfoKID
- [Acute Kidney Injury – About the future](#) (Web page), InfoKID
- [Think Kidneys - Keeping your child's kidneys safe](#) (PDF), British Kidney Patient Association

## Resources

### National Clinical Guidance

[Acute kidney injury: prevention, detection and management](#) (Web page), NICE clinical guideline CG169, National Institute for Health and Care Excellence

[Standardising the early identification of acute kidney injury](#) (PDF), Patient safety alert, NHS England

[Acute kidney injury \(AKI\) algorithm](#) (PDF), NHS England

### Suggested Resources

***\*Please note: these resources include links to external websites. These resources may not have national accreditation and therefore PCO UK cannot guarantee the accuracy of the content.***

Andreoli SP. Acute renal failure. *Curr Opin Pediatr* 2002;14(2):183–188 [[PubMed](#)]

Bellomo R, Ronco C, Kellum JA, et al. Acute renal failure—definition, outcome measures, animal models, fluid therapy and information technology needs: the Second International Consensus Conference of the Acute Dialysis Quality Initiative (ADQI) Group. *Crit Care* 2004;8(4):R204–R212 [[PubMed](#)]

[British Association for Paediatric Nephrology \(BAPN\) AKI Management Recommendations](#) (PDF), Think Kidneys

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