NICE National Institute for Health and Care Excellence

NICE guideline

Acute kidney injury: prevention, detection and management

Clinical guideline

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Your responsibility

The recommendations in this guideline represent the view of NICE, arrived at after careful consideration of the evidence available. When exercising their judgement, professionals and practitioners are expected to take this guideline fully into account, alongside the individual needs, preferences and values of their patients or the people using their service. It is not mandatory to apply the recommendations, and the guideline does not override the responsibility to make decisions appropriate to the circumstances of the individual, in consultation with them and their families and carers or guardian.

Local commissioners and providers of healthcare have a responsibility to enable the guideline to be applied when individual professionals and people using services wish to use it. They should do so in the context of local and national priorities for funding and developing services, and in light of their duties to have due regard to the need to eliminate unlawful discrimination, to advance equality of opportunity and to reduce health inequalities. Nothing in this guideline should be interpreted in a way that would be inconsistent with complying with those duties.

Commissioners and providers have a responsibility to promote an environmentally sustainable health and care system and should assess and reduce the environmental impact of implementing NICE recommendations wherever possible.

Contents

This guideline is the basis of QS76.

Introduction

Acute kidney injury, previously known as acute renal failure, encompasses a wide spectrum of injury to the kidneys, not just kidney failure. The definition of acute kidney injury has changed in recent years, and detection is now mostly based on monitoring creatinine levels, with or without urine output. Acute kidney injury is increasingly being seen in primary care in people without any acute illness, and awareness of the condition needs to be raised among primary care health professionals.

Acute kidney injury is seen in 13–18% of all people admitted to hospital, with older adults being particularly affected. These patients are usually under the care of healthcare professionals practising in specialties other than nephrology, who may not always be familiar with the optimum care of patients with acute kidney injury. The number of inpatients affected by acute kidney injury means that it has a major impact on healthcare resources. The costs to the NHS of acute kidney injury (excluding costs in the community) are estimated to be between £434 million and £620 million per year, which is more than the costs associated with breast cancer, or lung and skin cancer combined.

There have been concerns that suboptimal care may contribute to the development of acute kidney injury. In 2009, the National Confidential Enquiry into Patient Outcome and Death (NCEPOD)[1] reported the results of an enquiry into the deaths of a large group of adult patients with acute kidney injury. This described systemic deficiencies in the care of patients who died from acute kidney injury: only 50% of these patients had received 'good' care. Other deficiencies in the care of patients who died of acute kidney injury included failures in acute kidney injury prevention, recognition, therapy and timely access to specialist services. This report led to the Department of Health's request for NICE to develop its first guideline on acute kidney injury in adults and also, importantly, in children and young people.

This guideline emphasises early intervention and stresses the importance of risk assessment and prevention, early recognition and treatment. It is primarily aimed at the non-specialist clinician, who will care for most patients with acute kidney injury in a variety of settings. The recommendations aim to address known and unacceptable variations in recognition, assessment, initial treatment and referral for renal replacement therapy. The inpatient mortality of acute kidney injury varies considerably, depending on its severity, setting (intensive care or not), and many other

patient-related factors, but in the UK might typically be 25–30% or more. In view of its frequency and mortality rate, prevention or amelioration of just 20% of cases of acute kidney injury would prevent a large number of deaths and substantially reduce complications and their associated costs.

The guideline will assume that prescribers will use a drug's summary of product characteristics to inform decisions made with individual patients.

[1] National Confidential Enquiry into Patient Outcome and Death (2009) Acute kidney injury: adding insult to injury.

Patient-centred care

This guideline offers best practice advice on the care of adults, children and young people with or at risk of acute kidney injury.

Patients and healthcare professionals have rights and responsibilities as set out in the NHS Constitution for England – all NICE guidance is written to reflect these. Treatment and care should take into account individual needs and preferences. Patients should have the opportunity to make informed decisions about their care and treatment, in partnership with their healthcare professionals. If the patient is under 16, their family or carers should also be given information and support to help the child or young person to make decisions about their treatment. Healthcare professionals should follow the Department of Health's advice on consent. If someone does not have capacity to make decisions, healthcare professionals should follow the code of practice that accompanies the Mental Capacity Act and the supplementary code of practice on deprivation of liberty safeguards. In Wales, healthcare professionals should follow advice on consent from the Welsh Government.

NICE has produced guidance on the components of good patient experience in adult NHS services. All healthcare professionals should follow the recommendations in Patient experience in adult NHS services.

If a young person is moving between paediatric and adult services, care should be planned and managed according to the best practice guidance described in the Department of Health's Transition: getting it right for young people.

Adult and paediatric healthcare teams should work jointly to provide assessment and services to young people with or at risk of acute kidney injury. Diagnosis and management should be reviewed throughout the transition process, and there should be clarity about who is the lead clinician to ensure continuity of care.

Terms used in this guideline

Stages of chronic kidney disease

Stage	eGFR (ml/ min/ 1.73 m^2)	Description	Qualifier
1	≥ 90	Kidney damage, normal or increased GFR	Kidney damage (presence of structural abnormalities and/or persistent haematuria, proteinuria or microalbuminuria) for ≥ 3 months
2	60-89	Kidney damage, mildly reduced GFR	
3A	45-59	Moderately reduced GFR ± other evidence of kidney damage	GFR < 60 ml/min for ≥ 3 months ± kidney damage
3B	30-44		
4	15-29	Severely reduced GFR ± other evidence of kidney damage	
5	< 15	Established kidney failure	

Key priorities for implementation

The following recommendations have been identified as priorities for implementation.

Identifying acute kidney injury in patients with acute illness

- Investigate for acute kidney injury, by measuring serum creatinine and comparing with baseline, in adults with acute illness if any of the following are likely or present:
  - chronic kidney disease (adults with an estimated glomerular filtration rate [eGFR] less than 60 ml/min/1.73 m^2 are at particular risk)
  - heart failure
  - liver disease
  - diabetes
  - history of acute kidney injury
  - oliguria (urine output less than 0.5 ml/kg/hour)
  - neurological or cognitive impairment or disability, which may mean limited access to fluids because of reliance on a carer
  - hypovolaemia
  - use of drugs with nephrotoxic potential (such as non-steroidal anti-inflammatory drugs [NSAIDs], aminoglycosides, angiotensin-converting enzyme [ACE] inhibitors, angiotensin II receptor antagonists [ARBs] and diuretics) within the past week, especially if hypovolaemic
  - use of iodinated contrast agents within the past week
  - symptoms or history of urological obstruction, or conditions that may lead to obstruction
  - sepsis
  - deteriorating early warning scores
  - age 65 years or over.

- Investigate for acute kidney injury, by measuring serum creatinine and comparing with baseline, in children and young people with acute illness if any of the following are likely or present:
    - chronic kidney disease
    - heart failure
    - liver disease
    - history of acute kidney injury
    - oliguria (urine output less than 0.5 ml/kg/hour)
    - young age, neurological or cognitive impairment or disability, which may mean limited access to fluids because of reliance on a parent or carer
    - hypovolaemia
    - use of drugs with nephrotoxic potential (such as NSAIDs, aminoglycosides, ACE inhibitors, ARBs and diuretics) within the past week, especially if hypovolaemic
    - symptoms or history of urological obstruction, or conditions that may lead to obstruction
    - sepsis
    - a deteriorating paediatric early warning score
    - severe diarrhoea (children and young people with bloody diarrhoea are at particular risk)
    - symptoms or signs of nephritis (such as oedema or haematuria)
    - haematological malignancy
    - hypotension.

Assessing risk factors in adults having iodinated contrast agents

- Before offering iodinated contrast agents to adults for emergency or non-emergency imaging, assess their risk of acute kidney injury. Be aware that increased risk is associated with:

- chronic kidney disease (adults with an eGFR less than 40 ml/min/1.73 m^2 are at particular risk)
- diabetes but only with chronic kidney disease (adults with an eGFR less than 40 ml/min/1.73 m^2 are at particular risk)
- heart failure
- renal transplant
- age 75 years or over
- hypovolaemia
- increasing volume of contrast agent
- intra-arterial administration of contrast agent.

Ensure that risk assessment does not delay emergency imaging.

Assessing risk factors in adults having surgery

- Assess the risk of acute kidney injury in adults before surgery. Be aware that increased risk is associated with:
  - emergency surgery, especially when the patient has sepsis or hypovolaemia
  - intraperitoneal surgery
  - chronic kidney disease (adults with an eGFR less than 60 ml/min/1.73 m^2 are at particular risk)
  - diabetes
  - heart failure
  - age 65 years or over
  - liver disease
  - use of drugs with nephrotoxic potential in the perioperative period (in particular, NSAIDs after surgery).

  Use the risk assessment to inform a clinical management plan.

Ongoing assessment of the condition of patients in hospital

- When adults are at risk of acute kidney injury, ensure that systems are in place to recognise and respond to oliguria (urine output less than 0.5 ml/kg/hour) if the track and trigger system (early warning score) does not monitor urine output.

Detecting acute kidney injury

- Monitor serum creatinine regularly[2] in all adults, children and young people with or at risk of acute kidney injury.

Identifying the cause(s) of acute kidney injury

- Identify the cause(s) of acute kidney injury and record the details in the patient's notes.

Ultrasound

- When adults, children and young people have no identified cause of their acute kidney injury or are at risk of urinary tract obstruction, offer urgent ultrasound of the urinary tract (to be performed within 24 hours of assessment).

Referring to nephrology

- Discuss the management of acute kidney injury with a nephrologist or paediatric nephrologist as soon as possible and within 24 hours of detection when one or more of the following is present:
    - a possible diagnosis that may need specialist treatment (for example, vasculitis, glomerulonephritis, tubulointerstitial nephritis or myeloma)
    - acute kidney injury with no clear cause
    - inadequate response to treatment
    - complications associated with acute kidney injury
    - stage 3 acute kidney injury (according to (p)RIFLE, AKIN or KDIGO criteria)
    - a renal transplant
    - chronic kidney disease stage 4 or 5.

Information and support for patients and carers

- Give information about long-term treatment options, monitoring, self-management and support to people who have had acute kidney injury (and/or their parent or carer, if appropriate) in collaboration with a multidisciplinary team appropriate to the person's individual needs.

[2] The GDG did not wish to define 'regularly' because this would vary according to clinical need but recognised that daily measurement was typical while in hospital.

1 Recommendations

The following guidance is based on the best available evidence. The full guideline gives details of the methods and the evidence used to develop the guidance.

> The wording used in the recommendations in this guideline (for example words such as 'offer' and 'consider') denotes the certainty with which the recommendation is made (the strength of the recommendation). See About this guideline for details.

In this guideline the term 'adults' is used to describe people who are aged 18 years or older, and 'children' those who are aged 11 years or younger (excluding neonates less than 1 month old). 'Young people' describes those who are aged 12 to 17 years.

1.1 Assessing risk of acute kidney injury

Identifying acute kidney injury in patients with acute illness

1.1.1 Investigate for acute kidney injury, by measuring serum creatinine and comparing with baseline, in adults with acute illness if any of the following are likely or present:

- chronic kidney disease (adults with an estimated glomerular filtration rate [eGFR] less than 60 ml/min/1.73 m^2 are at particular risk)
- heart failure
- liver disease
- diabetes
- history of acute kidney injury
- oliguria (urine output less than 0.5 ml/kg/hour)
- neurological or cognitive impairment or disability, which may mean limited access to fluids because of reliance on a carer
- hypovolaemia
- use of drugs with nephrotoxic potential (such as non-steroidal anti-inflammatory drugs [NSAIDs], aminoglycosides, angiotensin-converting enzyme [ACE] inhibitors,

angiotensin II receptor antagonists [ARBs] and diuretics) within the past week, especially if hypovolaemic

- use of iodinated contrast agents within the past week
- symptoms or history of urological obstruction, or conditions that may lead to obstruction
- sepsis
- deteriorating early warning scores
- age 65 years or over.

1.1.2 Investigate for acute kidney injury, by measuring serum creatinine and comparing with baseline, in children and young people with acute illness if any of the following are likely or present:

- chronic kidney disease
- heart failure
- liver disease
- history of acute kidney injury
- oliguria (urine output less than 0.5 ml/kg/hour)
- young age, neurological or cognitive impairment or disability, which may mean limited access to fluids because of reliance on a parent or carer
- hypovolaemia
- use of drugs with nephrotoxic potential (such as NSAIDs, aminoglycosides, ACE inhibitors, ARBs and diuretics) within the past week, especially if hypovolaemic
- symptoms or history of urological obstruction, or conditions that may lead to obstruction
- sepsis
- a deteriorating paediatric early warning score

- severe diarrhoea (children and young people with bloody diarrhoea are at particular risk)
- symptoms or signs of nephritis (such as oedema or haematuria)
- haematological malignancy
- hypotension.

Identifying acute kidney injury in patients with no obvious acute illness

1.1.3 Be aware that in adults, children and young people with chronic kidney disease and no obvious acute illness, a rise in serum creatinine may indicate acute kidney injury rather than a worsening of their chronic disease.

1.1.4 Ensure that acute kidney injury is considered when an adult, child or young person presents with an illness with no clear acute component and has any of the following:

- chronic kidney disease, especially stage 3B, 4 or 5, or urological disease
- new onset or significant worsening of urological symptoms
- symptoms suggesting complications of acute kidney injury
- symptoms or signs of a multi-system disease affecting the kidneys and other organ systems (for example, signs or symptoms of acute kidney injury, plus a purpuric rash).

Assessing risk factors in adults having iodinated contrast agents

1.1.5 Before offering iodinated contrast agents to adults for non-emergency imaging, investigate for chronic kidney disease by measuring eGFR or by checking an eGFR result obtained within the past 3 months.

1.1.6 Before offering iodinated contrast agents to adults for emergency or non-emergency imaging, assess their risk of acute kidney injury. Be aware that increased risk is associated with:

- chronic kidney disease (adults with an eGFR less than 40 ml/min/1.73 m^2 are at particular risk)

- diabetes but only with chronic kidney disease (adults with an eGFR less than 40 ml/min/1.73 m^2 are at particular risk)
- heart failure
- renal transplant
- age 75 years or over
- hypovolaemia
- increasing volume of contrast agent
- intra-arterial administration of contrast agent.

Ensure that risk assessment does not delay emergency imaging.

1.1.7 Include the risks of developing acute kidney injury in the routine discussion of risks and benefits of the imaging procedure. Follow the recommendations on shared decision-making in Patient experience in adult NHS services (NICE clinical guidance 138).

Assessing risk factors in adults having surgery

1.1.8 Assess the risk of acute kidney injury in adults before surgery. Be aware that increased risk is associated with:

- emergency surgery, especially when the patient has sepsis or hypovolaemia
- intraperitoneal surgery
- chronic kidney disease (adults with an eGFR less than 60 ml/min/1.73 m^2 are at particular risk)
- diabetes
- heart failure
- age 65 years or over
- liver disease

- use of drugs with nephrotoxic potential in the perioperative period (in particular, NSAIDs after surgery).

Use the risk assessment to inform a clinical management plan.

1.1.9 Include the risks of developing acute kidney injury in the routine discussion of risks and benefits of surgery. Follow the recommendations on shared decision-making in Patient experience in adult NHS services (NICE clinical guidance 138).

1.2 Preventing acute kidney injury

Ongoing assessment of the condition of patients in hospital

1.2.1 Follow the recommendations in Acutely ill patients in hospital (NICE clinical guideline 50) on the use of track and trigger systems (early warning scores) to identify adults who are at risk of acute kidney injury because their clinical condition is deteriorating or is at risk of deteriorating.

1.2.2 When adults are at risk of acute kidney injury, ensure that systems are in place to recognise and respond to oliguria (urine output less than 0.5 ml/kg/hour) if the track and trigger system (early warning score) does not monitor urine output.

1.2.3 Consider using a paediatric early warning score to identify children and young people admitted to hospital who are at risk of acute kidney injury because their clinical condition is deteriorating or is at risk of deteriorating.

- Record physiological observations at admission and then according to local protocols for given paediatric early warning scores.
- Increase the frequency of observations if abnormal physiology is detected.

1.2.4 If using a paediatric early warning score, use one with multiple-parameter or aggregate weighted scoring systems that allow a graded response and:

- define the parameters to be measured and the frequency of observations
- include a clear and explicit statement of the parameters, cut-off points or scores that should trigger a response.

1.2.5 If using a paediatric early warning score, use one with multiple-parameter or aggregate weighted scoring systems that measure:

- heart rate
- respiratory rate
- systolic blood pressure
- level of consciousness
- oxygen saturation
- temperature
- capillary refill time.

1.2.6 When children and young people are at risk of acute kidney injury because of risk factors in recommendation 1.1.2:

- measure urine output
- record weight twice daily to determine fluid balance
- measure urea, creatinine and electrolytes
- think about measuring lactate, blood glucose and blood gases.

Preventing acute kidney injury in adults having iodinated contrast agents

1.2.7 Offer intravenous volume expansion to adults having iodinated contrast agents if:

- they are at increased risk of contrast-induced acute kidney injury because of risk factors in recommendation 1.1.6, or
- they have an acute illness.

Offer either isotonic sodium bicarbonate or 0.9% sodium chloride.

1.2.8 Consider temporarily stopping ACE inhibitors and ARBs in adults having iodinated contrast agents if they have chronic kidney disease with an eGFR less than 40 ml/min/1.73 m^2.

1.2.9 Discuss care with a nephrology team before offering iodinated contrast agent to adults with contraindications to intravenous fluids if:

- they are at increased risk of contrast-induced acute kidney injury, or
- they have an acute illness, or
- they are on renal replacement therapy.

Monitoring and preventing deterioration in patients with or at high risk of acute kidney injury

1.2.10 Consider electronic clinical decision support systems (CDSS) to support clinical decision-making and prescribing, but ensure they do not replace clinical judgement.

1.2.11 When acquiring any new CDSS or systems for electronic prescribing, ensure that any systems considered:

- can interact with laboratory systems
- can recommend drug dosing and frequency
- can store and update data on patient history and characteristics, including age, weight and renal replacement therapy
- can include alerts that are mandatory for the healthcare professional to acknowledge and review.

1.2.12 Seek advice from a pharmacist about optimising medicines and drug dosing in adults, children and young people with or at risk of acute kidney injury.

1.2.13 Consider temporarily stopping ACE inhibitors and ARBs in adults, children and young people with diarrhoea, vomiting or sepsis until their clinical condition has improved and stabilised.

1.3 Detecting acute kidney injury

1.3.1 Detect acute kidney injury, in line with the (p)RIFLE[3], AKIN[4] or KDIGO[5] definitions, by using any of the following criteria:

- a rise in serum creatinine of 26 micromol/litre or greater within 48 hours
- a 50% or greater rise in serum creatinine known or presumed to have occurred within the past 7 days
- a fall in urine output to less than 0.5 ml/kg/hour for more than 6 hours in adults and more than 8 hours in children and young people
- a 25% or greater fall in eGFR in children and young people within the past 7 days.

1.3.2 Monitor serum creatinine regularly[6] in all adults, children and young people with or at risk of acute kidney injury.

1.4 Identifying the cause(s) of acute kidney injury

1.4.1 Identify the cause(s) of acute kidney injury and record the details in the patient's notes.

Urinalysis

1.4.2 Perform urine dipstick testing for blood, protein, leucocytes, nitrites and glucose in all patients as soon as acute kidney injury is suspected or detected. Document the results and ensure that appropriate action is taken when results are abnormal.

1.4.3 Think about a diagnosis of acute nephritis and referral to the nephrology team when an adult, child or young person with no obvious cause of acute kidney injury has urine dipstick results showing haematuria and proteinuria, without urinary tract infection or trauma due to catheterisation.

Ultrasound

1.4.4 Do not routinely offer ultrasound of the urinary tract when the cause of the acute kidney injury has been identified.

1.4.5 When pyonephrosis (infected and obstructed kidney[s]) is suspected in adults, children and young people with acute kidney injury, offer immediate ultrasound of the urinary tract (to be performed within 6 hours of assessment).

1.4.6 When adults, children and young people have no identified cause of their acute kidney injury or are at risk of urinary tract obstruction, offer urgent ultrasound of the urinary tract (to be performed within 24 hours of assessment).

1.5 Managing acute kidney injury

Relieving urological obstruction

1.5.1 Refer all adults, children and young people with upper tract urological obstruction to a urologist. 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.

1.5.2 When nephrostomy or stenting is used to treat upper tract urological obstruction in adults, children and young people with acute kidney injury, undertake as soon as possible and within 12 hours of diagnosis.

Pharmacological management

1.5.3 Do not routinely offer loop diuretics to treat acute kidney injury.

1.5.4 Consider loop diuretics for treating fluid overload or oedema while:

- an adult, child or young person is awaiting renal replacement therapy, or
- renal function is recovering in an adult, child or young person not receiving renal replacement therapy.

1.5.5 Do not offer low-dose dopamine to treat acute kidney injury.

Referring for renal replacement therapy

1.5.6 Discuss any potential indications for renal replacement therapy with a nephrologist, paediatric nephrologist and/or critical care specialist immediately to ensure that the therapy is started as soon as needed.

1.5.7 When an adult, child or young person has significant comorbidities, discuss with them and/or their parent or carer and within the multidisciplinary team whether renal replacement therapy would offer benefit. Follow the recommendations on shared decision-making in Patient experience in adult NHS services (NICE clinical guidance 138).

1.5.8 Refer adults, children and young people immediately for renal replacement therapy if any of the following are not responding to medical management:

- hyperkalaemia
- metabolic acidosis
- symptoms or complications of uraemia (for example, pericarditis or encephalopathy)
- fluid overload
- pulmonary oedema.

1.5.9 Base the decision to start renal replacement therapy on the condition of the adult, child or young person as a whole and not on an isolated urea, creatinine or potassium value.

1.5.10 When there are indications for renal replacement therapy, the nephrologist and/or critical care specialist should discuss the treatment with the adult, child or young person and/or their parent or carer as soon as possible and before starting treatment. Follow the recommendations on shared decision-making in Patient experience in adult NHS services (NICE clinical guidance 138).

Referring to nephrology

1.5.11 Refer adults, children and young people with acute kidney injury to a nephrologist, paediatric nephrologist or critical care specialist immediately if they meet criteria for renal replacement therapy in recommendation 1.5.8.

1.5.12 Do not refer adults, children or young people to a nephrologist or paediatric nephrologist when there is a clear cause for acute kidney injury and the condition is responding promptly to medical management, unless they have a renal transplant.

1.5.13 Consider discussing management with a nephrologist or paediatric nephrologist when an adult, child or young person with severe illness might benefit from treatment, but there is uncertainty as to whether they are nearing the end of their life.

1.5.14 Refer adults, children and young people in intensive care to a nephrology team when there is uncertainty about the cause of acute kidney injury or when specialist management of kidney injury might be needed.

1.5.15 Discuss the management of acute kidney injury with a nephrologist or paediatric nephrologist as soon as possible and within 24 hours of detection when one or more of the following is present:

- a possible diagnosis that may need specialist treatment (for example, vasculitis, glomerulonephritis, tubulointerstitial nephritis or myeloma)
- acute kidney injury with no clear cause
- inadequate response to treatment
- complications associated with acute kidney injury
- stage 3 acute kidney injury (according to (p)RIFLE, AKIN or KDIGO criteria)
- a renal transplant
- chronic kidney disease stage 4 or 5.

1.5.16 Monitor[7] serum creatinine after an episode of acute kidney injury. Consider referral to a nephrologist or paediatric nephrologist when eGFR is 30 ml/min/1.73 m^2 or less in adults, children and young people who have recovered from an acute kidney injury.

1.5.17 Consider referral to a paediatric nephrologist for children and young people who have recovered from an episode of acute kidney injury but have

hypertension, impaired renal function or 1+ or greater proteinuria on dipstick testing of an early morning urine sample.

1.6 Information and support for patients and carers

1.6.1 Discuss immediate treatment options, monitoring, prognosis and support options as soon as possible with people with acute kidney injury and/or, if appropriate, their parent or carer. Follow the recommendations on patient views and preferences and shared decision-making in Patient experience in adult NHS services (NICE clinical guidance 138).

1.6.2 Give information about long-term treatment options, monitoring, self-management and support to people who have had acute kidney injury (and/or their parent or carer, if appropriate) in collaboration with a multidisciplinary team appropriate to the person's individual needs.

1.6.3 Give information about future care to people needing renal replacement therapy after discharge following acute kidney injury. This should include information about the frequency and length of dialysis sessions and the preparation needed (such as having a fistula or peritoneal catheter).

1.6.4 Discuss the risk of developing acute kidney injury, particularly the risk associated with conditions leading to dehydration (for example, diarrhoea and vomiting) and drugs with nephrotoxic potential (including over-the-counter NSAIDs), with people who are at risk of acute kidney injury, particularly those who have:

- chronic kidney disease with an eGFR less than 60 ml/min/1.73 m^2
- neurological or cognitive impairment or disability, which may mean limited access to fluids because of reliance on a carer.

Involve parents and carers in the discussion if appropriate.

[3] Risk, Injury, Failure, Loss, End stage renal disease, (p) refers to the paediatric classification.

[4] Acute Kidney Injury Network.

[5] Kidney Disease: Improving Global Outcomes.

[6] The GDG did not wish to define 'regularly' because this would vary according to clinical need but recognised that daily measurement was typical while in hospital.

[7] The frequency of monitoring should be based on the stability and degree of renal function at the time of discharge.

2 Research recommendations

The Guideline Development Group has made the following recommendations for research, based on its review of evidence, to improve NICE guidance and patient care in the future. The Guideline Development Group's full set of research recommendations is detailed in appendix L of the full guideline.

2.1 Long-term outcomes of acute kidney injury

What are the long-term outcomes of acute kidney injury in adults, children and young people?

Why this is important

Long-term follow-up studies, predominantly from North America, have shown that acute kidney injury is associated with an increased risk of chronic kidney disease or exacerbation of underlying chronic kidney disease. This can lead to end-stage renal disease (ESRD) and long-term dialysis. About a quarter to a third of the costs associated with acute kidney injury in adults are due to ESRD. Older adults with comorbidities are at particular risk.

Although acute kidney injury is traditionally regarded as reversible, the psychological effects are not well studied. Some studies of adults who have recovered from acute kidney injury suggest a reduced quality of life, including higher rates of depression. People also often need more social care or discharge to residential care.

The factors associated with the long-term complications of acute kidney injury are poorly understood. A large, prospective epidemiological or cohort study is needed with a control group (for example, patients admitted to hospital as an emergency with an acute illness, but without acute kidney injury). In adults follow-up should be for at least 2–3 years, and the study should be adequately powered to detect factors predictive of the two most costly outcomes in adults, new ESRD and new need for residential care or the inability to live independently in the community. In children and young people, longer follow-up beyond puberty is needed. Important long-term complications for children and young people include hypertension, proteinuria and reduced renal function.

2.2 Rapid referral to nephrology services for moderate to severe acute kidney injury

What is the clinical and cost effectiveness of rapid referral (within 12 hours) to nephrology services for adults with moderate to severe (stage 2 to 3) acute kidney injury not needing critical care?

Why this is important

There is national variation in referral of patients with moderate to severe acute kidney injury to nephrology services. Evidence is lacking on the effect of rapid referral (within 12 hours) on major outcomes, including the need for renal replacement therapy, mortality, length of hospital stay and health-related quality of life at 6 months. In most patients acute kidney injury is managed by correcting volume depletion and hypotension and avoiding further renal insults, including nephrotoxic drugs. This does not usually require specialist input from nephrology or critical care services.

In a proportion of patients, renal function may deteriorate further because of primary renal diseases needing specialist treatment (for example, immunosuppressive therapy), progressive organ failure needing treatment with adverse effects on the kidneys (for example, high-dose diuretics in congestive heart failure) or inadequate correction of volume depletion and hypotension.

The optimal timing for referral to nephrology services is not known. Rapid referral of all patients with stage 2 to 3 acute kidney injury may allow earlier detection of primary renal diseases and avoid delay in starting appropriate therapy. It may also ensure more rapid correction of volume depletion and hypotension and initiation of targeted investigations. Potential benefits also include prevention of progressive acute kidney injury, avoidance of renal replacement therapy, avoidance of a delayed transfer to critical care, improved chances of renal recovery, a shorter hospital stay and better long-term outcomes.

The challenge would be to provide rapid referral (within 12 hours) out of hours. This would be a particular challenge in hospitals without a renal unit on site. Rapid referral of all patients with stage 2 to 3 acute kidney injury would also mean extra costs associated with referring patients whose renal function would have recovered quickly with basic general management alone.

A randomised controlled trial is needed to evaluate the clinical and cost effectiveness of rapid referral (within 12 hours) to nephrology services for all adult patients with moderate to severe (stage 2 to 3) acute kidney injury compared with referral based on clinical judgement (that is,

standard care). Outcomes should include need for renal replacement therapy, mortality, length of hospital stay and health-related quality of life at 6 months.

2.3 Definition of acute kidney injury – system for staging and detection

Can a simplified definition and staging system, based on Système International (SI) units, be used to predict short- to medium-term outcomes in acute kidney injury?

Why this is important

Definitions of acute kidney injury have evolved fairly rapidly in recent years, from RIFLE (2004), through AKIN (2007), to KDIGO (2012) (a merger of RIFLE and AKIN, but with less rigorous requirements for detection in those with chronic kidney disease). All three are complex and rely on non-SI units for creatinine.

Absolute creatinine rises have been shown to be independently associated with mortality, but the evidence comes from US studies that used non-SI units for creatinine. Stage 1 acute kidney injury is currently defined by a rise in creatinine of 0.3 mg/dl within 48 hours, which translates to 26.4 micromol/litre in SI units (note that laboratories report creatinine as an integer value only). The current definitions are complex and difficult to use for non-specialists in healthcare systems that use SI units for creatinine measurement (including the UK).

A large, prospective epidemiological or cohort study is needed to investigate whether a simplified system, derived from KDIGO, would be useful for detecting and staging acute kidney injury in the NHS. The study should investigate the relationship of acute kidney injury, as defined by creatinine rise in SI units, with outcomes, adjusted for comorbidity. It also needs to investigate whether the same absolute rise in creatinine equally reflects outcomes among patients with and without chronic kidney disease. The study should include a control group (for example, patients admitted to hospital as an emergency with an acute illness, but without acute kidney injury) and be adequately powered to show the effect of acute kidney injury on mortality, length of stay and dialysis for acute kidney injury at 6 months.

2.4 Introducing renal replacement therapy

What is the clinical and cost effectiveness of early versus later introduction of renal replacement therapy in patients with acute kidney injury stages 2 and 3, when there is no urgent need for therapy?

Why this is important

In some patients renal replacement therapy is a lifesaving intervention (for example, in those with hyperkalaemia). For other patients, there may be no clear indicators of when renal replacement therapy should be started because oliguria, fluid overload and uraemia are common and ill-defined indications.

An early introduction of renal replacement therapy might reduce the incidence of uraemia or other complications of acute kidney injury, but might also expose the patient to more risks from the therapy itself. Later introduction might increase the incidence of uraemia or other complications of acute kidney injury, but might also reduce the risks associated with renal replacement therapy.

A prospective study is needed of adult inpatients with acute kidney injury AKIN stages 2 and 3, who are likely to need renal replacement therapy within a given timeframe (for example, 72 hours), but have no urgent need for therapy. Units participating in the study should be able to provide early or later dialysis for these patients. Mortality, length of stay, incidence of complications of acute kidney injury, incidence of complications of renal replacement therapy and usage of dialysis should be compared in patients having early therapy and those having later renal replacement therapy. Possible indicators for early renal replacement therapy could be weight gain less than 10%, urea less than 25 mmol/litre and oliguria 0.5 ml/kg/hour or less for at least 24 hours.

2.5 Preventing deterioration

What is the clinical and cost effectiveness of continuing ACE inhibitor or ARB treatment, versus stopping treatment 24 hours before cardiac surgery and resuming 24 hours after, in people with chronic kidney disease and an eGFR of less than 30 ml/min/1.73 m^2?

Why this is important

People who need cardiac surgery are often receiving ACE inhibitors or ARBs for their cardiac disease. It is unclear whether these people should stop ACE inhibitors or ARBs around the time of cardiac surgery when their blood pressure will be most unstable. Stopping ACE inhibitors or ARBs might cause deterioration of cardiac disease, which is often a concern for cardiology clinicians, but trials of ACE inhibitors and ARBs in cardiac disease have typically excluded patients undergoing cardiac surgery whose condition is unstable. Stopping ACE inhibitors or ARBs at the time of surgery may prevent exacerbation of acute kidney injury in patients whose condition is unstable.

A randomised controlled trial is needed in patients on ACE inhibitors or ARBs undergoing cardiac surgery to compare continuing treatment with stopping treatment for 48 hours (24 hours before and after surgery). Outcomes should include the incidence of acute kidney injury, cardiovascular events, all-cause mortality, number of patients needing renal replacement therapy and length of hospital stay.

3 Other information

3.1 Scope and how this guideline was developed

NICE guidelines are developed in accordance with a scope that defines what the guideline will and will not cover.

How this guideline was developed

NICE commissioned the National Clinical Guideline Centre to develop this guideline. The Centre established a Guideline Development Group (see section 4), which reviewed the evidence and developed the recommendations.

The methods and processes for developing NICE clinical guidelines are described in The guidelines manual.

3.2 Related NICE guidance

Details are correct at the time of publication of the guideline (August 2013). Further information is available on the NICE website.

Published

General

- Patient experience in adult NHS services. NICE clinical guidance 138 (2012).
- Medicines adherence. NICE clinical guideline 76 (2009).
- Acutely ill patients in hospital. NICE clinical guideline 50 (2007).

Condition-specific

- Myocardial infarction with ST-segment-elevation. NICE clinical guideline 167 (2013).
- Hyperphosphataemia in chronic kidney disease. NICE clinical guideline 157 (2013).
- Hypertension. NICE clinical guideline 127 (2011).
- Peritoneal dialysis. NICE clinical guideline 125 (2011).

- Anaemia management in people with chronic kidney disease. NICE clinical guideline 114 (2011).
- Chronic heart failure. NICE clinical guideline 108 (2010).
- Chest pain of recent onset. NICE clinical guideline 95 (2010).
- Unstable angina and NSTEMI. NICE clinical guideline 94 (2010).
- Critical illness rehabilitation. NICE clinical guideline 83 (2009).
- Type 2 diabetes. NICE clinical guideline 66, partially updated by CG87 (2008).
- Type 1 diabetes. NICE clinical guideline 15 (2004).

Under development

NICE is developing the following guidance (details available from the NICE website):

- Intravenous fluids therapy in children. NICE clinical guideline. Publication expected November 2015.
- Acute heart failure. NICE clinical guideline. Publication expected September 2014.
- Chronic kidney disease (update). NICE clinical guideline. Publication expected July 2014.
- Intravenous fluid therapy. NICE clinical guideline. Publication expected November 2013.
- Type 1 diabetes (update). NICE clinical guideline. Publication date to be confirmed.
- Diabetes in children and young people. NICE clinical guideline. Publication date to be confirmed.
- Anaemia management in chronic kidney disease (update). NICE clinical guideline. Publication date to be confirmed
- Type 2 diabetes (update). NICE clinical guideline. Publication date to be confirmed
- Clinitek Microalbumin 9 reagent strips for the early detection and monitoring of kidney disease. NICE technology appraisal. Publication date to be confirmed.

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About this guideline

NICE clinical guidelines are recommendations about the treatment and care of people with specific diseases and conditions in the NHS in England and Wales.

NICE guidelines are developed in accordance with a scope that defines what the guideline will and will not cover.

This guideline was developed by the National Clinical Guideline Centre. The National Clinical Guideline Centre worked with a Guideline Development Group, comprising healthcare professionals (including consultants, GPs and nurses), patients and carers, and technical staff, which reviewed the evidence and drafted the recommendations. The recommendations were finalised after public consultation.

The methods and processes for developing NICE clinical guidelines are described in The guidelines manual.

Strength of recommendations

Some recommendations can be made with more certainty than others. The Guideline Development Group makes a recommendation based on the trade-off between the benefits and harms of an intervention, taking into account the quality of the underpinning evidence. For some interventions, the Guideline Development Group is confident that, given the information it has looked at, most patients would choose the intervention. The wording used in the recommendations in this guideline denotes the certainty with which the recommendation is made (the strength of the recommendation).

For all recommendations, NICE expects that there is discussion with the patient about the risks and benefits of the interventions, and their values and preferences. This discussion aims to help them to reach a fully informed decision (see also Patient\u2011\centred care).

Interventions that must (or must not) be used

We usually use 'must' or 'must not' only if there is a legal duty to apply the recommendation. Occasionally we use 'must' (or 'must not') if the consequences of not following the recommendation could be extremely serious or potentially life threatening.

Interventions that should (or should not) be used – a 'strong' recommendation

We use 'offer' (and similar words such as 'refer' or 'advise') when we are confident that, for the vast majority of patients, an intervention will do more good than harm, and be cost effective. We use similar forms of words (for example, 'Do not offer…') when we are confident that an intervention will not be of benefit for most patients.

Interventions that could be used

We use 'consider' when we are confident that an intervention will do more good than harm for most patients, and be cost effective, but other options may be similarly cost effective. The choice of intervention, and whether or not to have the intervention at all, is more likely to depend on the patient's values and preferences than for a strong recommendation, and so the healthcare professional should spend more time considering and discussing the options with the patient.

Other versions of this guideline

The full guideline, ' Acute kidney injury: prevention, detection and management of acute kidney injury up to the point of renal replacement therapy' contains details of the methods and evidence used to develop the guideline. It is published by the National Clinical Guideline Centre.

The recommendations from this guideline have been incorporated into a NICE Pathway.

We have produced information for the public about this guideline.

Implementation

Implementation tools and resources to help you put the guideline into practice are also available.

Your responsibility

This guidance represents the view of NICE, which was arrived at after careful consideration of the evidence available. Healthcare professionals are expected to take it fully into account when exercising their clinical judgement. However, the guidance does not override the individual responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient, in consultation with the patient and/or guardian or carer, and informed by the summaries of product characteristics of any drugs.

Implementation of this guidance is the responsibility of local commissioners and/or providers. Commissioners and providers are reminded that it is their responsibility to implement the guidance, in their local context, in light of their duties to have due regard to the need to eliminate unlawful discrimination, advance equality of opportunity and foster good relations. Nothing in this guidance should be interpreted in a way that would be inconsistent with compliance with those duties.

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