Clinical Guideline

ACUTE KIDNEY INJURY IN CHILDREN (AKI)

SETTING Bristol Royal Hospital for Children

FOR STAFF Clinical staff caring for children with acute kidney injury

PATIENTS 0 – 18 years

GUIDANCE

Purpose of the guideline

The intention of this guideline is to inform all clinical staff on the assessment, diagnosis and management of acute kidney injury (AKI) in children and young people (CYP), including recognition of the need for referral to the Paediatric Nephrologist. This is in line with national published guidelines including National Institute for Health and Care Excellence [1, 2] and developed in consultation with Paediatric Nephrology colleagues.

Scope of the guideline

This clinical guideline is relevant to clinical staff caring for patients aged 0 to 18 years who are at risk of AKI or have diagnosed AKI. This is not intended as an exhaustive guide to the management of the wide variety of pathologies that may cause AKI.

Definition of AKI

AKI is defined by an abrupt decrease in kidney function, requiring prompt treatment to minimise complications/poor outcomes.

AKI is a broad clinical syndrome encompassing various aetiologies including specific kidney disease, as well as extra-renal pathology. The term acute renal failure (ARF) has been superseded by AKI as it is now recognises renal dysfunction as a continuum rather than a discrete finding [3]. AKI is reflected by a reduction in urine output **and/or** a rise in serum creatinine.

AKI Stage	***Urine output***	***Serum creatinine[4]*****
1	< 0.5ml/kg/hr for 6-12 hours	**>1.5 - 2 x baseline**
2	< 0.5ml/kg/hr for ≥ 12 hours	**2 - 3 x baseline**
3	< 0.3ml/kg/hr for ≥24 hours Anuria for ≥12 hours	**≥ 3 x baseline**

Baseline creatinine refers to a patient's previous creatinine results when well. If these results are not available, age related reference ranges can be used.
**See appendix 2 for paediatric creatinine ranges[4].

Causes of AKI

The majority of paediatric AKI cases are due to pre-renal causes but it is important to recognise co-existing or alternative aetiology.

PRE-RENAL

Shock

Hypovolaemic
- severe diarrhoea and vomiting, haemorrhage, burns, inappropriate diuresis, surgery

Distributive
- sepsis, anaphylaxis, nephrotic syndrome

Cardiogenic
- severe cardiac failure or arrhythmias

Renal vasculature
- NSAIDS, ACE inhibitors, renal artery stenosis, hepatorenal syndrome

Hypoxic insult
- Asphyxia/prolonged resuscitation

RENAL

Glomerular disease
- Post infectious
- SLE
- Thrombotic microangiopathy: HUS, TTP
- ANCA associated
- Henoch-Schonlein purpura
- Diabetes Mellitus

Tubular disease
- Acute tubular injury (ischaemia/toxins)
- Nephrotoxins aminoglycosides, radiocontrast media, myoglobin, cisplatin, heavy metals, light chains in myeloma kidney

Interstitial disease
- Acute interstitial nephritis – drugs (NSAIDS, antibiotics), infection, autoimmune diseases (sarcoidosis, TB)

POST-RENAL
- Calculus
- Thrombosis
- Urethral stricture
- Posterior urethral valves
- Pelviureteric junction dysfunction
- Vesicoureteric junction dysfunction

Obstructive post-renal aetiology requires prompt urological/surgical opinion

ASSESSMENT OF AKI

HISTORY
In particular
- Urinary stream
- Diarrhoea and vomiting
- Oedema
- Use of NSAIDs / nephrotoxic meds?

EXAMINATION
General examination
Assess perfusion status
- Capillary refill time centrally and peripherally
- Mucous membranes
- Peripheral and pulmonary oedema

Observations and fluid status
- Manual blood pressure
- Fluid input and output
- Urine output (ml/kg/hr)
- Daily weights

INVESTIGATION
Baseline
- U&Es, Bicarbonate, LFTs, Calcium, Phosphate, Magnesium, Urate, Glucose, FBC
- Urine dipstick and MC&S
- Urine protein:creatinine ratio
- Urine albumin:creatinine ratio
- Early urinary electrolytes
- If diarrhoea – stool culture E.Coli 0157
- If ***obstruction*** suspected (renal USS within 6 hours) or no other cause identified (renal USS within 24 hours) ***USS*** should include renal artery doppler studies (NICE guidance)

Additional
- Autoimmune screen ANA, ANCA, Anti-dsDNA, complement C3 & C4, ASOT, anti-GBM antibodies, immunoglobulins
- CK, LDH
- Venous gas
- Renal USS
- CXR

RE-ASSESS REGULARLY

KEY MANAGEMENT POINTS
Fluid management
- Adequate fluid resuscitation, being mindful of electrolyte balance and renal perfusion – see **'Fluid Management in Paediatric Patients'** clinical guideline
- Review any potassium containing fluids and consider stopping
- Euvolaemic patients – replace output + insensible losses (300-400ml/m^2/24hrs). Regularly re-assess (Vital signs and at least daily weights)
- **Medications (See Appendix 3)**
- Stop nephrotoxic medications - NSAIDs, aminoglycosides, ACE inhibitors, contrast agents

Discuss with Paediatric Nephrologist if:[1]
- Severe electrolyte imbalance (e.g. Potassium level >6.0mmol/L)
- Metabolic acidosis (Bicarbonate <20mmol/L)
- Hypertension (>95th centile for age). See appendix 2
- Fluid overload/pulmonary oedema
- Inadequate response to treatment or complications associated with AKI
- A possible diagnosis that may require specialist treatment
- No clear cause or stage 3 AKI
- Chronic Kidney Disease Stage 4 or 5
- All renal transplant patients

Follow-up
It is important to ensure that renal function has returned to baseline following an AKI. Individuals with Stage 3 AKI will require long-term follow-up. Please consider the following:
- Renal function monitoring until stabilised.
- Blood pressure and urine dipstick testing (proteinuria) annually following AKI. Increase frequency of monitoring if deranged.

Information for families[5]
www.infokid.org.uk/acute-kidney-injury

Table A

REFERENCES	1. National Institute for Health and Care Excellence (NICE) 2013, Clinical guideline 169, Acute Kidney Injury. 2. National Institute for Health and Care Excellence (NICE) 2014, Clinical guideline 182, Chronic Kidney Disease. 3. Kidney Disease: Improving Global Outcomes (KDIGO) Acute Kidney Injury Work Group. KDIGO Clinical Practice Guideline for Acute Kidney Injury. Kidney inter., Suppl. 2012; 2: 1–138 4. Think Kidneys: Guidance for clinicians managing children at risk of, or with, acute kidney injury, October 2017, 1-14 5. https://www.infokid.org.uk/acute-kidney-injury 6. Think Kidneys: Guidance for Medicines Optimisation in Patients with Acute Kidney Injury, July 2016, 1- 15 7. University Hospitals Bristol NHS Foundation Trust, Biochemistry Department. Creatinine Reference Ranges by age.
RELATED DOCUMENTS AND PAGES	[redacted]
AUTHORISING BODY	Paediatric Renal Governance Group
SAFETY	
QUERIES AND CONTACT	Contact Paediatric Nephrology team at Bristol Royal Hospital for Children via switchboard. Bleeps: [redacted]. Consultant always on call and can be contacted

APPENDIX 1

Interpreting inflammatory disease profiles

Nephrotic
- Minimal change GN: normal C3&4

Glomerulonephritis
- Post infectious GN: ASOT, anti-DNase B titres high after streptococcal infection, ↓ C3, C4 normal
- IgA nephropathy: normal C3

Multi-system/Vasculitis
- ANCA +
  - Granulomatosis with polyangiitis: cANCA and anti-PR3
  - Microscopic polyangiitis: pANCA and anti-MPO
- HSP: Clinical diagnosis after excluding other vasculitic causes
- SLE: ↑ CRP, ↑ESR, ↓ C3&C4, positive ANA dsDNA
- Goodpasture's disease: anti-GBM +

NOTE: Normal or negative investigation results do not exclude these conditions

Glossary of terms

SLE – Systemic Lupus Erythematosus
HUS – Haemolytic Uraemic Syndrome
TTP – Thrombotic Thrombocytopaenic Purpura
NSAIDs – Non-steroidal Anti-inflammatory Drugs
TB - Tuberculosis
ACE – Angiotensin Converting Enzyme
ANCA - Antineutrophil Cytoplasmic Antibody
c-ANCA - Classical Antineutrophil Cytoplasmic Antibodies
anti-PR3 -Antiproteinase 3 Antibodies
p-ANCA - Protoplasmic-staining Antineutrophil Cytoplasmic Antibodies
anti-MPO – Antimyeloperoxidase Antibodies
anti GBM - Antiglomerular Basement Membrane
ASOT - Antistreptolysin O

APPENDIX 2

Estimating baseline creatinine

Paediatric creatinine values vary with age, size and muscle mass and this must be considered when interpreting results.
These creatinine values are the reference ranges are derived from the **local Bristol population** after exclusion of children with renal disease[7]. Hospital specific reference ranges should be used first line, however, if these are not available reference can be made to values in the table below.

Creatinine serum reference ranges (umol/L)

Gender	Age	Low	High
Both	less than 2 weeks	27	77
Both	2 weeks - <1 year	14	34
Both	1 - 2 years	15	31
Both	3 - 4 years	23	37
Both	5 - 6 years	25	42
Both	7 - 8 years	30	47
Both	9 - 10 years	29	56
Both	11 years	36	64
Both	12 years	36	67

Age	Gender	Low	High	Gender	Low	High
13 years	M	38	76	F	38	74
14 years	M	40	83	F	43	75
15 years	M	47	98	F	44	79
16 years	M	54	99	F	48	81
17+ years	M	59	104	F	45	84

Blood pressure centiles

See Clinical Guideline – [redacted]

APPENDIX 3

Medication management in AKI [4]

Guidance for medicines optimisation in patients with AKI can be found online at: https://www.thinkkidneys.nhs.uk/aki/resources/paediatrics/ [6]