Acute kidney injury (AKI)

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See also: Hypertension (Microguide > Paediatrics & Neonatology > Paediatrics > A-Z > H)

Background

AKI =

- A recent **increase of >1.5x in creatinine from a previous baseline** or a value of **> 1.5 x upper limit of the reference interval for age.**
- **Usually associated with a fall in u**rine output **<0.5ml/kg/hr for 8 hours.**
- Creatinine result should be interpreted in the context of age, body and muscle mass and ethnicity.

BSUH reference ranges – for use in BSUH only

Adult	male: 62 - 106 µmol/L
Adult	female: 44 - 80 µmol/L

Source: Roche Cobas® Jaffé Creatinine kit insert 10-2015, V11.0

Neonates (premature)	29 - 87 µmol/L
Neonates (full term)	27 - 77 µmol/L
2 to 12 months	14 - 34 µmol/L
1 to <3 years	15 - 31 µmol/L
3 to <5 years	23 - 37 µmol/L
5 to <7 years	28 - 52 µmol/L
7 to <9 years	35 - 53 µmol/L
9 to <11 years	34 - 65 µmol/L
11 to <13 years	46 - 70 µmol/L
13 to <15 years	50 - 77 µmol/L
15 years and over	see adult ranges

Source:

0 - 5 years: Roche Cobas® Enzymatic Creatinine kit insert, 09-2014, V7.0

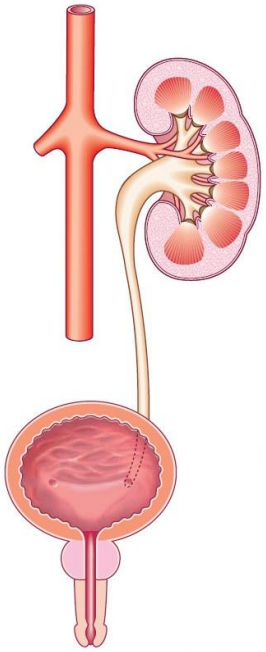
5 years and over: Roche Cobas® Jaffé Creatinine kit insert 10-2015, V11.0

AKI Warning Score

AKI stage	Creatinine change from baseline/ upper limit *or* eGFR (mL/min/1.73m^2)	Urine output
1	>1.5-2x *or* eGFR < 75	<0.5mls/kg for 8 hours
2	2-3x *or* eGFR < 50	
3	>3x *or* eGFR < 35	

eGFR should be calculated using the method below. Alternatively contact a member of the paediatric pharmacy team for assistance with the calculation.

Assessment



Causes of acute kidney injury.
Source : Davidsons Essentials of Medicine,

Causes	Considerations in the history
Pre-renal • Hypovolaemia • Impaired Cardiac output • Renal vessel occlusion • Hepato-renal syndrome	• Signs and symptoms of hypovolaemia e.g. vomiting or diarrhoea, decreased UO, dizziness, lethargy • FH of renal artery stenosis • PMH: biliary atresia, cardiac disease
Intrinsic renal disease • Glomerulonephritis • Involvement of renal microvasculature- HUS, HSP • Interstitial nephritis • Drugs • ATN • Tumour lysis syndrome	• Recent viral illness • Change in urine colour e.g. red or “coca cola” coloured • History of transplant or nephrotoxic drugs
Post-renal or obstructive • Posterior urethral valves • Bilateral ureteric obstruction (trauma, calculi) • Urethral obstruction (trauma, calculus)	• Abdominal pain • Reduced UO • History of trauma • History of kidney stones • Frequent UTI’s

eGFR Calculation

In children, eGFR is calculated using the following formula, in which:
k = 30 for children <1 year and k = 40 for children >1 year

$$\text{eGFR(mL/min/1.73m2)} = \frac{k \times \text{height(cm)}}{\text{serum creatinine (micromole/L)}}$$

Management

High risk groups

- Nephro-urological, cardiac, liver disease
- Malignancy, bone marrow transplant
- Dependence on others for access to fluids
- Medication: ACE-I ARB, NSAID, diuretics, calcineurin inhibitors

1. Risk Assessment

- Clinical history including infective symptoms, input output, Hx of transplant, renal disease, nephrotoxic drugs
- Fluid assessment - peripheral circulation, oedema, UO, mucous membranes
- Signs of cardiac failure
- Neurological exam -?electrolyte derangement
- Full set of observations
  - BP (changes are late & measurements in isolation not usually helpful)

High risk scenarios

- History of reduced UO
- Sepsis
- Hypoperfusion or dehydration
- Nephrotoxic drug / toxin exposure
- Renal disease or urinary tract obstruction
- Major surgery

2. Initial management

- Stop **nephrotoxic drugs** and consider alternatives in acute illness
- Monitor **PEWS**, **weight** and **input / output** closely
- Check **renal function** early
- Optimise fluid balance
- Educate parents on risks of dehydration-give **quantitative targets (100:50:20 rule)**

Urine output **<0.5mls/kg/hr** for **8 hour** OR **High risk scenario** OR Concerns in **high risk group**

3. Investigations

→ **U&E, FBC, bone profile, blood gas (bicarbonate)**
→ **Urinalysis, urine microscopy**

Subsequent findings

Cr between ULRI and 1.5x ULRI

Repeat U&E
- immediately then as advised by senior clinician or ECH

AKI stage 1

If clinically relevant investigations as per AKI 2/3

AKI stage 2 or 3

→ C3/4, ASOT, immunoglobulins, ANA, ANCA, anti-GBM, CK, LDH, blood film
→ Urinary tract USS
→ CXR and echocardiography
→ Catheterisation if obstructed

Referral - A paediatric nephrology referral to the Renal Team at Evelina Children's Hospital London (ECHL) **should** be made in:

- **Immediate referral for any stage AKI where**
  - K+ >6.5mmol/l
  - Oligo/anuria and plasma Na+ <125 mmol/L
  - Pulmonary oedema of hypertension unresponsive to diuretics
  - Plasma urea >40mmol/L unresponsive to fluid challenge
  - Persistent or worsening metabolic acidosis
- AKI stage 2 or 3 and consider for stage 1
- **Any AKI**
  - in CKD patient or patient with a renal transplant
  - Suspected intrinsic renal disease (e.g. nephritis / HUS)

If any concerns outside of this list, please discuss with ECHL

Fluid management in AKI

Clinical assessment of Fluid Status

- Fluid assessment- peripheral circulation, oedema, urine output
- Signs of cardiac failure- raised JVP, hepatomegaly, peripheral pitting oedema, bilateral lung creps
- Blood pressure (changes are late and measurements in isolation not usually helpful)
  - Low BP with cool peripheries -> intravascular depletion and shock
  - High BP with warm peripheries -> fluid overload

	Hypovolaemia	Euvolaemia	Overloaded
Initial management	**1. Fluid challenge 10 ml/kg 0.9% sodium chloride STAT** **2.** Initial fluid replacement = **insensible losses (400ml/m^2/day) + UO (last 24h)**	• Fluid challenge 10 ml/kg 0.9% sodium chloride **over 1 hour**	• Furosemide IV infusion 3-5 mg/kg up to 4 times a day (max dose 250mg; max 1g/day) may be considered but this should be a decision **by a senior clinician**
Ongoing management	○ Replace UO and insensible losses for at least 24-48h ▪ Beware of increased losses in fever, profuse D&V, hyperventilating ○ Beware of polyuric recovery phase	Replace ongoing fluid losses (insensible at 400ml/m2/d, urine, GI losses) Insensible losses are higher in febrile children and lower in ventilated children	Fluid restrict to 50-75% of UO

If renal function continuing to improve, set fluid target.

Ongoing management "Monitor, Maintain, Minimise"

1. Monitor

- **Strict and accurate input / output**
  At least **daily weights**
  - ALWAYS plot height and weight on a growth chart
  - Ideally at the same time each day, especially in small children
- **Blood pressure at least four hourly**
  - **https://bihsoc.org/wp-content/uploads/2017/11/GOSH-BP-flowsheet-Children-E-Brennan-May-2017-1.pdf**
- **Nutrition** - children with AKI are in a catabolic state and therefore need monitoring to ensure meeting adequate calorie requirement
- **Investigations**
  - Bloods: **DAILY U&E.** Management of electrolyte abnormalities especially **hyperkalaemia**
  - Urinalysis at least daily

2. Maintain

- Ensure adequate circulatory volume – address hypoperfusion urgently with fluid boluses (10 ml/kg) and inotropic support once volume is restored.

3. Minimise

- Further harm should be reduced by stopping nephrotoxic drugs and restarting when appropriate with dose adjustments
- Intravenous contrast should also be avoided

References
- **https://www.grepmed.com/images/3937/differential-nephrology-postrenal-diagnosis-prerenal-failure-kidney**
- **https://www.thinkkidneys.nhs.uk/aki/wp-content/uploads/sites/2/2016/05/Guidance_for_paediatric_patients_FINAL.pdf**
- **https://www.nuh.nhs.uk/download.cfm?doc=docm93jijm4n840**