Causes of AKI

Pre-Renal AKI - decreased perfusion of the kidneys:-

- **Volume depletion** (excessive diuresis, haemorrhage, shock, burns, severe trauma)
- **Cardiovascular disorders** (congestive cardiac failure & acute MI)
- **Obstruction of renal arteries** (renal thrombosis, renal artery stenosis)

Post-Renal AKI - obstruction to urine outflow, from the collecting ducts in the kidney down to the urethra.

- **Deposition of crystals** in the tubules, eg. uric acid, sulphonamides, aciclovir, cisplatin.
- **Renal stones** in the ureter or bladder
- **Tumour**, either within the tract or pressing on it from another pelvic organ, eg. prostate hypertrophy, bladder cancer, bowel cancer.

Intra-Renal AKI – damage to the kidney itself

- **Sustained hypoperfusion**, or exposure to **nephrotoxic agents**

Antibiotics - aminoglycosides, amphotericin.
Analgesics - paracetamol, salicylates
Ethylene glycol (antifreeze)

- **Autoimmune renal disease** - vasculitis, SLE, interstitial nephritis, glomerulonephritis, etc

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High Risk Medicines and Actions

When a patient is admitted with AKI, a thorough review of medication is required:

- ❖ To eliminate potential causes / risk / contributory factors for AKI
- ❖ To avoid inappropriate combinations of medicines in the context of AKI
- ❖ To ensure all prescribed medicines are clinically appropriate

Review all Medications

- ❖ Remember to check medication history thoroughly and ask about "Over the Counter" preparations, herbal remedies or teas and alternative therapies.
- ❖ Check use of recreational drugs (cocaine, ketamine, etc).
- ❖ Consider withholding nephrotoxic medications on admission in patients at high risk of AKI
- ❖ Ensure that all doses are amended concomitant with the patient's degree of renal impairment. Re-assess daily until AKI resolves
- ❖ Educate the patient before discharge re which medications to restart and when.
- ❖ Discuss medicines to avoid in future and "sick day" guidance.
- ❖ Ensure information on which medications to restart and when are communicated to the GP or next care setting.

KDIGO Staging System for Acute Kidney Injury

Stage	Serum creatinine	Urine output
1	rise ≥ 26 µmol/L within 48hrs or rise ≥1.5- to 1.9 X baseline SCr	<0.5 mL/kg/hr for > 6 consecutive hrs
2	rise ≥ 2 to 2.9 X baseline SCr	<0.5 mL/kg/hr for > 12 hrs
3	rise ≥3 X baseline SCR or rise 354 µmol/L or commenced on renal replacement therapy (RRT) irrespective of stage	<0.3 mL/kg/hr for > 24 hrs or anuria for 12 hrs

Acute Kidney Injury (AKI) Medicines Optimisation

UK Renal Pharmacy Group

AKI is a rapid deterioration in a patient's renal function over hours or days secondary to an acute event.

- ❖ 65% of AKI starts in community
- ❖ In the hospital setting 20% of acute admissions will develop AKI.
- ❖ Up to 30% of all cases of AKI are thought to be due to drugs.
- ❖ 5% of inpatients develop drug-induced renal impairment.

Comprehensive guidelines on medicines management and care bundles in patients with AKI can be found at:

www.thinkkidneys.nhs.uk/aki

	Effects on renal/fluid/electrolyte physiology	Change in the side effect profile when renal function is reduced	Action in presence of AKI
NSAIDs / COX II inhibitors	Altered haemodynamics within the kidney leading to underperfusion and reduced glomerular filtration		Avoid these agents in people at high risk of AKI
Opioid analgesics		Accumulation of active metabolites in AKI (especially morphine, pethidine and codeine) – increased incidence of CNS side effects & respiratory depression	Avoid long acting preparations. Reduce dose and frequency Use opiates with minimal renal excretion e.g. fentanyl, oxycodone, hydromorphone, tramadol
Pregabalin & Gabapentin		Accumulation leading to an increase in CNS side effects	Reduce dose
Antihypertensives (Ca-channel blockers, [redacted]-blockers, [redacted]-blockers, etc)	Hypotension may exacerbate renal hypo-perfusion	Risk of bradycardia with Beta Blockers	Consider withholding / reduce dose depending on blood pressure
ACEI / ARBs / Aliskiren	Hypotension Hyperkalaemia		In some situations, e.g. heart failure continuing them might actually be helpful In AKI consider with holding
Diuretics (Thiazide & Loop)	Volume depletion Acute interstitial nephritis (rare)	Loop diuretics preferred as thiazides less effective if GFR < 25ml/min. However thiazides can potentiate the effects of loop diuretics	If volume depleted, consider with holding
Potassium sparing diuretics amiloride, eplerenone spironolactone	Volume depletion Hyperkalaemia		Stop if AKI
Statins	May cause AKI if rhabdomyolysis is present	Increased risk of rhabdomyolysis	Stop if AKI due to rhabdomyolysis, OR if patient develops unexplained / persistent muscle pain
Digoxin	Hyperkalaemia	May accumulate in AKI leading to bradycardia, visual disturbances, mental confusion	Reduce dose Monitor potassium and drug levels
Direct Oral Anticoagulants		May accumulate leading to increased risk of bleeding	Consider withholding, particularly agents with high renal clearance.
Aciclovir / Valaciclovir	Crystal nephropathy Acute interstitial nephritis (rare)	Drug accumulates in reduced renal function leading to mental confusion, seizures	Reduce dose Encourage patient to drink plenty
Aminoglycosides	Tubular cell toxicity	Ototoxicity	Avoid if possible. If use is unavoidable, reduce dose &/or increase dosing interval. Monitor drug levels and renal function 2 – 3 times per week
Carbapenems		Drug accumulates in reduced renal function leading to mental confusion, seizures	Reduce dosing frequency
Fluconazole		Accumulation leading to acute mental confusion, coma, seizures	Reduce dose
Ganciclovir / Valganciclovir	Crystal nephropathy	Accumulation leading to neutropenia, anaemia and thrombocytopenia	Reduce dose Monitor renal function and full blood count
Vancomycin	Acute interstitial nephritis (rare)	Accumulation leading to renal toxicity, ototoxicity	Reduce dose / increase dose interval Monitor levels
Trimethoprim Co-trimoxazole	Increased risk of hyperkalaemia (especially in combination with spironolactone or ACEI/ARB)	Accumulation increases risk of hyperkalaemia (particularly with high doses), nausea and vomiting	Avoid or reduce dose (particularly if patient is already taking an ACEI, ARB or spironolactone)
Phenytoin	Acute interstitial nephritis (rare)	Risk of phenytoin toxicity if patient has low serum albumin levels	Monitor levels. Correct phenytoin levels for uraemia and low serum albumin
Hypoglycaemic Drugs		Accumulation in AKI may increase risk of hypoglycaemia	Avoid long acting preparations Monitor blood glucose levels & reduce dose if necessary
Metformin		Risk of lactic acidosis increased Accumulation leading to hypoglycaemia	Avoid if GFR < 30 ml/min