

Acute kidney injury (AKI)

- A reduction in renal function following an insult to the kidneys which occur over hours to days

Causes

- **Prerenal** → Ischemia
 - Hypovolemia secondary to diarrhea/vomiting
 - Renal artery stenosis
- **Intrinsic**
 - AGN
 - **Acute tubular necrosis (ATN)**
 - Acute interstitial nephritis (AIN)
 - Rhabdomyolysis
 - Tumor lysis syndrome (after killing large amount of tumor cells)
- **Postrenal**
 - Kidney stone in ureter or bladder
 - Benign prostatic hyperplasia (BPH)
 - External compression of the ureter

ATN (acute tubular necrosis)

- Most common renal cause of AKI
- Occurs after a prolonged ischemic event (e.g. massive hemorrhage, hypotensive shock) with increased creatinine
- There may be a history of nephrotoxins

interstitial nephritis (allergic)

- Allergy + hematuria

Drugs that are safe in AKI:

- Paracetamol
- Warfarin
- Statins
- Aspirin
- Clopidogrel
- B-blockers

Risk factors

- CKD
- Other organ failures
- Hx of AKI
- Nephrotoxic drugs (e.g. NSAIDs, aminoglycosides, ACE inhibitors & diuretics) → [DAMN]
- Usage of iodinated contrast in the past week
- >56 years old

Features

- Maybe asymptomatic until renal failure progresses
 - **Oliguria** (<0.5 ml/kg/hour)
 - **Fluid over load** → pulmonary and peripheral edema
 - ↑ **K⁺** → Arrhythmias
 - ↑ **Urea & creatinine** → pericarditis or encephalopathy

Chronic kidney disease (CKD)

Symptoms

- Usually asymptomatic, may be discovered by a chance
- Specific symptoms in severe CKD
 - Peripheral edema
 - Pruritis
 - Nausea, vomiting, fatigue
 - Sexual dysfunction

Signs

- Skin pigmentation
- Pallor (due to anemia of chronic disease)

- The only definite sign of CKD is previous blood results showing **high creatinine/low GFR**

Management

- **ACEI** (e.g. **Lisinopril**) or **ARB** in all ethnic groups with CKD and HTN
 - ACR (albumin creatinine ratio) ≥ 70
 - ACR ≥ 30 + **HTN**
 - ACR ≥ 3 + **Diabetic**

- **ACEIs** are contraindicated in renal artery stenosis and severe hyperkalemia

Nephrotic syndrome → loss of a lot of protein

- **1ry causes (80%)**
 - Children, young adults → **Minimal change disease**
 - Elder adults → **Membranous GN**, minimal change nephropathy or Focal & segmental glomerulosclerosis
- **2ry causes**
 - **SLE** (comes 3rd as in the most common causes in adults)
 - Hepatitis B & C, HIV
 - DM, Amyloidosis

Triad

1. Proteinuria (≥ 3 gm/24hr)
2. Hypoalbuminemia (≤ 30 g/L)
3. Edema (pre-orbital)

- A child with LL edema → order 24hr urine protein → order serum albumin, if confirmed nephrotic \$ → refer to a nephrologist
- Definitive investigation is **Renal biopsy**
 - Minimal change disease → fusion of podocytes

Complications

- **Renal vein thrombosis** (due to loss of anti-coagulation factors in urine e.g. Antithrombin III)
 - Sudden left loin pain, hematuria & sudden swelling of the left testis
- Infections (due to loss of immunoglobulin proteins in urine)
- Na⁺ retention (due to 2^{ry} hyperaldosteronism as a result of low renal perfusion)
- Hypercholesterolemia (due to non-specific increase in cholesterol synthesis)

Management

- **Diet:** Fluid restriction, low salt and sufficient protein
- **Drugs:** steroids (if resistance → cyclophosphamide) & diuretics

Nephritic syndrome → loss of a lot of blood

- Hematuria (microscopic or macroscopic) + **red cell cast**
- Proteinuria (++)
- Hypertension (mild)
- Low urine output (<300 ml/day)

- Goodpasture's treated with plasmapheresis and immunosuppressants

Causes

- **Post-streptococcal GN** → appear after 1-2 weeks after URTIs
- **IgA nephropathy (Berger's disease)** → appears after 1-2 days after URTIs
- Ravidly progressive glomerulonephritis
 - **Goodpasture's \$** (Anti-GBM antibodies)
 - Vasculitis disorder: **Wegener's granulomatosis** (C-ANCA), **Churg Strauss disease** (P-ANCA)
- Membranoproliferative GN
- **Henoch-Schoenlein purpura** → PAAN

Hematuria + HTN	ADPKD - US
Hematuria + Hemoptysis	Goodpasture's \$ - Anti-GBM antibodies - Kidney or lung biopsy
Hematuria + Hemoptysis + Nasal/sinus problems	Wegener's granulomatosis - C-ANCA
Hematuria + Jaundice	Alpha 1-antitrypsin deficiency

Post-streptococcal glomerulonephritis

- Typically occurs **1-2 weeks** following URTI, impetigo, otitis media or cellulitis
- Caused by: group A beta-hemolytic Streptococcus (usually streptococcus pyogenes)
- Young children (below age 7) are most commonly affected
- Caused by immune complex (**IgG, IgM and C3**) deposition in the glomeruli

Features

- Nephritic S + oliguria
- Tea-colored urine

Investigations

- Low C3
- Raised anti-streptolysin O titer → *indicates recent streptococcal infection*
- **Renal biopsy** → most accurate
 - It shows **subepithelial humps** (IgG and C3 deposition)

Post-streptococcal glomerulonephritis	IgA nephropathy (Berger's disease)
<ul style="list-style-type: none"> - 1-2 <u>weeks</u> after URTIs - Main symptom → <u>Proteinuria</u> - Low C3 	<ul style="list-style-type: none"> - 1-2 <u>days</u> after URTIs (IgA → ASAP) - Main symptom → <u>Hematuria</u> - <u>Young males</u>

Henoch-Schoenlein purpura

- Same pathology as IgA nephropathy and similar finding on renal biopsy
- However, it's common among children
- A systemic disease that involves skin, connective tissue, scrotum, joints, GIT and kidneys
- **Symptoms** also include: abdominal pain, joint pain (knees) and rash
- **Complication:** intussusception

Orthostatic or isolated proteinuria

- 1st step → Repeat the test
- Still +ve → 24-urine collection or urine protein creatinine ratio
- Recurrent → biopsy

- Isolated proteinuria in otherwise healthy individual → Repeat the dipstick analysis
- False positive proteinuria:
 - Alkaline urine
 - Exercise causes transient proteinuria

DD of small kidneys

- Hypertension
- Bilateral renal artery stenosis
- CKD
- Chronic pyelonephritis

Rule of thirds in Membranous Glomerulonephropathy

- 1/3 → Partial remission but still have the chronic disease
- 1/3 → Remission
- 1/3 → ESRD

Acute pyelonephritis

- Inflammation of the kidney and renal pelvis usually caused by ascending UTIs
- 80% of infections are due to E. coli

Risk factors

- Structural renal abnormalities, including **vesicoureteral reflux (VUR)**
- Calculi & urinary tract catheterization
- Stents
- Pregnancy
- Diabetes
- Neurogenic bladder
- Prostate enlargement

- **Acute** → Active infection (fever, loin pain, etc.)
- **Chronic** → Renal scarring (often asymptomatic, renal failure symptoms)

Presentation

- Rapid onset
- Unilateral/bilateral loin pain, suprapubic pain or back pain
- Costovertebral tenderness may be present
- Fever & rigors
- Vomiting
- Accompanying symptoms of lower UTI
 - Frequency, urgency
 - Suprapubic pain
 - Urethral burning on voiding

Upper UTIs

- 1st → Ciprofloxacin
- 2nd → Co-amoxiclav

Lower UTIs

- Trimethoprim
- Nitrofurantoin

Investigations

- Urinalysis → look for **blood, leukocyte esterase** and **nitrate**
- Midstream specimen of urine (MSU) → for microscopy and culture
 - This should be done before starting empirical antibiotics

Imaging is required with complicated pyelonephritis:

- Persistent Fever more than 48h despite AB
- Recurrent episodes
- Suspected stone
- Patients with DM and immunocompromised

Management

- Usually requires admission
- Antibiotics
 - Start empirical antibiotic treatment whilst waiting for culture and sensitivity results

Non-pregnant women, men & people with indwelling catheters

- Ciprofloxacin 500mg twice daily for 7 days
- Alternatively, co-amoxiclav for 14 days

Children

- Co-amoxiclav as 1st line
- Alternatively, cefixime

Pregnant women who don't require admission

- Cefalexin
-

Chronic pyelonephritis

Imaging

- **Renal US** → small kidneys with a thin cortex
- **Intravenous pyelogram (IVP)** → may show small kidneys, ureteric and caliceal dilatation/blunting with cortical scarring
- **Micturating cystourethrogram (MCUG)** → to identify reflux
- **Tc-99m (Tc-DMSA)** → the most sensitive for demonstration of renal scar

Recurrent UTI

- Defined as >2 infections in the past 6 months or 3 within 12 months
- **E. coli** is the most common organism in all age groups
- There's often an underlying functional or anatomical problem and infection will often not resolve until this has been corrected

Causes

- Incomplete bladder emptying
- Renal or bladder stones
- Indwelling catheters
- Chronic bacterial prostatitis
- Vesicovaginal or colovesical fistula
- Bacteria within an obstructed or atrophic infected kidney

Presentation

- Dysuria
- Frequency
- Urgency
- Suprapubic pain or discomfort
- Cloudy foul-smelling urine

Investigations

- **MSU microscopy and culture**
- **KUB X-ray** → to detect *radio-opaque renal calculi*
- Renal and bladder **US**
 - Looking for renal stones
 - To determine the presence or absence of hydronephrosis
 - To measure pre-void bladder volume (PVBV) and post-void residual urine volume (PVRV)
- **Flexible cystoscopy**, to identify abnormalities that may cause recurrence such as bladder stones, an underlying bladder cancer which is rare, urethral or bladder neck stricture or fistula

Management

- Deal with the underlying cause
- Low-dose antibiotic prophylaxis → **trimethoprim, nitrofurantoin** or cefalexin
- If there's residual urine present → optimize bladder emptying by **intermittent catheterization**
- **Estrogen** replacement in post-menopausal women → lack of estrogen in post-menopausal women cause loss of vaginal lactobacilli and increased colonization by E. coli

Rhabdomyolysis

- It results from breakdown of skeletal muscle with the release of its contents
 - Myoglobin & creatine kinase (CK)
 - K⁺, P, urate

Causes

- Sudden, severe crush injury
- Status epilepticus
- Severe exertion

Complications

- AKI
- Hyperkalemia

Investigations

- Best initial → **Urinalysis** (to look for hematuria)
- Most important → **ECG & K⁺ level**
- Confirmed by → markedly elevated **CK (>10,000 U/L)**
- Rapidly rising **creatinine** level

Management

- **Ca chloride/gluconate**
 - If there are ECG abnormalities from hyperkalemia
- **IV fluid rehydration**
 - Priority to prevent AKI
 - Decreases the duration of contact between the nephrotoxic myoglobin and the kidney tubule
- **IV sodium bicarbonate**
 - To alkalinize urine to pH >6.5, to stabilize a less toxic form of myoglobin
 - Alkalinizing the urine with bicarbonate may help prevent the precipitation of the pigment in the tubule
- **Dialysis**
 - Only needed in severe cases

Scenarios

- Elderly patient with hx of fall followed by long duration on the floor
- Mountain biker rescued from being trapped under heavy rocks for many hours
- Trapped under a fallen wardrobe for several hours
- IV drug user found on floor not moving for a few days → tissue compression → muscle ischemia
- Marathon runner who just completed a long-distance run

DD

- **Dermatomyositis**
 - Gottron's papules (over the knuckles)
 - Heliotrope rash (around the eyelids)

Autosomal dominant polycystic kidney disease (ADPKD)

- Gross hematuria following trauma is a classic presentation of ADPKD
- Sometimes present with kidney failure (usually in the fourth to sixth decade of life)
- May be asymptomatic on screening of family members
- Intracranial aneurysm is the most serious complication → leads to **Subarachnoid hemorrhage**

Features

- Flank pain
- Hematuria (micro & gross)
- UTIs and calculi
- Hypertension
- Bilateral kidney enlargement (maybe palpable)

Diagnosis

- US KUB

Treatment

- Nonspecific, treatment of hypertension

Hemolytic uremic syndrome (HUS)

- A triad of **hemolytic anemia, uremia, stomach virus and thrombocytopenia**
- Hemolytic anemia will be intravascular in nature with abnormal blood smear showing schistocytes, helmet cells and fragmented red cells
- Mainly caused by E. coli. *Occurs after eating undercooked contaminated meat*
- Usually in young children, bloody diarrhea followed by renal impairment

Signs

- Abdominal pain
- Bloody diarrhea
- Signs of AKI

HUS → Hemolysis, Uremia, Stomach virus + thrombocytopenia
 TTP = HUS + fever + neurological symptoms

- Usually in adults
- Platelet count is much lower (around 35)

Diagnosis

- *Initially* → **E. coli serology**, stool culture, urine analysis, FBC
- **Renal US**, to rule out damage

Management

- IV fluids, blood transfusion and dialysis if required
- **DO NOT** give antibiotics to those with possible HUS; this organism will release more toxins as it dies
- FFP is reserved for severe cases of HUS not associated with diarrhea

Host-versus-graft disease

1. **Hyperacute** – occurs within minutes
2. **Accelerated** – occurs within a few days → *managed by IV methylprednisolone followed by high dose oral prednisolone*
3. **Acute** – occurs between 1-12 weeks
4. **Chronic** – a series of episodes of acute rejections over months that lead to a gradual loss of organ function

Management

- If the patient is anuric with severe hyperkalemia → **Dialysis**
- Definitive management → **Renal transplant**

Indications for dialysis (AEIOU)

- Acidosis
- Electrolyte imbalance (hyperkalemia)
- Ingesting toxins
- Overload (volume)
- Uremia (encephalopathy, pericarditis)
- Drug overdose (e.g. Aspirin, ethylene glycol, Lithium)

Contrast induced nephropathy

prevention

- Increasing fluid intake
- IV normal saline (12h pre- and 12h post-procedure)
- N-acetylcysteine (NAC)
- Stop metformin (if being taken)

Nephrology

METABOLIC _ _ ACIDOSIS	METABOLIC ALKALOSIS
<ul style="list-style-type: none"> • Excess Production of Organic Acids <ul style="list-style-type: none"> • Ketoacidosis • Alcoholic • Violent Convulsions • Excessive Ingestion of Toxins • Aspirin • Methanol Alcohol • Excess Loss of HCO_3^- • Diarrhoea • Addison's Disease • Retention of Organic Acids • Renal Insufficiency of Any Cause 	<ul style="list-style-type: none"> • HCl Loss • Vomiting • Excessive Administration of HCO_3^- • Hypokalaemia • Hypovolaemia • Increased Renal Excretion of Acid • Diuretic Therapy • Secondary Hypoparathyroidism
RESPIRATORY ACIDOSIS	RESPIRATORY _ _ ALKALOSIS
<ul style="list-style-type: none"> • Airway Obstruction • Aspiration • COPD • Respiratory Center Depression • Circulatory Collapse • Cardiac Arrest • Pulmonary Oedema • Neurogenic Causes <ul style="list-style-type: none"> • Cervical Spine Injury • Drugs (Paralytic Agents, Organophosphates) • Multiple Sclerosis • Restrictive Effects • Haemothorax • Pneumothorax • Ascites 	<p><i>Any event causing hyperventilation</i></p> <ul style="list-style-type: none"> • Lung Disease • Pulmonary Embolism • CNS - Respiratory Stimulation • Cerebral Vascular Accident (Stroke) • Anxiety-Hyperventilation Syndrome • Salicylate Intoxication • Congestive Cardiac Failure • Mechanical Ventilation

Base excess (+/- 2mmol/L) → <-2 means acidosis, >+2 means alkalosis