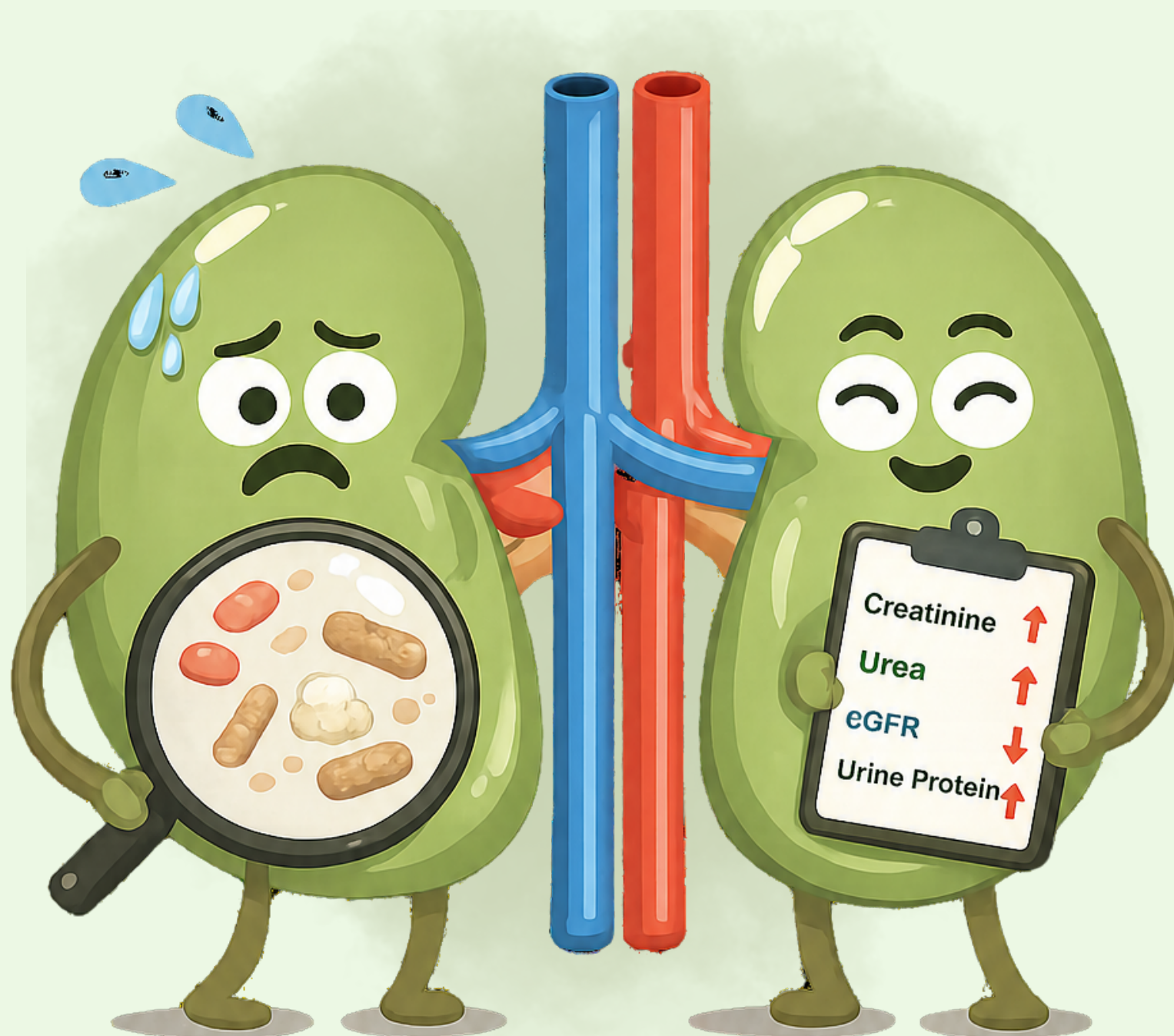


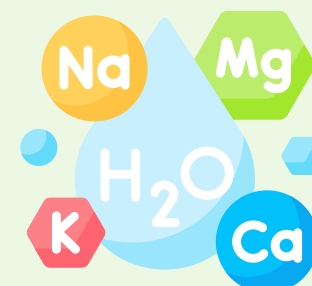
# Renal profile

## AKI vs CKD



# What is included in a renal profile?

- A renal profile, often called **Urea, Electrolytes, Creatinine (UEC)**
- Assess kidney function, fluid balance, electrolyte status and acid-base status



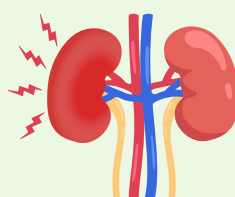
| Test                                 | Reference Range                                                     | What it means                                                                                                                                                                                                          |
|--------------------------------------|---------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Creatinine</b>                    | Female: 45–90 $\mu\text{mol/L}$ ;<br>Male: 60–110 $\mu\text{mol/L}$ | <ul style="list-style-type: none"><li>• Marker of kidney filtration</li><li>• <math>\uparrow</math>: glomerular filtration decreases</li><li>• <math>\downarrow</math>: reduced muscle mass (eg: elderly)</li></ul>    |
| <b>eGFR</b>                          | $\geq 90 \text{ mL/min/1.73m}^2$                                    | <ul style="list-style-type: none"><li>• Marker of kidney function</li><li>• Stage <b>Chronic Kidney Disease (CKD)</b></li><li>✗ Less reliable in Acute Kidney Injury (AKI) as creatinine is changing rapidly</li></ul> |
| <b>Urea</b>                          | $\sim 3.5\text{--}8.0 \text{ mmol/L}$                               | <ul style="list-style-type: none"><li>• <math>\uparrow</math>: kidney impairment, dehydration, high protein catabolism, GI bleed</li></ul>                                                                             |
| <b>Urea:Creatinine ratio (UCR) ⚠</b> | 40:1– 100:1 (mmol/L: mmol/L)                                        | <ul style="list-style-type: none"><li>• <math>\uparrow\uparrow</math>: pre-renal AKI (eg: dehydration)</li></ul>                                                                                                       |
| <b>Sodium</b>                        | 135–145 mmol/L                                                      | <ul style="list-style-type: none"><li>• Marker of plasma osmolality and volume status</li></ul>                                                                                                                        |
| <b>Potassium</b>                     | 3.5–5.2 mmol/L                                                      | <ul style="list-style-type: none"><li>• Derangements <math>\rightarrow</math> life-threatening arrhythmias</li></ul>                                                                                                   |
| <b>Chloride</b>                      | 95–110 mmol/L                                                       | <ul style="list-style-type: none"><li>• Assess fluid and acid-base balance</li></ul>                                                                                                                                   |



Units need to be the same before making the ratio.  
Reference ranges vary between laboratories.

## Common indications of renal profile

- Suspected **AKI** or **CKD**
- Fluid overload or heart failure
- Dehydration, vomiting, diarrhoea, sepsis or shock
- Electrolyte disturbance (Refer to our *Electrolyte Imbalance* posts)
- Monitoring ACE inhibitors, ARBs, diuretics, NSAIDs, lithium or nephrotoxic drugs
- Diabetes, hypertension or known kidney disease
- Before/after contrast exposure or major procedures



## Acute kidney injury (AKI)

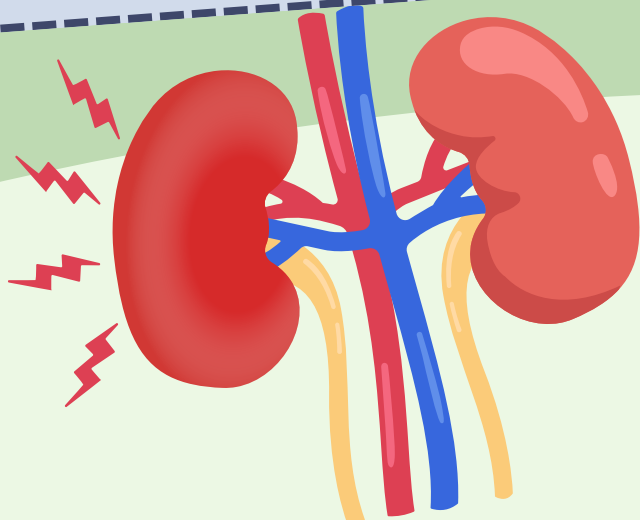
- Abrupt reduction in kidney function defined as any of the following:
  - Serum **creatinine**  $\uparrow$   $\geq 26.5 \mu\text{mol/L}$  ( $\geq 0.3 \text{ mg/dl}$ ) within **48 hours**
  - Serum **creatinine**  $\uparrow$   $\geq 1.5$  times baseline within the **previous 7 days**
  - Urine output  $< 0.5 \text{ mL/kg/hour}$  for **6 hours**



## Chronic kidney disease (CKD)

(Either of the following present for **> 3 months**)

- **GFR**  $< 60 \text{ mL/min/1.73 m}^2$
- Markers of **kidney damage**:
  - Albuminuria
  - Urine sediment abnormalities
  - Electrolyte and other abnormalities due to tubular disorders
  - Histological abnormalities
  - Structural abnormalities detected by imaging tests
  - History of kidney transplantation



KDIGO: Prognosis of CKD by GFR and albuminuria categories

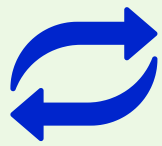
Persistent albuminuria categories  
Description and range

| A1                                           | A2                                                              | A3                                             |
|----------------------------------------------|-----------------------------------------------------------------|------------------------------------------------|
| Normal to mildly increased                   | Moderately increased                                            | Severely increased                             |
| $< 30 \text{ mg/g}$<br>$< 3 \text{ mg/mmol}$ | $30\text{--}300 \text{ mg/g}$<br>$3\text{--}30 \text{ mg/mmol}$ | $> 300 \text{ mg/g}$<br>$> 30 \text{ mg/mmol}$ |

| GFR categories (ml/min/1.73 m <sup>2</sup> )<br>Description and range | G1  | Normal or high                   | $\geq 90$ |  |  |  |
|-----------------------------------------------------------------------|-----|----------------------------------|-----------|--|--|--|
|                                                                       | G2  | Mildly decreased                 | 60–89     |  |  |  |
|                                                                       | G3a | Mildly to moderately decreased   | 45–59     |  |  |  |
|                                                                       | G3b | Moderately to severely decreased | 30–44     |  |  |  |
|                                                                       | G4  | Severely decreased               | 15–29     |  |  |  |
|                                                                       | G5  | Kidney failure                   | $< 15$    |  |  |  |

Green: low risk (if no other markers of kidney disease, no CKD); Yellow: moderately increased risk; Orange: high risk; Red: very high risk. GFR, glomerular filtration rate.

# AKI vs CKD

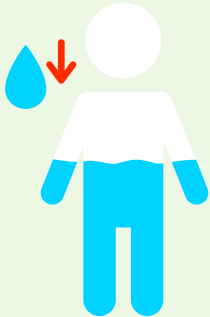
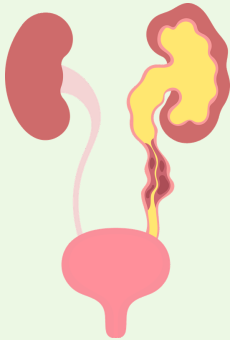
| Feature            | AKI                                                                                                                                                                         | CKD                                                                                                                                                                                      |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Time course        | Hours to days                                                                              | Progressive for >3 months                                                                             |
| Creatinine         | Sudden ↑                                                                                   | Persistently and progressively ↑                                                                                                                                                         |
| eGFR               |  Sudden ↓ (less reliable)                                                                  | Persistently ↓; Used to stage CKD                                                                                                                                                        |
| Urea               | Sudden and disproportionate ↑                                                                                                                                               | May be chronically ↑, especially in later stages                                                                                                                                         |
| Potassium          | Hyperkalaemia may develop quickly and is life-threatening                                                                                                                   | Hyperkalaemia may occur gradually, in advanced CKD or with ACE inhibitors / ARBs / MRAs                                                                                                  |
| Bicarbonate        | ↓ in metabolic acidosis                                                                                                                                                     | ↓ in metabolic acidosis                                                                                                                                                                  |
| Urine output       | May be oliguria / anuria                                                                | Often preserved until late stages                                                                                                                                                        |
| Etiology           | Pre-renal, intra-renal and post-renal injuries (See next page)<br><br><b>Reversible</b>  | Diabetes, hypertension, hereditary kidney disease, obstructive uropathy<br><br><b>Irreversible</b>  |
| Hemoglobin         | Usually normal                                                                                                                                                              | Anemia                                                                                                                                                                                   |
| Extra tests needed | Urinalysis (dipstick & microscopy), urine ACR/PCR, renal ultrasound if obstruction suspected                                                                                | Urine ACR, urinalysis, FBC, calcium/phosphate/PTH if advanced, renal ultrasound when indicated                                                                                           |



**FOR AKI, DO NOT USE eGFR ALONE.** In AKI, serum creatinine changes rapidly, so eGFR is less reliable. Estimated GFR does not reflect measured GFR in AKI as accurately as in CKD.



# Etiologies of AKI

| Feature                    | Pre-renal                                                                                                    | Intrinsic renal                                                                                                | ⚠ Post-renal                                                                                                          |
|----------------------------|--------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| Main issue                 | ↓ renal perfusion                                                                                            | Damage of kidney tissues                                                                                       | Urinary obstruction                                                                                                   |
| Creatinine                 | ↑                                                                                                            | ↑                                                                                                              | ↑                                                                                                                     |
| Urea                       | ↑↑ disproportionate                                                                                          | ↑                                                                                                              | ↑ variable                                                                                                            |
| UCR                        | >100:1                                                                                                       | <40:1                                                                                                          | variable                                                                                                              |
| Urine sodium               | Low<br>often <20 mmol/L                                                                                      | High<br>often >40 mmol/L                                                                                       | Variable                                                                                                              |
| Urine osmolality           | >500                                                                                                         | <350                                                                                                           | Not Applicable                                                                                                        |
| ⚠ FENa (not commonly done) | <1%                                                                                                          | >1–2%                                                                                                          | Variable                                                                                                              |
| Urine sediment             | Bland                                                                                                        | Blood, protein, casts                                                                                          | Variable ± haematuria                                                                                                 |
| Key clue                   | Dehydration/<br>shock<br> | Active urine findings<br> | Retention/<br>hydronephrosis<br> |

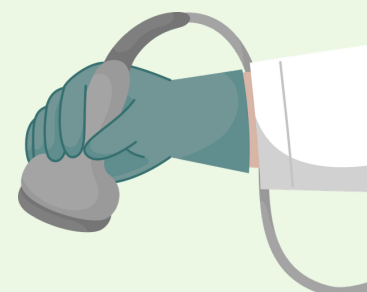


**FENa = Fractional Excretion of Sodium**

→ to **determine the cause** of AKI by analyzing sodium and creatinine levels in blood and urine



If **post-renal AKI** is suspected, a **USG KUB** is required.



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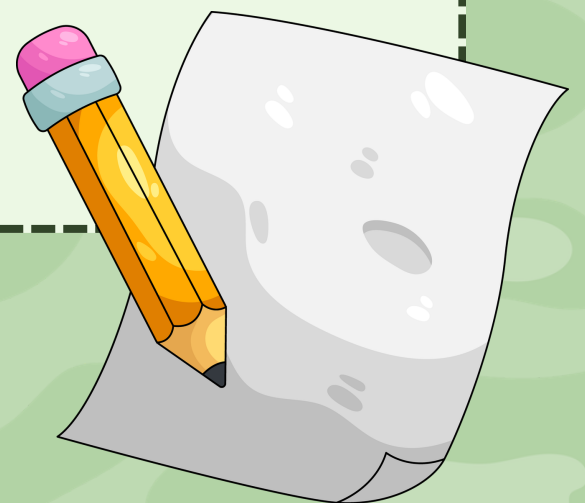


# Quiz Time!

## Question 1

A 67-year-old man with a history of mild hypertension develops a severe acute myocardial infarction while walking to his car. On arrival at the emergency department, he is pale, cold, and diaphoretic, with tachycardia and hypotension. ECG shows ST-segment elevations. He is treated with morphine, oxygen, and aspirin and undergoes cardiac catheterization. The next day, he has low urine output, urea 75 mmol/L, creatinine 115  $\mu$ mol/L, and blood pressure 85/55 mmHg. Urinalysis reveals a few hyaline casts. What is the most likely cause of his low urine output?

- A. A blockage of the ureters or urethra
- B. Acute tubular necrosis
- C. Interstitial nephritis
- D. Low urine output is normal in times of stress
- E. Poor perfusion of the kidneys



# Quiz Time!

## Question 2

An 83-year-old woman with hypertension, type 2 diabetes, and depression presents with fatigue and mild edema. Examination shows BP 152/88 mmHg, weight 42 kg, mild pallor, and 1+ peripheral edema. Investigations: Hb 9.6 g/dL (MCV 87 fL),  $\text{HCO}_3^-$  18 mmol/L, creatinine 133  $\mu\text{mol/L}$ , with otherwise unremarkable results. Despite only a mildly elevated creatinine, she is found to have Stage 4 CKD.

Which of the following best explains why this patient has Stage 4 CKD despite only mildly elevated creatinine?

- A. Creatinine is always an accurate marker of renal function
- B. Elderly patients have increased muscle mass
- C. eGFR may be significantly reduced despite near-normal creatinine in thin elderly patients
- D. Serum bicarbonate elevation indicates normal kidney function
- E. Hyperchloremia excludes chronic kidney disease

