

Acute kidney injury

Objectives (regarding the Blueprint):

1. To be able to identify stages, causes and initial work-up of acute kidney injury.
2. Identify indications for urgent dialysis.
3. To be able to distinguish between acute kidney injury and chronic kidney disease.

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Editing File

Color Index

- Slides / Reference Book
- Doctor notes
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- Important
- Extra

1- To be able to identify stages, causes and initial work-up of acute kidney injury.

Acute Kidney Injury (AKI):

Deterioration of renal function over a period of hours to days, resulting in

- The failure of the kidney to excrete nitrogenous waste products and
- To maintain fluid and electrolyte homeostasis.

Acute Kidney Injury (KDIGO definition):

An abrupt (within 48 hours)

- Absolute increase in creatinine by 0.3 mg/dl (26.4 µmol/l) or
- Percentage increase of >50% from baseline or
- Urine output <0.5 ml/hour for 6 hours

Acute Renal Failure (ARF):

ARF in one study was defined as:

- a 0.5 mg/dL increase in serum creatinine if the baseline serum creatinine was ≤1.9 mg/dL,
- an 1.0 mg/dL increase in serum creatinine if the baseline serum creatinine was 2.0 to 4.9 mg/dL, and
- a 1.5 mg/dL increase in serum creatinine if the baseline serum creatinine was ≥5.0 mg/dL

Oliguria:

< 400 ml urine output in 24 hours.

Anuria:

< 100 ml urine output in 24 hours.

Acute Kidney Injury (RIFLE definition):

| | GFR/Creatinine criteria | Urine Output criteria |
|---------|--|--|
| Risk | Increase in creatinine x1.5 Or GFR decrease >25% | UO < 0.5ml/kg/hr for 6 hrs |
| Injury | Increase in creatinine x 2 Or GFR decrease >50% | UO < 0.5ml/kg/hr for 12 hrs |
| Failure | Increase in creatinine x 3 Or GFR decrease >75% | UO < 0.3ml/kg/hr for 24 hrs or Anuria for 12 hrs |
| Loss | Persistent ARF = complete loss of renal function > 4 weeks | |
| ESRD | End Stage Renal Disease > 3 months | |

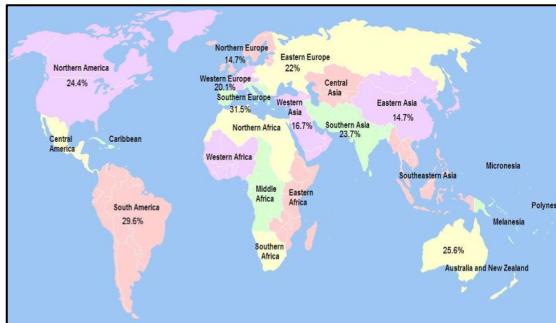
Acute Kidney Injury:

"Acute kidney injury, mortality, length of stay, and costs in hospitalized patients"

19,982 patients admitted to academic medical centre in SF 9,205 pts with >1 creatinine results.

| Rise in creatinine | Multivariable OR (hospital mortality) |
|---------------------------|--|
| ≥ 0.3 mg/dl (26.4 µmol/L) | 4.1 |
| ≥ 0.5 mg/dl (45 µmol/L) | 6.5 |
| ≥ 1.0 mg/dl (90 µmol/L) | 9.7 |
| ≥ 2.0 mg/dl (180 µmol/L) | 16.4 |

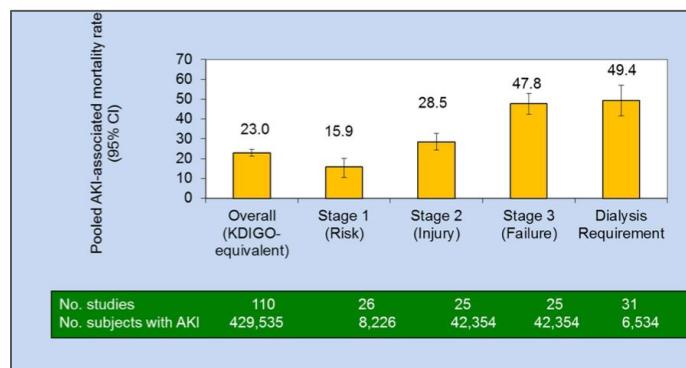
Incidence:



Epidemiology:

- It occurs in
 - 5% of all hospitalized patients and
 - 35% of those in intensive care units.
- Mortality is high:
 - Up to 75–90% in patients with sepsis
 - 35–45% in those without.

Outcome:



Acute Kidney Injury

Correlation between AKI classification and outcome:

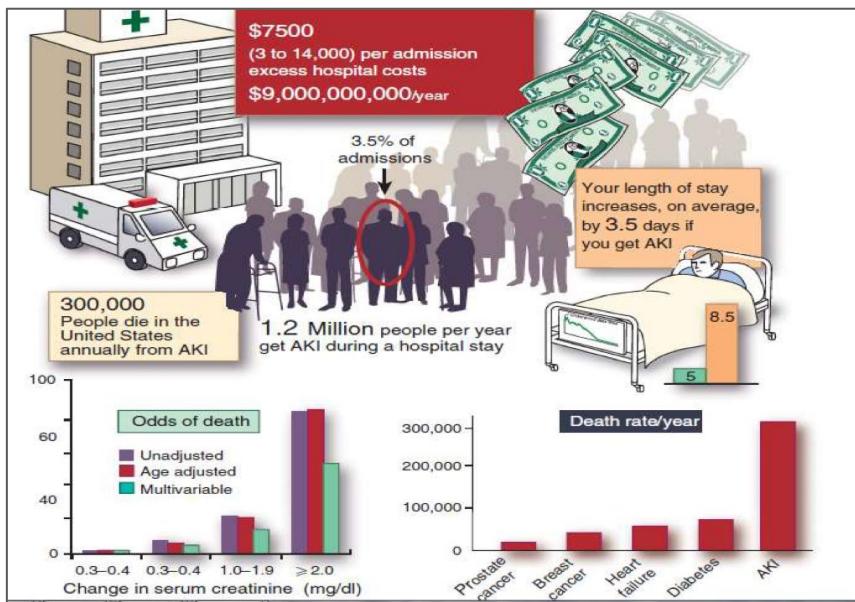
22,303 adult patients admitted to 22 ICUs in UK and Germany between 1989–1999 with ICU stay ≥ 24 hours.

| | No AKI 65.6% | AKI I 19.1% | AKI II 3.8% | AKI III 12.5% |
|--------------------------------------|-----------------|----------------|----------------|------------------|
| Mean age | 60.5 | 62.1 | 60.4 | 61.1 |
| ICU mortality | 10.7% | 20.1% | 25.9% | 49.6% |
| Hospital mortality | 16.9% | 29.9% | 35.8% | 57.9% |
| Length of stay in ICU (median) | 2 d | 5 d | 8 d | 9 d |

Risk of Chronic Kidney Injury (CKD):

Increasing evidence that episodes of AKI leave permanent renal damage.

Clinical outcome:



AKIN definition

| | Creatinine criteria | Urine output criteria |
|-----------|--|---|
| Stage I | <ul style="list-style-type: none"> • 1.5-2 times baseline. Or • 0.3 mg/dL increase from baseline ($\geq 26.4 \mu\text{mol/L}$). | <ul style="list-style-type: none"> • $\text{UO} < 0.5 \text{ ml/kg/h}$ for $> 6 \text{ hrs}$. |
| Stage II | <ul style="list-style-type: none"> • 2-3 times baseline | <ul style="list-style-type: none"> • $\text{UO} < 0.5 \text{ ml/kg/hr}$ for $> 12 \text{ hrs}$ |
| Stage III | <ul style="list-style-type: none"> • 3 times baseline. Or • 0.5 mg/dL ($44 \mu\text{mol/L}$) increase if baseline $> 4 \text{ mg/dL}$ ($\geq 354 \mu\text{mol/L}$). Or • Any renal replacement therapy given. | <ul style="list-style-type: none"> • $\text{UO} < 0.3 \text{ ml/kg/hr}$ for $> 24 \text{ hrs}$. Or • Anuria for $> 12 \text{ hrs}$. |

Types of AKI

| Pre renal | Renal | Post renal |
|---|--|---|
| when perfusion to the kidney is reduced | when the primary insult affects the: kidney itself | when there is obstruction to urine flow at any point from the tubule to the urethra |
| <ul style="list-style-type: none"> • Volume depletion. • Decrease cardiac output. | <ul style="list-style-type: none"> • Acute tubular necrosis (ATN). • Acute interstitial nephritis (AIN). • Acute Glomerulonephritis (GN). | <ul style="list-style-type: none"> • Ureteric obstruction. • Bladder neck obstruction. • Urethral obstruction. |

Acute Kidney Injury

Clinical Consequences of AKI:

- Chronic Kidney disease
- End stage renal disease
- Hospitalization
- Mortality

Etiology of ARF:

Pre-renal:

- Sudden and severe drop in blood pressure (shock).
- Interruption of blood flow to the kidneys from severe injury or illness.

Intrarenal:

- Direct damage to the kidneys by inflammation, toxins, drugs, infection, or reduced blood supply.

Postrenal:

Ureteric obstruction:

- Stone disease
- Tumor
- Fibrosis
- Ligation during pelvic surgery

Bladder neck obstruction

- Benign prostatic hypertrophy [BPH]
- Cancer of the prostate
- Neurogenic bladder
- Drugs (Tricyclic antidepressants, ganglion blockers)
- Bladder tumor
- Stone disease
- Hemorrhage/clot

Urethral obstruction:

- Strictures
- Tumor

Pre-renal AKI

| 1 Volume depletion | 2 Drugs | 3 Decreased CO |
|--|---|---|
| 1. Renal losses (diuretics, polyuria) 2. GI losses (vomiting, diarrhea), 3. Cutaneous losses (burns, Stevens-Johnson syndrome) 4. Hemorrhage: internal (peptic ulcer) or external (Car Accident)) 5. Pancreatitis (third spacing: there's extravasation of fluid from pancreas to abdomen) | 1. Diuretics 2. ACE inhibitors 3. ARBs 4. NSAIDs 5. Calcineurin inhibitors 6. Iodinated contrast | 1. Heart failure. 2. Pulmonary embolism 3. Acute myocardial infarction 4. Severe valvular heart disease 5. Abdominal compartment syndrome(tense ascites) 6. Sepsis 7. Cardiogenic shock |

Presentation and treatment

Presents with :

- Hypotension¹
- Tachycardia
- Signs of poor peripheral perfusion, such as delayed capillary return
- Postural hypotension (a fall in blood pressure of > 20/10 mmHg from lying to standing) are valuable
- Weight decrease
- Dry mucous membranes
- Low JVP (not visible even when lying down)
- Concentrated urine (>500mM osmolality) with very low urine Na (<20 mmol/L), because kidney is intact.
- Increased skin turgor

Treatment:

fluid replacement, balanced crystalloid solutions, such as Plasma-Lyte, Hartmann's or Ringer's lactate, may be preferable to isotonic saline (0.9% NaCl) when large volumes of fluid resuscitation are required, in order to avoid hyperchloremic acidosis.

1.it is important to note that prerenal AKI may also occur without systemic hypotension, particularly in

Renal AKI

| Cause | ATN | AIN | GN |
|------------------|---|--|--|
| Symptoms | Oliguria, anuria (depends on the etiology). | raised BUN and Creatinine with: fever, rash, arthralgias. | Rash, weight loss, arthralgia, Chest symptoms (pulmonary renal syndromes), IV drug use |
| Signs | Hypovolemia, hypotension | Skin rash | Presentation of primary disease e.g. HTN, Lower limb edema, joint pain and malar rash |
| Urine | Dense granular (Muddy brown) casts,, epithelial casts/tubular casts. | Leukocyturia with WBC casts , Eosinophils, "Hansel stain for Eosinophils" | Hematuria (RBC casts) , dysmorphic red cells, proteinuria |
| Urine Osmolality | < 350 Diluted urine | Variable > 350 | Variable > 350 |
| Urine Na | > 20 High | Variable | Variable |

Acute tubular necrosis

Causes of ATN

Ischemia

- Hypotension
- Sepsis
- Prolonged prerenal state

Toxic

- **Heme pigment:** **rhabdomyolysis**, intravascular hemolysis
- **Crystals:** tumor lysis syndrome (**High uric acid**), seizures, ethylene glycol poisoning (Oxalate), megadose vitamin C, acyclovir, indinavir, methotrexate.
- **Drugs:** **aminoglycosides**, lithium, amphotericin B, pentamidine, cisplatin, ifosfamide, radiocontrast agents, tenofovir, ACEIs

Renal AKI

Diagnosis and Treatment

- Diagnose by: history, increase in FENa (>2%) sediment with coarse **granular casts**.
- Treatment is **supportive care**:
 - Maintenance of euvoolemia (with diuretics e.g. in HF, IVF as necessary)
 - Avoidance of hypotension
 - Avoidance of nephrotoxic medications (including NSAIDs, methotrexate and ACEI)
 - Dialysis, if necessary
- 80% will recover, if initial insult can be reversed.

Comparison between prerenal and ATN

| | Prerenal | ATN |
|----------------------------|---------------|--------------------------|
| Urea/Creatinine ratio | >20:1 | 10-15:1 |
| Urine | Normal | Muddy brown casts |
| Urine Osmolality | >500 | <350 |
| Urine specific gravity | >1.020 | <1.010t |
| Urine Na | <20 | >20 |
| Fractional excretion of Na | <1% | >1% |

- In ATN there is a prolonged hypotension

Fraction excretion of Na calculator:
$$FE_{Na} = \frac{U_{Na} * P_{Cr}}{P_{Na} * U_{Cr}} * 100$$

FENa <1% (Prexrenal state)

- Contrast nephropathy
- Acute GN
- Myoglobin induced ATN

FENa >1% (intrinsic cause of AKI)

Renal AKI

Acute Interstitial Nephritis (AIN):

Causes of AIN:

- Drugs
- Infection
- Systemic diseases

Diagnosis of AIN:

- History of systemic disease
- Known to be associated with AIN
- Skin rash
- Eosinophilia
- WBC cast (urine)
- Eosinophiluria
- Renal biopsy

Treatment of AIN:

- D/c offending agent
- Conservative
- May use steroids

Acute Glomerulonephritis (GN):

Causes:

- Mainly GN causes AKI if the presentation is Rapidly progressive GN:

Anti-GBM antibody Immune complex

- Post-infectious
- Connective tissue disease: Lupus nephritis, Henoch-Schönlein purpura
- MPGN

Pauci-immune

- Wegener granulomatosis (WG)
- Microscopic polyangiitis (MPA)
- Churg-Strauss syndrome

Clinical features:

- Symptoms and signs of systemic disease.
- Non specific: lower limb swells, hematuria, frothy urine.
- Symptoms and signs of ESRD.

Treatment:

- General
- Disease specific:
 - Steroid
 - Immunosuppressive agents
 - Plasmapheresis

Post Renal AKI

Causes:

1- Bladder neck obstruction:

- Benign prostatic hypertrophy (BPH).
- Cancer of the prostate
- Neurogenic bladder
- Drugs (Tricyclic antidepressants, ganglion blockers).
- Bladder (tumor, stone disease, hemorrhage/clot).
- Congenital bladder neck obstruction.

2- Ureteric obstruction:

- Stone disease.
- Tumor (cervical).
- Fibrosis.
- Ligation during pelvic surgery.
- Ureteric stricture (tuberculosis, especially after treatment; calculus; after surgery)
- Congenital megaureter.

3- Urethral obstruction

- Strictures (e.g: gonococcal tumor).

4- Other causes of urinary tract obstruction:

- **Within the lumen**
 - Sloughed papilla (diabetes; analgesia abuse; sickle cell disease or trait)
- **Within the wall**
 - Pelviureteric neuromuscular dysfunction (congenital, 10% bilateral)
 - Ureterovesical stricture (congenital; ureterocele; calculus; schistosomiasis)
 - Congenital urethral valve Pin-hole meatus
- **Pressure from outside**
 - Pelviureteric compression (bands; aberrant vessels)
 - Tumours (e.g. retroperitoneal tumour; carcinoma of colon; pelvic tumors, e.g. carcinoma of cervix)
 - Diverticulitis
 - Aortic aneurysm
 - Retroperitoneal fibrosis (periaortitis)
 - Prostatic obstruction Phimosis

Indications for urgent dialysis (Obj)

Indications for Renal Replacement Therapy (RRT)

- Severe metabolic acidosis, e.g., pH < 7.1 and/or serum bicarbonate < 12 mmol/L.
- Refractory severe electrolyte abnormalities, e.g., hyperkalemic emergency, hypercalcemic crisis.
- Symptoms of uremia, particularly uremic pericarditis, uremic encephalopathy, and/or bleeding.
- Fluid overload refractory to medical management, e.g., in CKD, CHF.
- Poisoning or overdose with a dialyzable substance, e.g., lithium, toxic alcohols.
- Additionally, in ESRD:
 - Refractory hypertension.
 - Anorexia or weight loss despite nutritional interventions.

Clinical Scenarios

Scenario 1:

50 years old Saudi male s/p Right hemicolectomy 6 hours ago for colon cancer intra operative course complicated by bleeding and hypotension required 6 units of blood transfusion urine output decreased significantly serum creatinine 285 μ mol/l?

- Previously healthy
- And urine output for the last 3 hours is <10 cc and dark colour

Vital signs:

| Vital signs | Result | Normal Range |
|----------------|------------|--------------|
| Pulse | 134/min | 60-100/min |
| Blood pressure | 80/55 mmHg | 130/80 mmHg |
| Temperature | 37.0°C | 36.6-37.2°C |

Jugular venous pressure was low, cold periphery,

Cardiovascular examination:

- Normal first and second heart sound no added sound or murmurs.

Respiratory system examination

- Lungs are clear to percussion and auscultation.

Abdominal examination:

- No tenderness, liver and spleen were not palpable.

Blood test:

| Test | Value | Normal Range |
|-------------|-----------------|--------------------|
| Creatinine | 350 μ mol/L | 62-115 μ mol/L |
| Urea | 29 mmol/L | 2.5-6.4 mmol/L |
| Potassium | 6.2 mmol/L | 3.5-5.1 mmol/L |
| Sodium | 137 mmol/L | 135-145 mmol/L |
| Bicarbonate | 16 | 22-26 mmol/L |

Clinical Scenarios

Scenario 1 cont...:

Complete blood count (CBC):

| CBC | Result | Normal Range |
|------------------|----------------------|--|
| Hemoglobin | 70 g/L | Male : 135-175 g/L (13.5-17.5 g/dl) Female : 120-155 g/L (12-15.5 g/dl) |
| White cell count | $12 \times 10^9 /L$ | $4.5-11.0 \times 10^9 /L$ |
| Platelet count | $198 \times 10^9 /L$ | $140-450 \times 10^9 /L$ |

Urine Analysis:

| | Result | Normal Values |
|---------------------|------------|---------------|
| Color | Dark | Amber yellow |
| Character | Clear | clear |
| PH | 6.0 acidic | 4.8-8.0 |
| Specific gravity | 1.003 | 1.015-1.025 |
| Protein | +2 | (-) |
| Glucose | (-) | (-) |
| Red blood cells | 1-2 /hpf | (-) |
| Hemoglobin | Negative | (-) |
| Pus cells (WBC) | 1-2 /hpf | (-) |
| Epithelial cells | (-) | (-) |
| Amorphous phosphate | (-) | (-) |
| Bacteria | (-) | (-) |
| Granular cast | seen | (-) |

Clinical Scenarios

Scenario 1 cont...:

What is your diagnosis?

- Acute Kidney Injury

Where is the etiology?

Renal?

- ATN (acute tubular necrosis)
- AIN (acute interstitial nephritis)
- GN (glomerulonephritis)

Diagnosis:

- Acute Kidney Injury secondary to Acute tubular necrosis due to shock.

Indication for dialysis in acute kidney injury setting:

- Symptoms of uremia (encephalopathy,...)
- Uremic pericarditis
- Refractory volume over load
- Refractory hyperkalemia
- Refractory metabolic acidosis

Scenario 2:

75 years old female, known to have:

- DM II
- HTN

Presented with nausea, vomiting and diarrhea for 3 days

Medication: Insulin, lisinopril

Vital signs:

| Vital signs | Result | Normal Range |
|----------------|-------------|--------------|
| Pulse | 95/min | 60-100/min |
| Blood pressure | 112/67 mmHg | 130/80 mmHg |
| Temperature | 37.0°C | 36.6-37.2°C |

Jugular venous pressure was low, dry mucus membrane,

Cardiovascular examination:

- Normal first and second heart sound no added sound or murmurs.

Respiratory system examination:

- Lungs are clear to percussion and auscultation.

Abdominal examination:

- No tenderness, liver and spleen were not palpable.

Clinical Scenarios

Scenario 2 cont..:

Blood test:

| Test | Value | Normal Range |
|-------------|------------|----------------|
| Creatinine | 154 µmol/L | 62-115 µmol/L |
| Urea | 23 mmol/L | 2.5-6.4 mmol/L |
| Potassium | 4.3 mmol/L | 3.5-5.1 mmol/L |
| Sodium | 137 mmol/L | 135-145 mmol/L |
| Bicarbonate | 20 | 22-26 mmol/l |

Complete blood count (CBC):

| CBC | Result | Normal Range |
|------------------|----------------------|--|
| Hemoglobin | 134 g/L | Male : 135-175 g/L (13.5-17.5 g/dl) Female : 120-155 g/L (12-15.5 g/dl) |
| White cell count | $12 \times 10^9 /L$ | $4.5-11.0 \times 10^9 /L$ |
| Platelet count | $198 \times 10^9 /L$ | $140-450 \times 10^9 /L$ |

Acute kidney injury vs. Chronic kidney injury:

| | Acute | Chronic |
|------------------|---------------------------|----------------------|
| History | Short (days-week) | Long (month-years) |
| Haemoglobin | Normal | Low |
| Renal size | Normal | Reduced |
| Serum Creatinine | Acute reversible increase | Chronic irreversible |

Clinical Scenarios

Scenario 2 cont..:

Urine Analysis:

| | Result | Normal Values |
|---------------------|-------------|---------------|
| Color | Dark yellow | Amber yellow |
| Character | Clear | clear |
| PH | 6.0 acidic | 4.8-8.0 |
| Specific gravity | 1.025 | 1.015-1.025 |
| Protein | +1 | (-) |
| Glucose | (-) | (-) |
| Red blood cells | 1-2 / hpf | (-) |
| Hemoglobin | Negative | (-) |
| Pus cells (WBC) | 1-2 / hpf | (-) |
| Epithelial cells | (-) | (-) |
| Amorphous phosphate | (-) | (-) |
| Bacteria | (-) | (-) |
| Granular cast | (-) | (-) |

What is your diagnosis?

- Acute Kidney Injury.

What is the etiology of AKI?

- Pre renal (dehydration)

What do you expect to find in urine analysis?

- Normal

What do you expect urinary Na, osmolality?

- Urinary Na < 10
- Osmolality > 300
- Fractional excretion of Na < 1%

Clinical Scenarios

Scenario 3:

19 years old girl known to have:

- Inflammatory bowel disease
- Referred for evaluation of high
- Serum creatinine 320
- Creatinine (baseline 90) July 2015
- Creatinine (160) June 2017

Vital signs:

| Vital signs | Result | Normal Range |
|----------------|-------------|--------------|
| Pulse | 95/min | 60-100/min |
| Blood pressure | 123/67 mmHg | 130/80 mmHg |
| Temperature | 37.0°C | 36.6-37.2°C |

Jugular venous pressure was normal,

Cardiovascular examination:

- Normal first and second heart sound no added sound or murmurs.

Respiratory system examination:

- Lungs are clear to percussion and auscultation.

Abdominal examination:

- No tenderness, liver and spleen were not palpable.

Blood test:

| Test | Value | Normal Range |
|-------------|------------|----------------|
| Creatinine | 320 µmol/L | 62-115 µmol/L |
| Urea | 27 mmol/L | 2.5-6.4 mmol/L |
| Potassium | 4.3 mmol/L | 3.5-5.1 mmol/L |
| Sodium | 137 mmol/L | 135-145 mmol/L |
| Bicarbonate | 17 | 22-26 mmol/l |

Clinical Scenarios

Scenario 3 cont..:

Complete blood count (CBC):

| CBC | Result | Normal Range |
|------------------|----------------------|--|
| Hemoglobin | 146 g/L | Male : 135-175 g/L (13.5-17.5 g/dl) Female : 120-155 g/L (12-15.5 g/dl) |
| White cell count | $8 \times 10^9 /L$ | 4.5-11.0 $\times 10^9 /L$ |
| Platelet count | $198 \times 10^9 /L$ | 140-450 $\times 10^9 /L$ |

Urine Analysis:

| | Result | Normal Values |
|---------------------|-------------|---------------|
| Color | Dark yellow | Amber yellow |
| Character | Clear | clear |
| PH | 6.0 acidic | 4.8-8.0 |
| Specific gravity | 1.025 | 1.015-1.025 |
| Protein | +1 | (-) |
| Glucose | (-) | (-) |
| Red blood cells | 1-2 /hpf | (-) |
| Hemoglobin | Negative | (-) |
| Pus cells (WBC) | 30-40 /hpf | (-) |
| Epithelial cells | (-) | (-) |
| Amorphous phosphate | (-) | (-) |
| Bacteria | (-) | (-) |
| Granular cast | WBC cast | (-) |

Clinical Scenarios

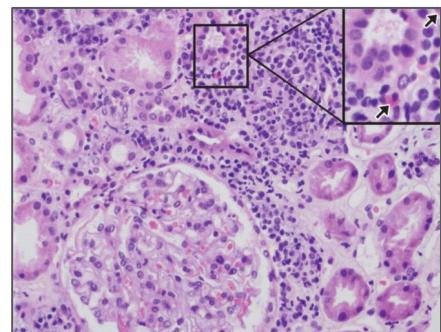
Scenario 3 cont..:

What is your diagnosis?

- Acute Kidney Injury secondary to interstitial nephritis.

What is the treatment of this condition?

- Look for offending agent
- Steroid



Scenario 4:

19 years old Saudi male, s/p road traffic accident 7 months ago, bedridden, on foley's catheter. you have been called to see because of

- High serum creatinine is 198 µmol/l
- Baseline creatinine 45 µmol/l 2 days ago
- Urine output 1.2 litter/day

Vital signs:

| Vital signs | Result | Normal Range |
|----------------|-------------|--------------|
| Pulse | 65/min | 60-100/min |
| Blood pressure | 124/67 mmHg | 130/80 mmHg |
| Temperature | 37.0°C | 36.6-37.2°C |

Jugular venous pressure was normal,

Cardiovascular examination:

- Normal first and second heart sound no added sound or murmurs.

Respiratory system examination:

- Lungs are clear to percussion and auscultation.

Abdominal examination:

- No tenderness, liver and spleen were not palpable.

Blood test:

| Test | Value | Normal Range |
|-------------|------------|----------------|
| Creatinine | 198 µmol/L | 62-115 µmol/L |
| Urea | 16 mmol/L | 2.5-6.4 mmol/L |
| Potassium | 3.9 mmol/L | 3.5-5.1 mmol/L |
| Sodium | 137 mmol/L | 135-145 mmol/L |
| Bicarbonate | 23 | 22-26 mmol/L |

Clinical Scenarios

Scenario 4 cont...:

Complete blood count (CBC):

| CBC | Result | Normal Range |
|------------------|----------------------|--|
| Hemoglobin | 146 g/L | Male : 135-175 g/L (13.5-17.5 g/dl) Female : 120-155 g/L (12-15.5 g/dl) |
| White cell count | $9 \times 10^9 /L$ | 4.5-11.0 $\times 10^9 /L$ |
| Platelet count | $178 \times 10^9 /L$ | 140-450 $\times 10^9 /L$ |

Urine Analysis:

| | Result | Normal Values |
|---------------------|------------|---------------|
| Color | Dark | Amber yellow |
| Character | Clear | clear |
| PH | 6.0 acidic | 4.8-8.0 |
| Specific gravity | 1.021 | 1.015-1.025 |
| Protein | (-) | (-) |
| Glucose | (-) | (-) |
| Red blood cells | 0 /hpf | (-) |
| Hemoglobin | Negative | (-) |
| Pus cells (WBC) | 0 /hpf | (-) |
| Epithelial cells | (-) | (-) |
| Amorphous phosphate | (-) | (-) |
| Bacteria | (-) | (-) |
| Granular cast | (-) | (-) |

Clinical Scenarios

Scenario 4 cont...:

Approach to a patient with high creatinine:

Step one: determine the baseline of creatinine to specify which type of kidney injury does the patient have (acute/ chronic/acute in top of chronic) through **baseline creatinine (45 mol/L) two days ago.**

- Acute

Step two: determine the etiology (prerenal, renal or postrenal)

- History + normal specific gravity excludes pre renal causes
- For renal: AT: usually caused by prolonged hypotension, which is not seen in the history AIN: usually causes by toxic medications, also not seen in the history. GN: no hematuria seen and no proteinuria.
- Now: check for obstruction using an ultrasound.



What is your diagnosis? AKI.

What is the etiology of AKI? Post renal (obstruction) because of wrong catheter (Reason, he had his foley catheter (intraurethral) changed odor a condom catheter causing obstruction because he has paraplegia (neurogenic bladder) so he cannot empty his bladder without a foley catheter.).



Treatment? Remove the wrong catheter.

Scenario 5:

76 years old man Known to have:

- Long standing diabetes and hypertension
- Ischemic heart disease

Presented with acute chest pain and shortness of breath diagnosed to have Acute coronary syndrome, underwent cardiac catheterization. Baseline creatinine 120 , **2 days** later creatinine has increased to 560 with oliguria.

Vital signs:

| Vital signs | Result | Normal Range |
|----------------|-------------|--------------|
| Pulse | 98/min | 60-100/min |
| Blood pressure | 146/67 mmHg | 130/80 mmHg |
| Temperature | 37.5°C | 36.6-37.2°C |

Jugular venous pressure was normal, skin lesion over lower limbs and absent dorsalis pedis and posterior tibial arteries, black toes bilaterally.

Cardiovascular examination:

- Normal first and second heart sound no added sound or murmurs.

Respiratory system examination:

- Bilateral basal crackles.

Abdominal examination:

- Soft and lax , liver and spleen were not palpable.

Clinical Scenarios

Scenario 5 cont...:

Blood test:

| Test | Value | Normal Range |
|-------------|------------|----------------|
| Creatinine | 560 µmol/L | 62-115 µmol/L |
| Urea | 26 mmol/L | 2.5-6.4 mmol/L |
| Potassium | 5.7 mmol/L | 3.5-5.1 mmol/L |
| Sodium | 134 mmol/L | 135-145 mmol/L |
| Bicarbonate | 13 | 22-26 mmol/l |



What is your diagnosis?

- Acute kidney injury

What is your differential diagnosis?

- Atheroembolic disease
- Contrast induced AKI

Atheroembolic AKI:

1-2 weeks post procedure, creatinine peaks

- Commonly occur after intravascular procedures or cannulation (cardiac cath, CABG, AAA repair, etc.)
- Associated with emboli of fragments of atherosclerotic plaque.

Diagnose by history, physical findings

- Evidence of other embolic phenomena
- CVA
- Ischemic digits "blue toe" syndrome
- Absent pulses
- Livedo reticularis
- Low serum C3 and C4
- Peripheral eosinophilia
- Eosinophiluria

Treatment

- Supportive In general

Prognosis

- Poor

Clinical Scenarios

Contrast induced AKI:

12-24 hours post exposure,
Creatinine peaks in 3-5 days

- ❖ Non-oliguric, FENa <1% !!
- ❖ Risk Factors:
 - CKD
 - Older age
 - Hypovolemia ,DM,CHF

Treatment /Prevention:

Alternative procedure if feasible

- 1/2 NS 1 cc/kg/hr 12 hours pre/post
- N-acetyl cysteine 600 BID pre/post (4 doses)
- Monitoring of urine output
- Creatinine and lytes

Scenario 6:

34 years old man Presented with lower limb swelling and SOB for 2 weeks and fatigue.
Found to have high creatinine.

Vital signs:

| Vital signs | Result | Normal Range |
|----------------|-------------|--------------|
| Pulse | 88/min | 60-100/min |
| Blood pressure | 167/94 mmHg | 130/80 mmHg |
| Temperature | 37.1°C | 36.6-37.2°C |

Jugular venous pressure was normal , bilateral lower limb edema.

Cardiovascular examination:

- Normal first and second heart sound no added sound or murmurs.

Respiratory system examination:

- Lungs are clear to percussion and auscultation.

Abdominal examination:

- Soft and lax , liver and spleen were not palpable.

Blood test:

| Test | Value | Normal Range |
|-------------|------------|----------------|
| Creatinine | 245 µmol/L | 62-115 µmol/L |
| Urea | 17 mmol/L | 2.5-6.4 mmol/L |
| Potassium | 4.9 mmol/L | 3.5-5.1 mmol/L |
| Sodium | 139 mmol/L | 135-145 mmol/L |
| Bicarbonate | 17 | 22-26 mmol/l |

Clinical Scenarios

Scenario 6 cont...:

Complete blood count (CBC):

| CBC | Result | Normal Range |
|------------------|----------------------|--|
| Hemoglobin | 146 g/L | Male : 135-175 g/L (13.5-17.5 g/dl) Female : 120-155 g/L (12-15.5 g/dl) |
| White cell count | $9 \times 10^9 /L$ | 4.5-11.0 $\times 10^9 /L$ |
| Platelet count | $178 \times 10^9 /L$ | 140-450 $\times 10^9 /L$ |

Urine Analysis:

| | Result | Normal Values |
|---------------------|------------|---------------|
| Color | Yellow | Amber yellow |
| Character | Clear | clear |
| PH | 6.0 acidic | 4.8-8.0 |
| Specific gravity | 1.021 | 1.015-1.025 |
| Protein | (+++) | (-) |
| Glucose | (-) | (-) |
| Red blood cells | 11 /hpf | (-) |
| Hemoglobin | Negative | (-) |
| Pus cells (WBC) | 1-2 /hpf | (-) |
| Epithelial cells | (-) | (-) |
| Amorphous phosphate | (-) | (-) |
| Bacteria | (-) | (-) |
| Granular cast | (+) | (-) |

Clinical Scenarios

Scenario 6 cont...:

What is your diagnosis?

- Acute kidney injury
- Renal: most likely glomerulonephritis

How would you investigate this patient further?

- Blood urea nitrogen and serum creatinine
- CBC, peripheral smear, and serology
- Urinalysis, 24 hours urine collection for proteins
- Urine electrolytes
- U/S kidneys
- Serology: ANA, ANCA, Anti DNA, HBV, HCV, Anti GBM, Cryoglobulin, CK, Urinary Myoglobin
- Kidney biopsy

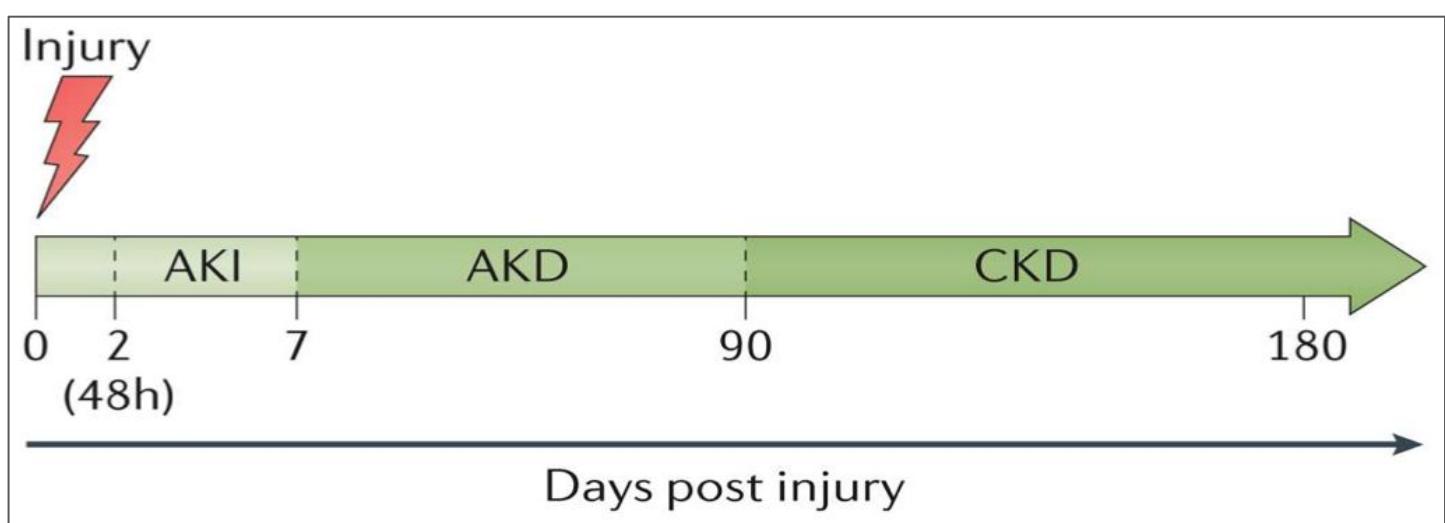
Summary:

Acute Kidney Injury is a syndrome characterised by the rapid loss of the **kidney's** excretory function.

Acute Kidney Injury is common and serious health problem which carry high mortality and morbidity.

Acute Kidney Injury is amenable to prevention, early detection and treatment.

The Continuum of AKI, AKD and CKD:



Summary

Acute and Chronic Kidney Disease are terms describing abnormalities of structure and/or function:

| | AKI | AKD | CKD | NKD |
|----------------------------|---|---|--|----------------------------|
| Duration | Within 7 days | <= 3 months | > 3 months | |
| Functional Criteria | Increase in Scr by \geq 50% within 7 days, OR Increase in Scr by ≥ 0.3 mg/dl (26.5 μ mol/L) within 2 days, OR Oliguria for \geq 4 hours | AKI, OR GFR < 60 mL/min/1.73m, OR Decrease in GFR by $\geq 35\%$ times baseline, OR Increase in Scr by $\geq 50\%$ times baseline | GFR < 60 mL/min/1.73m | GFR > 60 mL/min/1.73m |
| AND/OR | OR | OR | OR | AND |
| Structural Criteria | Not defined | marker of kidney damage (albuminuria, hematuria, or pyuria are most common) | marker of kidney damage (albuminuria is most common) | No marker of kidney damage |

Lecture Quiz

Q1: Prerenal acute kidney injury is commonly caused by:

- A. Obstruction of the urinary tract
- B. Damage to the renal tubules
- C. Reduced blood flow to the kidneys
- D. Inflammation of the glomeruli

Q2: The RIFLE criteria are used to:

- A. Determine the severity of acute kidney injury
- B. Assess the risk factors for chronic kidney disease
- C. Diagnose urinary tract infections
- D. Evaluate the effectiveness of dialysis

Q3: Which of the following is a long-term consequence of severe acute kidney injury?

- A. Chronic kidney disease
- B. Type 2 diabetes mellitus
- C. Rheumatoid arthritis
- D. Coronary artery disease