Acute Kidney Injury

Mohamad Ali Alhajhusain MD
Nephrologist

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Objectives

- To define Acute Kidney Injury (AKI)
- To understand the etiologies of AKI
  - Pre-renal, Intrinsic, Post-renal.
- To explain the evaluation and management of AKI including indications for renal replacement therapy (RRT)

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Importance of Acute Kidney Injury

- AKI occurs in approximately 9% of the hospitalized patients according to the RIFLE criteria. (1)
  - Up to 50% of patients in the ICU. (1)
  - Peri-operative complications
- Complications of AKI
  - Increased length of stay
  - Higher mortality
  - Increased cost

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Definition of AKI

- No specific symptoms
- Kidneys are not functioning which mean no Glomerular filtration or tubular secretion or reabsorption .
- High creatinine or low urine .

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Stages of AKI

- Kidney Disease: Improving Global Outcomes (KDIGO) Classification – Stages of AKI
  - Staging system we use for our inpatients.
- Stage 1 Increase in serum creatinine of > or = to 0.3 mg/dl or 1.5-1.9 times baseline **OR** Urine output of < 0.5 ml/kg/hr for 6-12 hrs
- Stage 2 Increase in serum creatinine to 2.0-2.9 times baseline **OR** Urine output of < 0.5 ml/kg/hr for 12-24 hrs
- Stage 3 increase in serum creatinine to > or = to 3 times baseline **OR** Urine output of < 0.3 ml/kg/hr for > 24 hrs or anuria for > or = to 12 hr **OR** Initiation of renal replacement therapy

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General Classification of AKI

- Pre-renal
- Renal/Intrinsic
- Post-renal
- Other
  - Unique to specific clinical situations

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Case

- A 75 year old man presents to ER from his nursing home with complaints of failure to thrive. It is reported that the patient has not been eating or drinking well for the past 4-5 days. Other associated symptoms include: diminished urine output. Vitals showing BP 70/50, Pulse 100, Respirations 20, and SpO2 of 90% on room air. Pertinent positive physical exam findings include: mildly dry mucous membranes and decreased skin turgor. Results of the renal function panel are as follows: Sodium 143. Potassium 3.8. Chloride 103. Venous bicarbonate 25. BUN 50. Creatinine 2.20.
- PMH: Hypertension, Hyperlipidemia, Chronic Kidney Disease Stage 3 with baseline creatinine of 1.2-1.4.
- Outpatient medications include: Hydrochlorothiazide, Lisinopril, Atorvastatin, and Ibuprofen PRN for aches and pains.

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Case

- Questions to answer :
  - What is the most likely mechanism of this patient's AKI?
  - Are there any other mechanisms that could be considered given the HPI?
  - What work-up should be ordered to further evaluate the patient?
  - How should this patient be treated?
    - What is the first line intervention?
    - Should any medications be stopped?

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Treatment

- IV Fluid
- What is best fluid to give this patient ?

A) Normal saline

B) LR

C) Albumin 5 %

D) Albumin 25 %

E) Sodium bicarb

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Answer

- lactated Ringer's or Plasma-Lyte A solution
- Balanced solutions appear to minimally decrease the risk of major adverse kidney events in critically ill ICU patients and emergency room patients.

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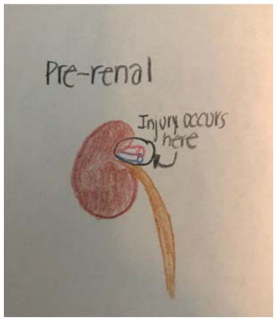
Pre-renal AKI



Introduction
- MOST COMMON cause of AKI in the outpatient setting.
- Second most common cause of AKI in the inpatient setting.

Reason for injury:
- Blood flow to the kidney is low.
- No damage to the structure of the tubules but if persistent, could progress to acute tubular necrosis (ATN)

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Pre-renal AKI

- Reasons for low blood flow include:
  - Intravascular volume depletion
    - Hemorrhage
    - GI losses: Vomiting and Diarrhea
    - Renal losses: Polyuria due to diabetes insipidus or osmotic diuresis
    - Skin losses: Fever and Sweating
    - Third spacing/severe protein calorie malnutrition: Pancreatitis and low albumin states

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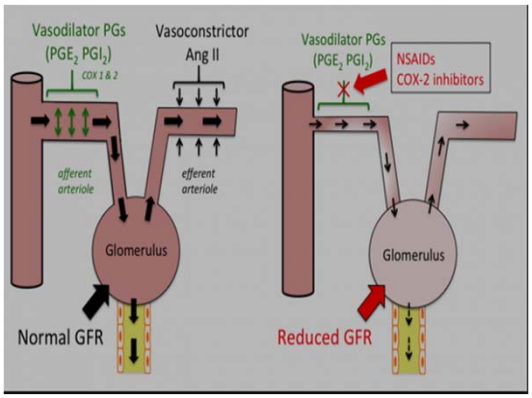
Pre-renal AKI

- Specific medications and their actions
  - Non-Steroidal Anti-inflammatory Drugs (NSAIDs)
  - Angiotensin-Converting Enzymes Inhibitors (ACEis) and Angiotensin Receptor Blockers (ARBs)



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Pre-renal AKI

- Evaluation
  - Urine sediment – Typically bland. May have some hyaline casts.
  - Urine electrolytes – Urine sodium level typically < 20.
  - FeNa – Calculation yields value that is < 1%

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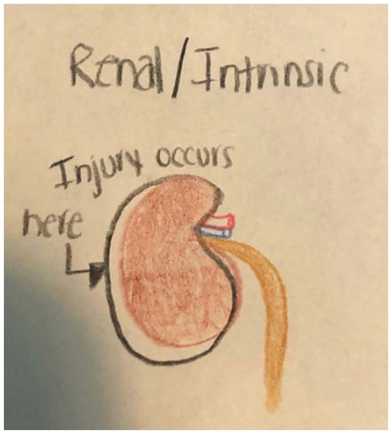
Renal/Intrinsic Injury

- Injury occurs at the level of the kidney.
- Different part of the kidney can be affected.
  - Vascular
  - Glomerular
  - Tubular/Interstitial
  - Combination



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Renal/Intrinsic Injury

- Acute Tubular Necrosis (ATN)
  - Most common cause of AKI in the hospital setting. (1)
  - ”Stunned” kidney
    - Tubules do not work because they are occluded or necrotic.

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Renal/Intrinsic Injury

- Acute Tubular Necrosis (ATN)
  - Reason for injury:
    - Prolonged ischemia
    - Sepsis
    - Nephrotoxins
      - Vancomycin, Zosyn (piperacillin/tazobactam), Aminoglycosides, Cisplatin, Radiocontrast
    - Heme-Pigment Induced
      - Rhabdomyolysis: myoglobin release from muscle
      - Hemolysis: hemoglobin release from RBCs

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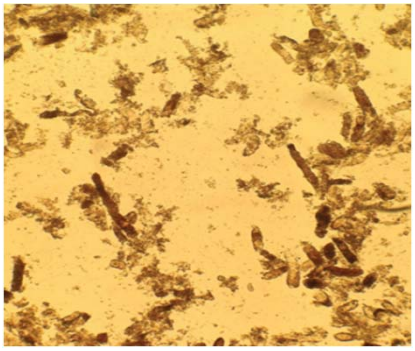
Renal/Intrinsic Injury

- Acute Tubular Necrosis (ATN)
  - Evaluation
    - Urine sediment – Muddy brown granular casts; epithelial cell casts
    - Urine electrolytes – Urine sodium is typically > 20.
    - FeNa – Calculation yields value > 2%



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Renal/Intrinsic Injury

- Acute Tubular Necrosis (ATN)
  - Treatment
    - Fluid management
      - Goal is avoid hypotension. Need to monitor closely to avoid hypervolemia.
    - Electrolyte management
      - Potassium
      - Sodium
      - Phosphorus
    - Removal of nephrotoxins
    - Supportive care until the patient achieves renal recovery

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Comparison Chart

Evaluation	Pre-renal	ATN
Urine sediment	BlanComparison Chartd; Hyaline Casts	Muddy brown granular casts; epithelial cell casts and tubular epithelial cells
Urine electrolytes	Urine sodium < 20	Urine sodium > 20
FeNa	FeNa < 1 %	FeNa > 1%
BUN/creatinine ratio	Ratio > 20:1	Ratio < 20:1

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Furosemide Stress Test.

- How it done

(1.0 mg/kg loop to diuretic-na¨ıve subjects and 1.5 mg/kg in subjects with prior furosemide exposure) in patients with AKI stages 1–2 to determine the risk of progression to stage 3.

It is not treatment

It is prognostic test .

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Case

- A 76 year old female is on hospital day 10 for sepsis. You are consulted because her creatinine has been trending up for the past 2 days. Her creatinine was 0.9 on admission. It was 1.4 yesterday and is up to 2.2 today. Her eosinophil count on CBC is elevated and she has some RBC/WBC present on her UA. You suspect she has AIN. Which of the following medications is most likely to be the cause?

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- **Which of the following medications is most likely to be the cause?**
  - A. Azithromycin/Zithromax
  - B. Metronidazole/Flagyl
  - C. Doxycycline
  - D. Zosyn/Piperacillin-Tazobactam

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Answer

- **Which of the following medications is most likely to be the cause?**
  - A. Azithromycin/Zithromax
  - B. Metronidazole/Flagyl
  - C. Doxycycline
  - **D. Zosyn/Piperacillin-Tazobactam – Penicillin drugs are one of the most common culprits of AIN**

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Renal/Intrinsic Injury

- Acute Interstitial Nephritis (AIN) – Inflammatory infiltrate of the kidney typically caused by drug therapy.
  - Most common culprits: NSAIDs, penicillins, cephalosporins, sulfamethoxazole/trimethoprim (Bactrim), diuretics, ciprofloxacin, rifampin, proton-pump inhibitors, cimetidine, and allopurinol.
  - Clinical findings: Classic findings include fever, rash, eosinophilia
  - Lab findings: Elevated creatinine, elevated eosinophil count on CBC, WBC/RBCs in the urine
  - Definitive diagnosis is obtained via biopsy.
  - Treatment: Removal of the offending agent and supportive management

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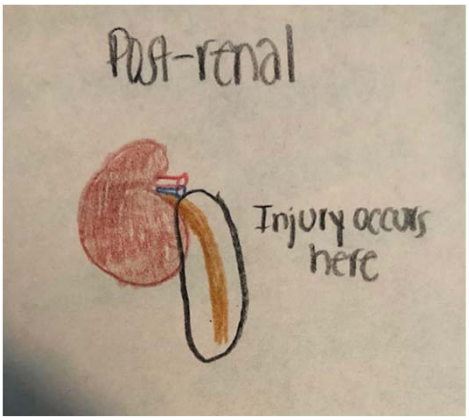
Post-renal AKI

- Reason for injury: Obstruction of the urinary tract
  - Ureteric obstruction – Neoplasm, clot, retroperitoneal fibrosis, calculus, iatrogenic
  - Urethral obstruction – Neoplasm, clot, benign prostatic hypertrophy, calculus, foreign object, neurogenic bladder



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Post-renal AKI

- Evaluation
  - Bladder scan
  - Catheter insertion (straight catheterization or Foley insertion)
  - Renal ultrasound
    - Look for stones or hydronephrosis

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Case

- A 70 year old male presents to the ER with back pain and difficulty voiding for the past 24 hours. Labs show creatinine is 3.8 which is elevated from his normal baseline of 1.5. A renal ultrasound is obtained and shows bilateral obstructing stones with subsequent bilateral hydronephrosis. You insert a Foley catheter with some urine return. What is the next best step in the management of this post-renal injury?

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- **What is the next best step in the management of this post-renal injury?**
  - A. Order a CT scan with contrast
  - B. Consult urology
  - C. Order a CT scan without contrast
  - D. Send a urinalysis

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Answer

- What is the next best step in the management of this post-renal injury?
  - A. Order a CT scan with contrast
  - **B. Consult urology – The patient has evidence of obstructing stones with hydronephrosis. Surgical intervention by urology is likely needed.**
  - C. Order a CT can without contrast
  - D. Obtain urinalysis

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Indications for Renal Replacement Therapy (RRT)

- Reasons to consider RRT in patients with AKI:
  - Hyperkalemia, EKG changes
  - Metabolic acidosis, pH < 7.2 on ABG despite sodium bicarbonate supplementation
  - Pulmonary edema refractory to medical therapy (diuretics)
  - Uremic symptoms, uremic pericarditis, obtundation, asterixis, seizures
  - Certain drug intoxications: Ethylene glycol

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Hyperkalemia

- Do not wait for EKG changes (do not wait for dialysis)
- Calcium — Calcium directly antagonizes the membrane actions of hyperkalemia, relatively short lived (30 to 60 minutes)
- Insulin with glucose- injection of 10 units of regular insulin, followed immediately by 50 mL of 50 percent dextrose (25 g of glucose) start to work 10 to 20 minutes, peaks at 30 to 60 minutes, and lasts for four to six hours
- Albuterol can be given as 10 to 20 mg in 4 mL of saline by nebulization over 10 minutes (which is 4 to 8 times the dose used for bronchodilation)
- Sodium bicarbonate ????????
- Remove potassium from the body :Loop diuretics, Sodium polystyrene sulfonate

Sodium zirconium cyclosilicate, Patiromer

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Case

- 45 year old female who present to the hospital after complaining of fever and shortness of breath. The patient was intubated upon arrival. The labs reveal acute kidney injury and metabolic acidosis. The patient has been on a bicarbonate drip for 4 hours to try to reverse the acidosis

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- **Which of the following findings on repeat laboratory studies would be an indication to start the patient on dialysis?**
  - A. Chest X-ray findings of pneumonia
  - B. pH of 7.15 on a repeat arterial blood gas (ABG)
  - C. Potassium of 5 without EKG changes
  - D. An Echo showing an ejection fraction of 50%

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Answer

- **Which of the following findings on repeat laboratory studies would be an indication to start the patient on dialysis?**
  - A. Chest X-ray consistent with pneumonia
  - **B. pH of 7.15 on repeat ABG – persistent acidosis despite a bicarbonate drip**
  - C. Potassium of 5 without any EKG changes
  - D. An Echo with an ejection fraction of 50%

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Kidney Recovery

- May take days, weeks or months.
  - If no recovery within three months, the patient may require renal replacement therapy indefinitely.
- Chances for recovery are decreased if:
  - Patient is over 65.
  - Patient has pre-existing chronic kidney disease
  - Patient has heart failure

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