

ACUTE KIDNEY INJURY



Objectives:

- Introduction to the renal pathology.
- Acute Kidney Injury.
- Definition, Types, Clinical Overview, Causes.
- Pathological findings.
- Differential Diagnosis.

Important note: During the previous blocks, we noticed some mistakes just before the exam and we didn't have the time to edit the files. To make sure that all students are aware of any changes, please check out this link before viewing the file to know if there are any additions or changes. The same link will be used for all of our work: [Pathology Edit](#).

Acute Kidney Injury. Robbins page 518

● What is acute kidney injury (also called acute renal failure)?

Acute kidney injury is defined as an abrupt ¹decline in renal function. (within hours to days).

● What do we mean by renal function?

The most important function of the kidney is filtration of blood & excretion of waste products such as creatinine & blood urea nitrogen (BUN).

● How do we know that a patient has acute kidney injury?

In acute kidney injury, there is **elevation** of waste products such as **creatinine & BUN** (azotemia).

● What is azotemia?

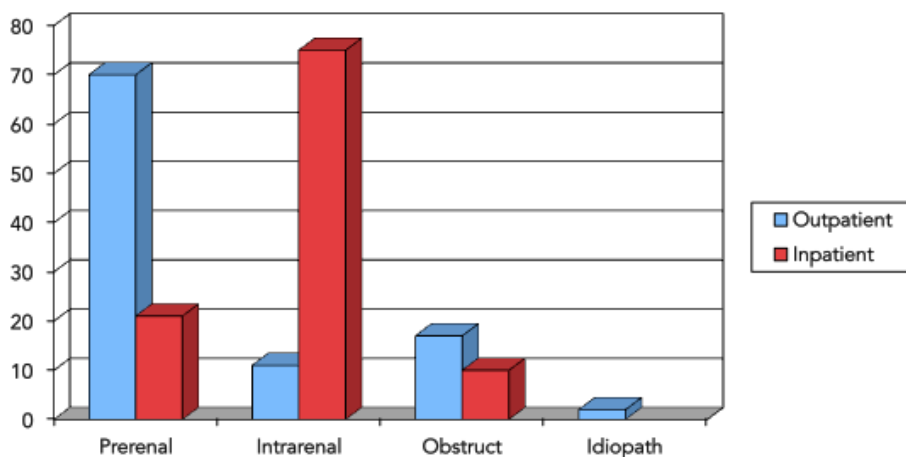
Azotemia is elevation of BUN & creatinine usually secondary to decreased GFR.²

● What is uremia?

It is azotemia + clinical manifestations & systemic biochemical abnormalities.

Examples of clinical manifestations of uremia:

- Lethargy³.
- Anorexia⁴.
- Dysgeusia⁵.
- Pericarditis.
- Neuropathy.
- Nausea ⁶and vomiting.
- Pruritis⁷.
- Dyspnea.



Oliguria: It is decreased urine output (less than 400cc /24h)

Non-oliguria: urine output is not decreased (greater than 400cc /24h).

Anuria: It is no urine outflow (less than 50cc/24h).

After this brief introduction, we should be able of handling the definition of acute kidney injury provided by Robbins: “ Acute kidney injury is dominated by oliguria or anuria (no urine flow), and recent onset of azotemia. It can result from glomerular injury (such as rapidly progressive glomerulonephritis), interstitial injury, vascular injury (such as thrombotic microangiopathy), or acute tubular injury.”

¹ Sudden, unexpected

² Glomerular Filtration Rate

⁴ Loss of appetite for food

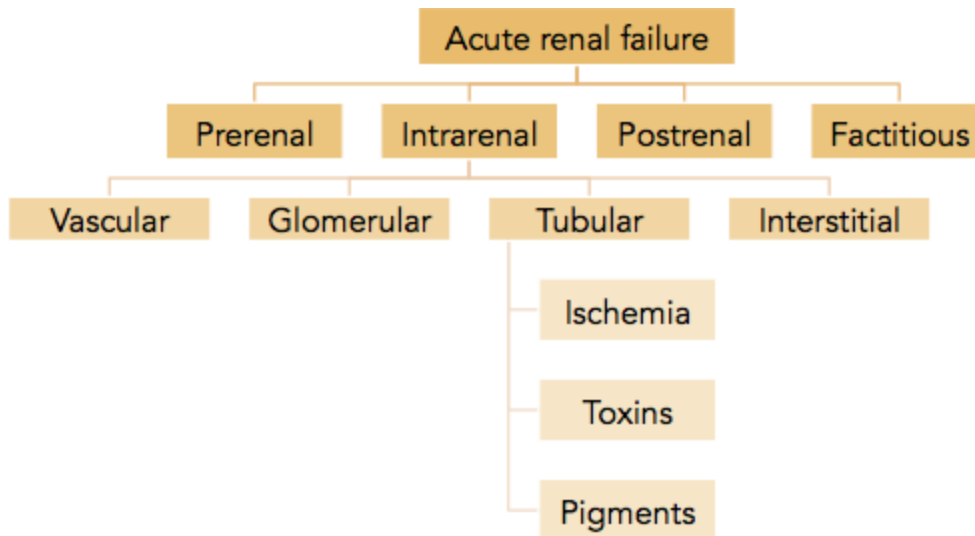
⁵ Distortion of the sense of taste

⁶ Sensation of discomfort of the upper stomach

⁷ Itch

Cause of Acute Kidney Injury. Guyton and Hall Textbook of Medical Physiology Page 399

To reemphasize, **azotemia** is elevation of creatinine & BUN secondary to decreased GFR. Therefore, a decrease in GFR would cause azotemia. Decreased GFR could be due to many different reasons. Now we will list the possible causes of decreased GFR, which lead to azotemia.



Before we begin, we should point out what factitious⁸ is, because it isn't important for our purposes.

Factitious Disorder: is a mental disorder in which a person acts as if he or she has a physical or mental illness when, in fact, he or she has consciously created their symptoms.

Prerenal azotemia:

GFR is directly proportional to renal blood flow. Therefore, any condition that decreases renal blood flow, or systemic blood pressure would cause a decrease in GFR → azotemia

Examples of **prerenal** azotemia:

- Hypotension:** shock (septic, cardiogenic, hypovolemic).
- Vascular pathology:** renal artery stenosis → decreased blood flow to kidney / abdominal aortic aneurysm may apply pressure on renal artery → decreased blood flow to kidney.
- Third spacing:** occurs when too much fluid moves from the intravascular space (blood vessels) into the interstitial, This can cause potentially serious problems such as edema, reduced cardiac output, and hypotension.
- Volume depletion:** loss of fluids causes a decrease in blood pressure.
- It could be **drug** induced: AngII normally constricts efferent arterioles of the glomerular capsule → increased pressure in the glomerular capillaries → increase GFR. If the patient is on angiotensin converting enzyme inhibitor (ACE I) there will be decreased AngII → decreased constriction of efferent arteriole → decreased pressure in glomerular capillaries → decreased GFR.

⁸ المريض يختلق المشكلة

- In prerenal azotemia there is decreased renal perfusion with no damage to the kidney parenchymal cells (in the beginning).
- **There is a continuum from prerenal physiology to ischemic pathology**

If there is decreased blood flow, there will be a decrease in GFR, which gives rise to azotemia. In addition, there is ischemia to the nephrons which may lead to necrosis of the kidney's cells after hours.

Postrenal azotemia:

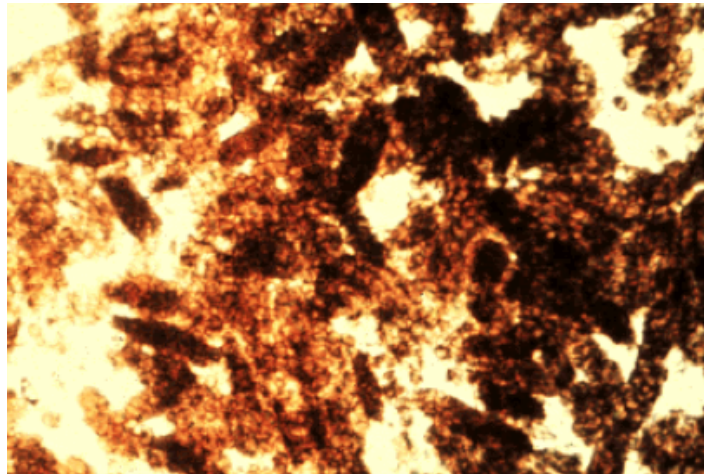
- This results when urine flow is obstructed.
- Examples include kidney stones, BPH (Benign Prostatic Hyperplasia), etc.
- In terms of pathophysiology: when there is obstruction to urine flow, pressure will back up to the Bowman's space. This will lead to an increase in the hydrostatic pressure in Bowman's space. The hydrostatic pressure of Bowman's space opposes GFR → The net result is decreased GFR.

Intrarenal azotemia: Robbins page 537

Acute Tubular Injury (ATI) is described pathologically & clinically:

- *Pathologists describe* it as damaged tubular epithelial cells (tubular necrosis).
- *Clinicians describe* it as acute decline in renal function with granular casts & tubular cells observed in the urine.

What are granular casts? Granular cast is a type of urinary cast. Urinary casts are cylindrical structures produced by the kidney and present in the urine in certain disease states. They form in the distal convoluted tubule and collecting ducts of nephrons, then dislodge and pass into the urine, where they can be detected by microscopy.



Sediment in ATN Urine sediment showing multiple, muddy brown granular casts. These findings are highly suggestive of acute tubular necrosis in a patient with acute renal failure. Courtesy of Harvard Medical School.

Intrarenal Causes of AKI:

- a. Severe *glomerular disease* manifested clinically by Rapidly Progressive Glomerular Disease (RPGN).

RPGN is a syndrome defined by the loss of renal function over days to weeks due to acute glomerulonephritis.

- b. Severe *vascular diseases* (ischemia: shock, sepsis, incompatible blood transfusion, thrombotic disease)
c. Acute **drug induced** allergic interstitial nephritis

Examples of tubular toxins:

- Antimicrobials:** aminoglycosides, vancomycin, foscarnet, pentamidine, amphotericin B.
- Chemotherapeutics:** cisplatin, mitomycin C, ifosfamide.
- Immunotherapy:** IVIG.
- Complex Sugars:** maltose, sucrose, mannitol.
- Heavy metals.
- Sepsis, hypoxia.
- Radiocontrast agents.

Some toxins can be produced by our own bodies: **myoglobin** (which is found in skeletal muscles) could cause injury to the tubular cells.

Take this for example: a patient has had a crush injury (a wall fell on his/her leg) → rhabdomyolysis⁹ → release of large amounts of myoglobin → acute kidney injury (renal failure).



SUMMARY

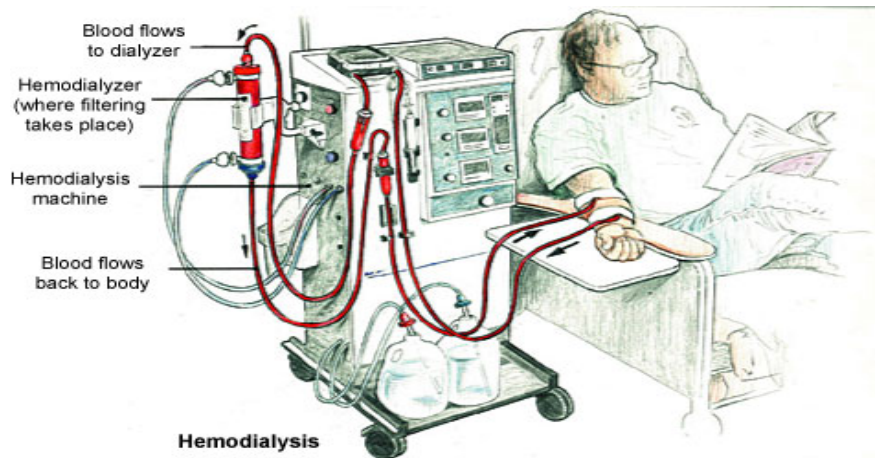
Acute Tubular Injury

- ATI is the most common cause of acute kidney injury; its clinical manifestations are electrolyte abnormalities, acidosis, uremia, and signs of fluid overload, often with oliguria.
- ATI results from ischemic or toxic injury to renal tubules, and is associated with intrarenal vasoconstriction resulting in reduced GFR and diminished delivery of oxygen and nutrients to tubular epithelial cells.
- ATI is characterized morphologically by injury or necrosis of segments of the tubules (typically the proximal tubules), proteinaceous casts in distal tubules, and interstitial edema.

⁹ death of skeletal muscles



Dialysis.



Predictors of Dialysis in AKI:

- Oliguria:
 - **<400cc/24hr 85%** will require dialysis.
 - **>400cc/24hr 30-40%** will require dialysis.
- Mechanical ventilation.
- Acute myocardial infarction.
- Arrhythmia (K+ Level up).
- Hypoalbuminemia.
- ICU stay.
- Multisystem organ failure.

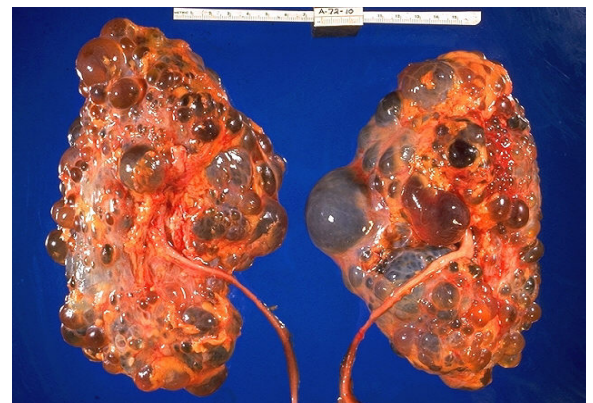
This part isn't included in the objectives.

Autosomal dominant polycystic kidney disease: is an inherited systemic disorder that predominantly affects the kidneys, Approximately 50% of people with this disease will develop end stage kidney disease and require dialysis or kidney transplantation.

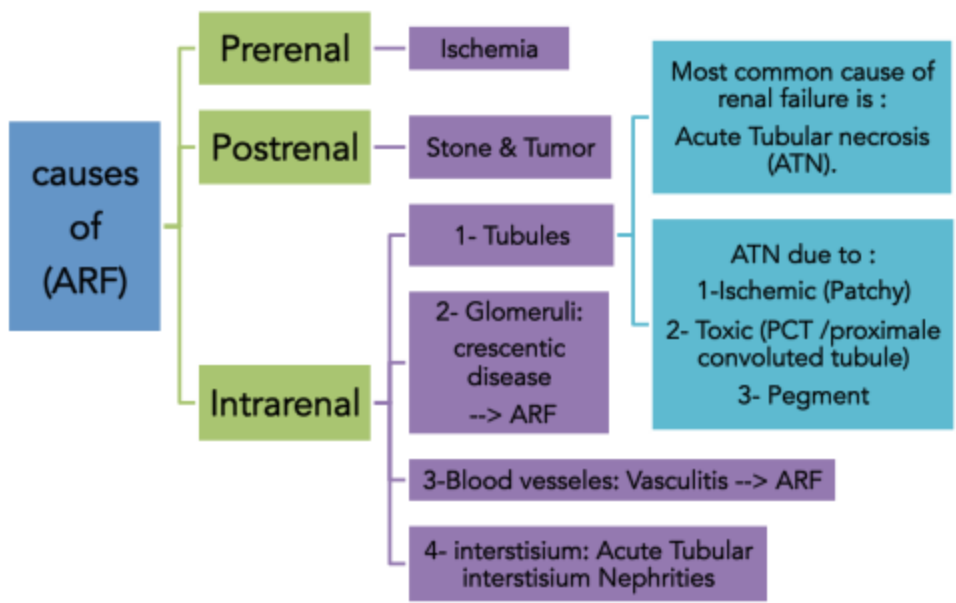
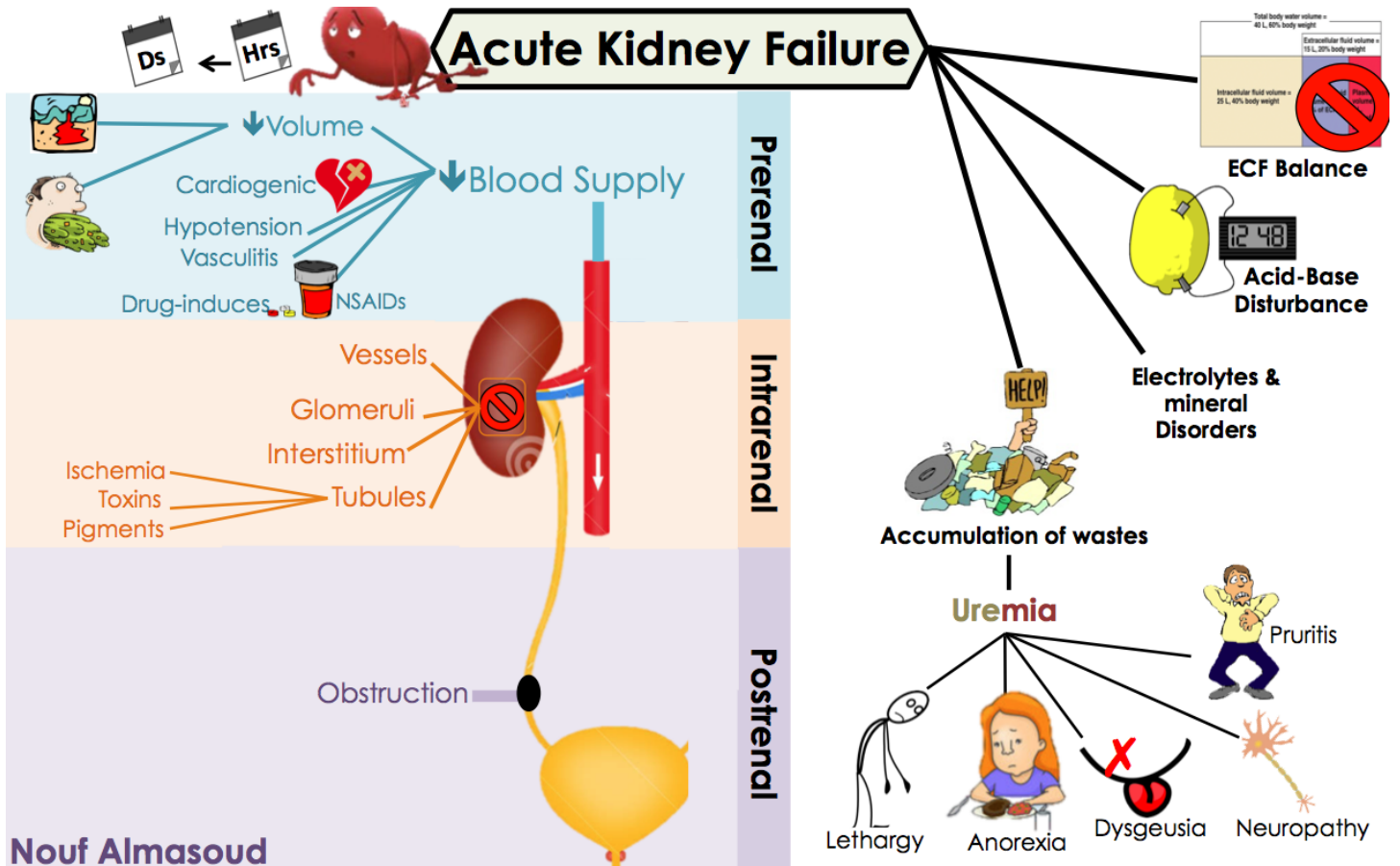
Autosomal recessive polycystic kidney disease: is less common than autosomal dominant polycystic kidney.

- **Mutations in the PKHD1.**

Renal dysplasia: is a condition that results from the malformation of the kidney during fetal development. The kidney consists of irregular cysts of varying sizes and has no function.



Summary.



MCQ's.

1- Which of the following is NOT true regarding Acute Renal Injury?

- a) the most common cause in outpatients is Prerenal .
- b) It is irreversible injury
- c) Although the medical technology have progressed the mortality rates remained the same
- d) It Cause Accumulation of nitrogenous waste products

Answer : B

2- Which of the following is termed to urine output less than 500cc/24hr

- a) Nonoliguria
- b) Oliguria
- c) Anuria
- d) Azotemia

Answer : B

3- Which of the following is not included in the prerenal causes of ARI:

- a) Hypertension
- b) Reduction of blood volume
- c) NSAID
- d) Vasculitis

Answer: A

4- Injury is caused by obstruction of urine flow. (urethral obstruction by enlarged prostate or tumor; ureteral or kidney pelvis obstruction by calculi)

- a) prerenal
- b) intrarenal
- c) post renal
- d) perirenal

answer : c

5- The cause of _____ injury is impaired blood supply to the kidney (Fluid Volume Deficit, hemorrhage, heart failure, shock)

- a) prerenal
- b) intrarenal
- c) post renal
- d) perirenal

Answer : a

6- Injury is caused by Acute damage to renal tissue and nephrons or acute tubular necrosis: abrupt decline in tubular and glomerular function due to either prolonged ischemia and/or exposure to nephrotoxins. (Acute glomerulonephritis, malignant hypertension, ischemia; nephrotoxic drugs or substances; red blood cell destruction; muscle tissue breakdown due to trauma, heatstroke)

- a) prerenal
- b) intrarenal
- c) post renal
- d) perirenal

answer B

7- Which of your patients would be at highest risk for significant problems with the kidney?

- a) Hypertensive patient
- b) Diabetic patient
- c) Elderly
- d) All of above

Answer D

8- An elderly male patient produced only 25 mL of urine in the past 24 hours. The urologist discovers that prostatic hypertrophy is the cause. Which one of the following *best describes* this patient's acute renal failure?

- a) prerenal
- b) intrarenal
- c) post renal
- d) perirenal

answer: c

9- a 34 year old female she experienced a severe decline in urine output .she then diagnosed with Acute Renal Failure what is the most common cause .

- a) acute tubular necrosis
- b) nephrotoxicity

answer A

Contact us on: Pathology434@gmail.com

Twitter: @Pathology434

Good Luck!

Done by:

مها الربيعة
سارة محمد الجاسر
Najlaa Khalid
نوف المسعود

محمد الخراز
عمر الرهيني