

ACUTE KIDNEY INJURY



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**IT IS THE 1ST AND MAIN SOURCE FOR STUDYING THIS LECTURE
(REVISED WITH DR.KFOURI)**

ALONG WITH A SUMMARY WHICH YOU CAN USE AS A FINAL REVISION

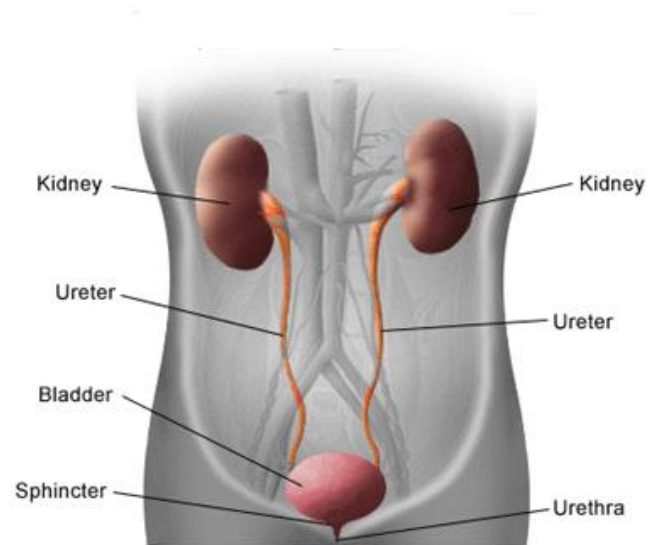
SPECIAL THANK YOUS TO “MOHAMMAD AL-KHURAIJI”, FOR HIS HELP...

The Kidney

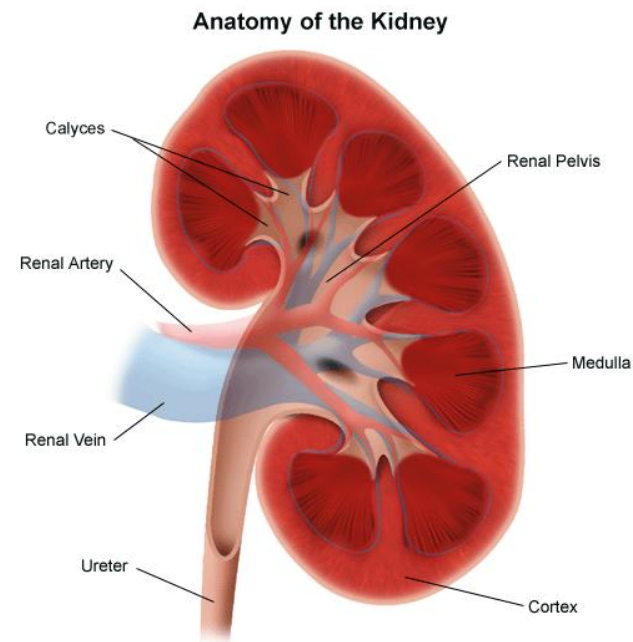
NORMAL ANATOMY AND KIDNEY STRUCTURE

Urinary system :

- Kidneys
- Ureters
- Bladder
- Urethra



- The kidney are retroperitoneal organs.
- Each adult kidney weights 120g to 150g
- Is covered by a thin capsule of connective tissue and a layer of perinephric fat.
- Outer layer is cortex, inner region is medulla
- **Medulla**
has pyramidal segments 10 – 20 pyramids with base at cortex, medullary junction and apex at minor calyx of ureter
- **Renal papillae** with openings of collecting ducts
- **Medullary rays** extend into cortex from pyramid base
- Each ray has **collecting tubules** and components of nephrons



☒ NEPHRON :

➤ Each kidney is composed of approximately 1 million nephrons, the basic functional unit of the kidney.

- 1- The glomerulus with its afferent and efferent arterioles, consists of a tuft of capillary loops that protrude into Bowman's capsule.

The glomerular tuft has several components.

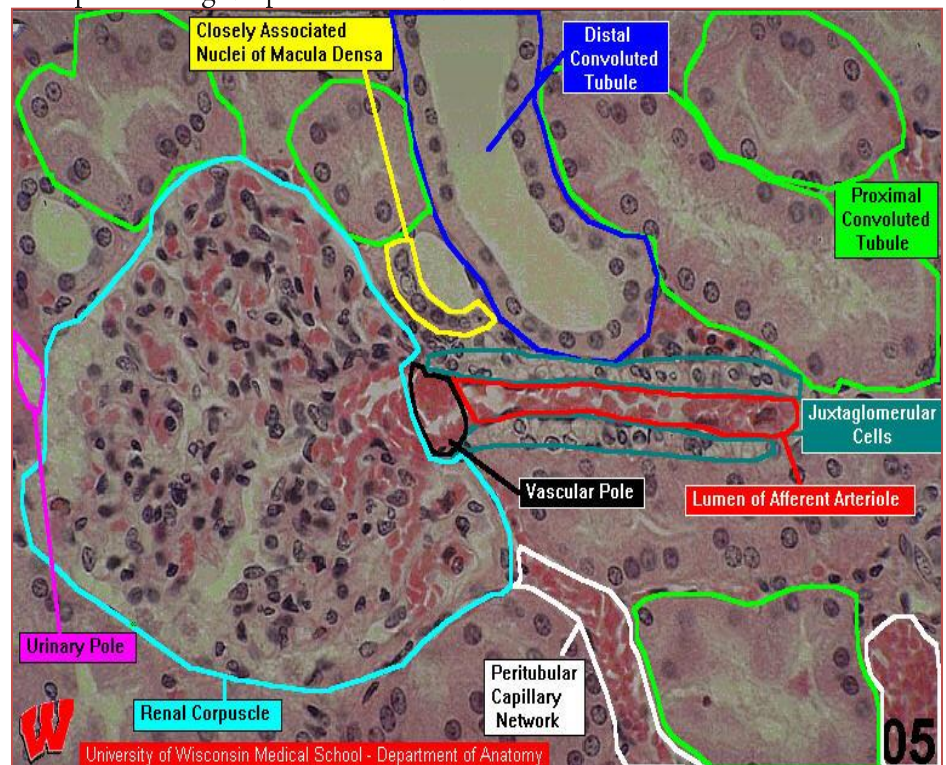
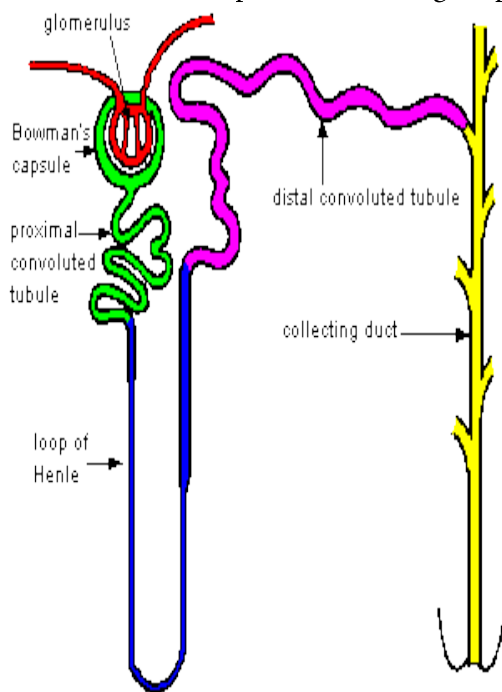
- a) The **mesangium** is a supporting structure composed of cells and matrix.
- b) the **glomerular capillary loops** are endothelial-lined tubes, which are covered with basement membrane and visceral epithelium and held in place by the mesangium.
- c) The **glomerular basement membrane (GBM)** and **visceral epithelial cells** together comprise the ultrafiltration barrier necessary for urine formation.

- 2- The renal tubule begins as Bowman's capsule and consists of the proximal convoluted tubule - Loop of Henle - distal convoluted tubule - collecting duct (the last of which conveys urine to the renal pelvis and ureter).

- 3- The interstitium is a C.T consisting of reticular fibres and interstitial cells, lymphatics and nerves.

➤ There are two distinct types of nephrons:

- 1- **Cortical nephron:** they are the predominant type and have glomeruli situated in the outer cortex.
- 2- **Juxtamedullary nephron:** have glomeruli located at the corticomedullary junction. These nephrons have long loops of Henle penetrating deep into the medulla.



☒ URINARY TRACT STRUCTURE

The urinary tract connects to the kidney at the renal pelvis
Consists of the ureters, urinary bladder and urethra

The Kidney Biopsy

A biopsy is when a small sample of tissue is removed from a part of the body (just 1 of 2000 of the kidney).

The **first thing** the pathologist have to **look at** in kidney biopsy is the **adequacy** (is my slide enough??)
(in adult it should be at least 8 Glomeruli present to be adequate and When we have a biopsy of only the medulla, this is not adequate)

Then, To make a **diagnosis** we should look at **4 elements**:

- Blood Vessels
- Glomerulus [for any necrosis or inflammation]
- Tubules [for any necrosis or inflammation]
- Interstitial (between the tubules) [for any edema]

Stains Used for a biopsy:

- H&E
- PAS
- Silver
- Trichrome

used to

- stain the basement membrane
- to assess how much fibrosis in the interstitial

Immunofluorescence:

An immunological reaction (antigen-antibody reaction)

how?

we take a tissue, let it have an “antigen-antibody” reaction **by** putting the fluorescence on the antibody

The antigen presents the antibody → it will get attached and if we washed it

The fluorescence will stay there → we can see it by the microscope

((in an immunofluorescence, we freeze the tissue **by** cryostat WE DON'T FIX IT IN FORMALIN (because it will die ..)

We freeze the tissue immediately → we cut our section → put the antibody → look for the antigen

- for example we look for IGA, IGE , IGM , C3 ,, each one will be with a specific fluorescent))

The Electron Microscopy:

is used to make the structure SO BIG

Nano-technology and Biotechnology

Is a tool designed for the study of the protein structures at the atomic level (molecular).

Renal Failure:

A Rapid and frequently reversible deterioration (loss) of renal function.

It is discussed under **Acute Tubular Necrosis** because it frequently occur in it

(when they ask u about renal failure → u should think about **ATN** immediately)

Dr.
emphasized
on it

It is clinically associated with:

1. Accumulation of nitrogenous waste products (increased BUN –blood urea nitrogen-
2. Increased serum Creatinine levels
→ low GFR
3. Derangement of extracellular fluid balance.
4. Acid-base disturbance.
5. Electrolyte and mineral disorders.

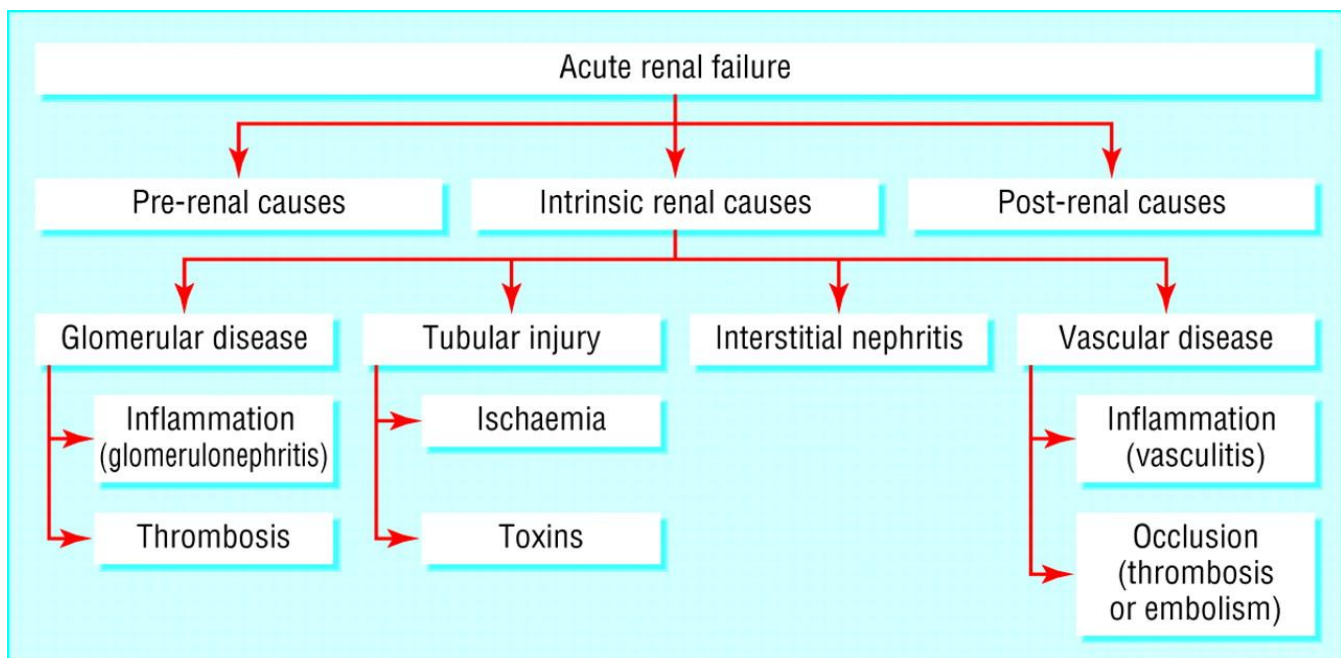
Diagnostic Approach to acute renal failure:

- The Patient's medical history (a record review would also be a part of the history)
- Consider therapeutic trials (whatever the patient is having on therapy would be considered)
volume challenge – foley replacement – hemodynamic support
- Physical examination would assess the volume status
- Bladder evaluation
- Urinalysis
- Renal biopsy
- Embiric therapy (therapy derived from observations)

Types

We have 3 types of ARF, pre-renal, renal (or intrarenal) and post-renal (Pre-renal is due to ischemia)

However we care more about the **Renal** in this lecture



1- Pre-renal

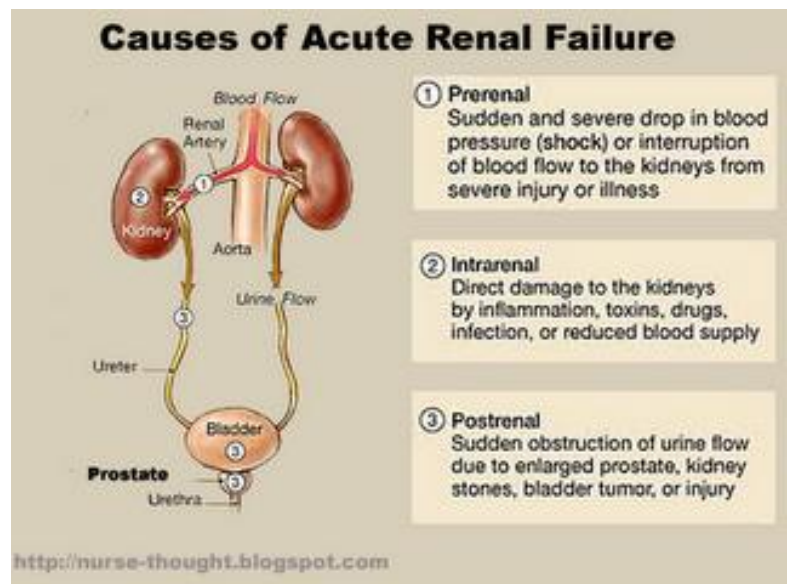
a. Volume depletion

- Renal losses (diuretics, polyuria)
- GI losses (vomiting, diarrhea)
- Cutaneous losses
(burns, Stevens-Johnson syndrome)
- Hemorrhage
- Pancreatitis

b. Decreased cardiac output

- Heart failure
- Pulmonary embolus
- Acute myocardial infarction
- Severe valvular heart disease

Abdominal compartment syndrome (tense ascites)



2- Post-renal

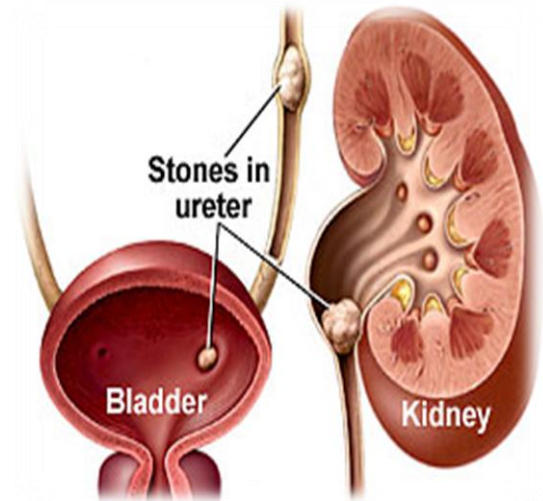
a. Ureteric obstruction

- i. Stone disease,
- ii. Tumor,
- iii. Fibrosis,
- iv. Ligation during pelvic surgery

b. Bladder neck obstruction

- i. Benign prostatic hypertrophy [BPH]
- ii. Cancer of the prostate
- iii. Neurogenic bladder
- iv. Drugs (Tricyclic antidepressants, ganglion blockers,
- v. Bladder tumor,
- vi. Stone disease, hemorrhage/clot)

c. Urethral obstruction (strictures, tumor)



Mortality of ARF:

Mortality rates seem to have remained unchanged at around 50%.”

GLOMERULAR INJURY:

❖ **RAPIDLY PROGRESSIVE (CRESCENTIC) GLOMERULONEPHRITIS (RPGN):**

a nephritic syndrome with rapid and progressive loss of renal function due to acute glomerulonephritis.

- A heterogeneous condition, represents the end result of severe glomerular damage.
- If untreated, a renal failure and death may result (after weeks or months)
- A form of glomerulonephritis, found in streptococcal infection, lupus nephritis, goodpasture's syndrome, vasculitis, cryoglobulinemia or it may be idiopathic.
- manifestations:
 - a) Microscopic Hematuria, Dysmorphic red blood cells and red blood cell casts in the urine sediment
 - b) mild to moderate *Proteinuria*
- the histological picture is characterized by the presence of crescents
- Crescents are produced by :
 - 1- proliferation of the parietal epithelial cells of Bowman's capsule in response to injury (exudation of plasma proteins including fibrin into Bowman's space).
 - 2- infiltration of monocytes and macrophages into Bowman's space.

Causes it may be restricted to kidneys or systemic... and there's a doubt that it is immunologically mediated

TUBULAR INJURY:

- Acute Tubular Necrosis
 - A. the most **common** cause of acute renal failure.
 - B. Clinicopathologic Entity (*It's a clinical presentation syndrome which is associated with pathological finding*):
 - **Characterized clinically by:** acute suppression of renal function usually (urine is below 400ml/day or no urine at all) but not always associated with oliguria.
 - **Characterized morphologically by:** destruction of the tubular "epithelial cells".

Anuria: total cessation of urine output.

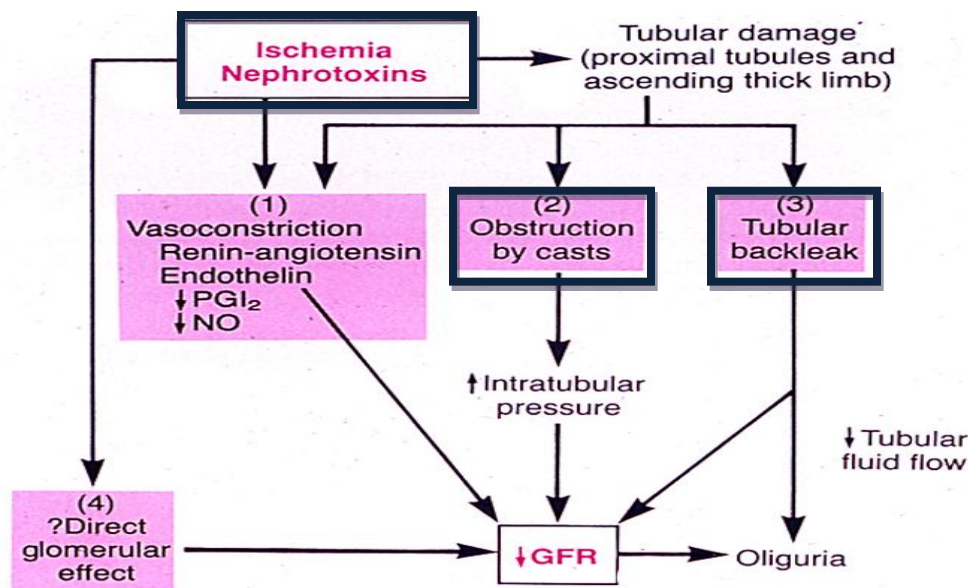
Oliguria: diminished urine output below the level of intake of water and solutes.

C. Classification of ATN:**1. ISCHEMIC**

- Pathogenesis involves patchy necrosis of tubular epithelial cells resulting from reduced blood flow.
Tubular obstruction by sloughed epithelial cells may perpetuate the lesion.
- Renal biopsies are characterized by flattened tubular epithelium, regenerating cells, interstitial edema and pigmented granular & hyaline casts.

2. TOXIC

- Associated with heavy metal poisoning, ingestion of organic solvents (methanol) and certain antibiotics (aminoglycosides).
- Characteristically the lesion in the renal tubules is generalized in the proximal tubule.

**D. causes:**

- 1- Vascular obstruction(pre-renal) e.g. Polyarthrititis nodosa (PAN) ,malignant hypertension and hemolytic-uremic syndrome.
- 2- Glomerular diseases e.g. RPGN (this could be a complication of crescentic glomerulonephritis)
- 3- **Acute Tubulointerstitial nephritis** (this is the 2nd type of "tubular injury").
- 4- Disseminated intravascular coagulation (when pregnant women bleed, they get coagulations in their vessels)
- 5- Urinary obstruction by: tumors, prostatic gland hypertrophy, stones and blood clots (post-renal)

E. Conditions associated with ATN:

1. Shock
2. Sepsis
3. Incompatible blood transfusions
4. Burns
5. Crush injury
6. Drug

Hemolytic-uremic syndrome (HUS)

is a rare condition that affects mostly children under the age of 10, but also may affect the elderly as well as persons with other illnesses.

HUS, which most commonly develops after a severe bowel infection with certain toxic strains of a bacteria,

- **Acute Tubulointerstitial nephritis:**
 - it is the 2nd type of tubular injury next to ATN.
 - it involves the tubules and their interstitial .
 - most commonly occurs due to **drugs hypersensitivity**
 - could cause interstitial injury due to edema.

Pyelonephritis:

an ascending urinary tract infection that has reached the pelvis of the kidney.

It caused by

- toxins like drugs e.g (aminoglycosides , chemotherapy).
- massive infections(pyelonephritis)
- neoplasms.
- immunological reactions e.g (transplant rejection).
- vascular diseases

Tubular Toxins:

The most important and the most affected region by these toxins is the **proximal convoluted tubules (PCT)** because they are very sensitive to toxicity.

These toxins could be:

- Antimicrobial /antibiotics **e.g.** (Aminoglycosides).
- Chemotherapeutics. - Immunotherapy. - Complex Sugars **e.g.** (maltose, sucrose, mannitol).
- Heavy metals → cause poisoning.
- ingestion of organic solvents **e.g.** (methanol, ethylene glycol)
- Sepsis → (hypoxia due to bacterial infection.)
- Radiocontrast agents.

Diseases involving blood vessels:

- 1) Benign nephrosclerosis
- 2) Malignant nephrosclerosis
- 3) Thrombotic microangiopathies

Caused by:

Vasculitis, hypertension.

Blood Vessels Injury:

All diseases of the kidney involve the vessels secondarily

Systemic Vascular Diseases such as

- Various forms of Vasculitis which affect the “Renal Vessels” that’d affect the kidney’s function
- Hypertension is also linked with the kidney (the kidney disease can be a cause/consequence of high blood pressure)

Cause: benign and malignant Nephrosclerosis – renal artery stenosis

Interstitial Injury:

Due to edema (can also be associated with *Acute Tubulointerstitial nephritis*)

Diseases affecting tubules and interstitium:

- 1) inflammatory involvement:

Tubulointerstitial nephritis "TIN" (pyelonephritis)

Caused by bacterial infection, intravascular coagulation

- 2) Ischemic or toxic tubular injury:

A. **Acute tubular necrosis (ATN):**

Causes:

destruction of tubular epithelial cells + the urine is < 400, tumors, hypertrophy, TIN

B. **Acute renal failure (ARF):**

Causes: shock, sepsis, incompatible blood transfusion, burns, crush injury, drugs.