

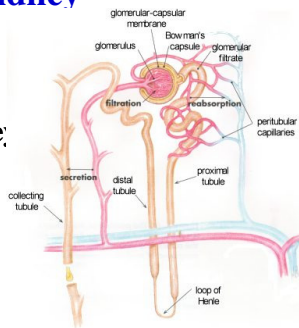
Renal Disorders

Renal Functions

- Cleanse ECF
- Maintain acid-base balance
- Excretion of metabolic wastes
- Maintenance of blood volume (pressure)

A&P of the Kidney

- Nephron is the basic functional unit of the kidney



Nephron

- Glomerulus
- Proximal Convoluted tubule
- Loop of Henle
- Distal convoluted tubule
- Collecting duct

Kidney Processes

- Filtration –
 - Occurs in glomerulus
 - passive, nonselective
- Reabsorption
 - active transport, water follows solute
- Active tubular secretion
 - Proximal convoluted tubule
 - Acid pumps
 - Base pumps

Reabsorption

- Proximal Convoluted Tubule
 - 65% of Na and Cl
 - Virtually all bicarb and K
- Loop of Henle
 - 20% of Na and Cl
 - Descending – permeable to water
 - Ascending – not permeable to water
- Distal
 - 10% of Na and Cl

Reabsorption

- **Late distal Convoluted Tubule and Collecting duct**
 - **Sodium-potassium exchange – aldosterone**
 - Actually causes more pumps to be made
 - **Final concentration of urine – ADH**
 - Controls water permeability of collecting duct

Diagnostic and Laboratory

- **Blood Urea Nitrogen (BUN): 10 – 20**
- **Creatinine: 0.7 – 1.2**
- **Creatinine Clearance**
- **Variety of Urinalysis tests**
 - pH
 - Specific gravity
 - Presence of Proteins, Blood, Urobilinogen, Leukocytes, Bacteria, Glucose, Ketones
 - Microscopic examination

Diuretics

- **Most work by inhibiting reabsorption of NaCl**
 - **Earlier in the tubule they work, the stronger**
 - **Fun with Math**
 - **180 liters of filtrate produced daily**
 - **1% blockade of NaCl → 1.8 liters urine**
 - **3% blockade of NaCl → 5.4 liters urine**
 - 12 pounds in one day

Adverse Impact

- **Hypovolemia**
- **Acid-base imbalance**
- **Electrolyte imbalance**

- **Mitigating**
 - Use short acting
 - Timing

Diuretics

- **High Ceiling (Loop) diuretics**
- **Thiazide diuretics**
- **Potassium-sparing**
 - Aldosterone antagonists
 - Non-aldosterone antagonists
- **Osmotic Diuretics**
- **Carbonic anhydrase inhibitors (not used for diuresis; used for IOP)**

Loop Diuretics

- **Act in ascending loop of Henle**
- **Strongest**
- **Drugs**
 - Furosemide (Lasix)
 - Bumetinide (Bumex)
 - Torsemide (Demadex)
 - Ethacrynic acid (Edecrin)

Furosemide (Lasix)

- **Pharmacokinetics**
 - PO onset 60 minutes, duration 8 hours
 - IV onset 5 minutes, duration 2 hours
 - Hepatic metab, renal excretion
- **Therapeutic uses**
 - Pulmonary edema
 - CHF
 - Edema
 - Hypertension
 - Work even with severe renal impairment

Adverse effects

- Hyponatremia, Hypochloremia, Dehydration
- Hypotension
 - Monitor BP at home
 - Get up slowly
- Hypokalemia
- Ototoxicity
- Hyperglycemia – caution in DM
- Elevated uric acid
- Lipids, Calcium, Magnesium

Drug Interactions

- Digoxin
- Ototoxic drugs
- Potassium sparing diuretics
- HTN drugs
- NSAIDS

Thiazide Diuretics

- Hydrochlorothiazide (HCTZ)
- Action – blocks NaCl in early DCT
 - Do not work when GFR < 15-20 ml.min
- Pharmacokinetics
 - PO, Onset 2 hours, peaks 2 – 6 hours
 - Excreted unchanged in kidneys
- Uses
 - HTN
 - Edema

Adverse effects

- Hyponatremia, Hypochloremia, Dehydration
- Hypotension
 - Monitor BP at home
 - Get up slowly
- Hypokalemia
- Hyperglycemia – caution in DM
- Elevated uric acid
- Lipids, Calcium, Magnesium

HCTZ dosing

- Smaller is better these days
- Starting dose 6.25 or 12.5 mg
- Max dose 50 mg/day
- Prefer max of 25 mg/day
- Dirt cheap
- Frequently combined with other antihypertensive medications

Potassium Sparing

- **Spironolactone (Aldactone)**
 - Aldosterone antagonist
 - HTN and Edema
 - Portal Hypertension/Ascites
 - CHF
 - Adverse effects
 - Hyperkalemia
 - Endocrine effects
 - Interactions
 - Other Diuretics, Potassium raising drugs

Potassium Sparing

- **Non-aldosterone affecting**
 - Inhibit Sodium-Potassium pump
 - Triamterene
 - Combination with HCTZ: Maxzide, Dyazide
 - Amiloride

Osmotic Diuretics

- **Mannitol**
 - 6 carbon sugar
 - Not metabolized
 - Not reabsorbed
 - Increases osmolality of filtrate
 - Uses
 - Renal failure prophylaxis
 - ICP
 - IOP

Measures of Renal Function

- BUN
- Creatinine
- Electrolytes: esp. Na, K, Cl
- Estimated GFR: 85 – 135 (insuff <60)
- Creatinine Clearance
- Urine volume
- Urinalysis

Urinalysis

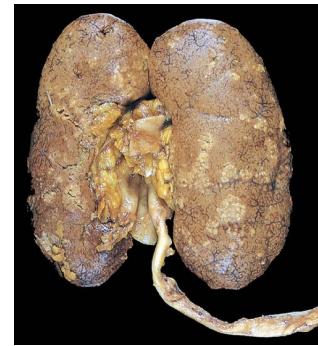
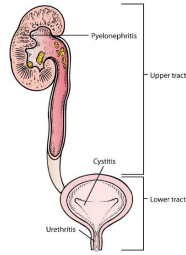
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|------------------|--------------------|
| ▪ Color | ▪ Sp. Grav |
| ▪ Odor | ▪ Osmolality |
| ▪ Protein (uria) | ▪ pH |
| ▪ Glucose (uria) | ▪ RBCs (hematuria) |
| ▪ Ketones (uria) | ▪ WBCs (leukocyte) |
| ▪ Urobilinogen | ▪ Casts |
| | ▪ Culture* |

Renal and Urinary D/Os

- **Infectious (UTI)**
 - Cystitis, Pyelonephritis, Urethritis, Prostatitis, Epididymitis, PID
- **Kidney**
 - Glomerulonephritis
 - Nephrotic syndrome
- **Calculi**
- **Renal Failures: ATN, Acute, Chronic**

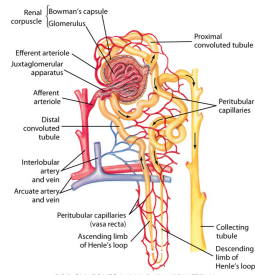
Infectious Diseases

- Lower Tract
 - DOC: TMP/SMX
 - Fluoroquinolone
- Upper tract
 - Pyelonephritis
 - Inflammation of parenchyma
- Interstitial cystitis
 - “Fake UTI”



Glomerulonephritis

- Immune damage
 - extent of damage
 - etiology
 - extent of changes
- Mechanism
 - Type II
 - Type III



Glomerulonephritis

- Acute Poststreptococcal (Type III)
- Goodpasture's syndrome (Type II)
- Rapidly Progressive (ARF)
- Nephrotic syndrome
 - 1/3 Dz, i.e., DM, SLE; 2/3: Idiopathic
 - ↑ permeability to protein
 - Symptoms:
 - Tx: ACEI, NSAID, sodium-protein restri

Rhabdomyolysis

- Increased muscle destruction
 - Proteinemia
 - Proteins clog glomerulus
 - May lead to Renal Failure

Renal Failures

- ARF (50% mortality with treatment)
 - Prerenal: blood flow
 - Intrarenal
 - Postrenal: ureteral blockage
- CRI/CRF
 - GFR < 60 l/min
 - ESRD < 15 l/min
 - Dialysis
 - Kidney Transplant

ARF: General

- ↑ Fluid, BUN, Creat, electrolytes
- ↓ Urine output (<400ml/day)
- azotemia: uremic frost
- Acidosis
- Anemia, Agranulocytosis
- Stages: Initiation → Oliguric (1-7 days) → Diuretic → Recovery
- Dialysis if necessary

ARF

- Prerenal
 - Decreased blood flow
 - Renal artery stenosis
 - Hypovolemia, Shock, Heart failure
 - Drugs: e.g. Norepinephrine
- Tx
 - Underlying disease
 - Drugs: Dopamine, mannitol

ARF

- Intrarenal
 - Acute Tubular Necrosis (ATN)
 - Ischemia, toxins, pigments** (contrast)
- Postrenal
 - Kidney stones or strictures
 - Cancer
 - Hydronephrosis
 - Remove blockage

Chronic Kidney Disease

- Major risk factors
 - Diabetes 45%
 - Hypertension 27%
- Prevention Prevention Prevention
 - Control above diseases
 - ACE Inhibitor/ARB

Manifestations

- Early
 - ↓ Creatinine Clearance
 - ↑ BUN/Creatinine
 - Proteinuria
- Later
 - Fluid retention --> edema, oliguria
 - Anemia --> reduced erythropoietin
 - Acidosis
 - ↑ Electrolytes and other waste products