


**Introduction to Clinical Medicine –
Nephrology**

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What do the kidney do?


- Excrete impurities
- Prevent loss of blood proteins and cells
- Regulate fluid balance
- Regulate mineral and ion
- Regulate blood pressure
 - Renin
- Regulate hematocrit
 - Erythropoietin



How well are the kidneys working?

- If an abnormality occurs, is it because
 - The stimulus is more than normal kidneys can handle, or
 - Kidney function is decreased from disease?
- If a person has kidney disease, is it getting better or worse?


How should we measure kidney function?



The vulcan mind-meld approach

A better approach

- Kidney function can be predicted by glomerular filtration rate (GFR)



How to measure glomerular filtration rate?

- Present in blood
- Freely filtered by glomerulus
- Not reabsorbed or secreted by renal tubules




What compounds can we use to measure GFR?

- Creatinine
 - Produced by muscles
 - Easy to assay (cheap!)
 - Completely filtered
 - Not reabsorbed
 - Minimal tubular secretion
 - In renal insufficiency, relative tubular secretion increases (may be 50% of creatinine excretion rate with severe renal insufficiency)






How to interpret a serum creatinine

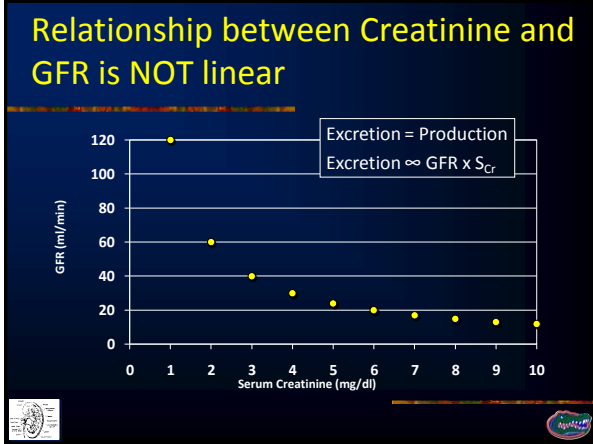
- Under steady-state,
 - Production = Removal
 - Removal = $GFR \times S_{Cr}$
 - Production = $GFR \times S_{Cr}$
 - $GFR = Production / S_{Cr}$

How to interpret a serum creatinine?

- Best – MDRD Formula
 - $eGFR = 186 * S_{Cr}^{-1.154} * Age^{-0.203}$
 - * 0.742 if ♀
 - * 1.21 if African-American
 - Result is independent of weight or height
 - Assumes no major physical deformities
 - Paralysis
 - Amputation



- ### What other compounds can we use to measure GFR?
- Inulin
 - Best, assay very difficult, not available
 - Iothalamate
 - Radionuclide
 - Used for best clinical research studies
 - Urea (BUN, blood urea nitrogen)
 - Production
 - Increased by intestinal bleeding, dietary protein intake
 - Decreased by protein restriction
 - Reabsorbed by renal tubules in response to volume depletion

When should you be wary of the serum creatinine?



- Production ≠ excretion
 - Creatinine lags 2-3 days behind actual GFR
- Creatinine production not normal
 - Abnormal muscle mass

24 hour urine collection

- Calculate clearance rate as estimate of GFR
- Accuracy depends on accuracy of "timed urine collection"




$$U_x \times V = Cl_x \times P_x$$

$$Cl_x = \frac{U_x \times V}{P_x}$$

$$Cl_{Cr} = \frac{U_{Cr} \times V}{P_{Cr} \times (Time/100)}$$





What do the kidney do?

- Excrete water soluble impurities
- Prevent loss of blood proteins and cells


Proteinuria

- Indicator of glomerular disease
- May contribute to progression of renal disease
- Measurement
 - 24 hour urine collection
 - Random urine protein:creatinine ratio


"Dipstick" measures of renal function

- Specific gravity – urine concentration
- pH – acid excretion
- Hemoglobinuria
- Proteinuria
 - Only measures albumin
 - Poorly quantitative
- Leukocyte esterase, nitrite – WBC activation



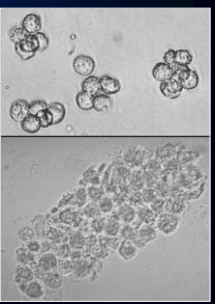

"Dipstick" measures of renal function

- Glucose – diabetes mellitus
- Ketones
 - DKA
 - Starvation
 - Atkins Diet
- Bilirubin – hepatic dysfunction




Urine microscopy

- Leukocytes
 - Infection


Other nucleated cells

- Renal tubular epithelial cells
 - Cell death
 - Acute tubular necrosis (ATN)



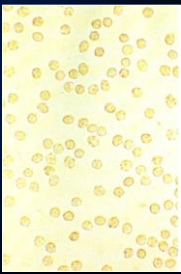
Other nucleated cells

- Squamous epithelial cells
 - Source – perineum




Non-nucleated cells

- RBC
 - Glomerulonephritis
 - GU tract bleeding




Some renal disease are macroscopic

- Renal imaging
 - CT
 - MR
 - Ultrasound
 - Size
 - Echogenicity
 - Masses



Some diseases affect the renal artery

- Causes
 - Fibromuscular dysplasia
 - Atherosclerosis
 - Vasculitis
- Manifestations
 - Renovascular hypertension
 - Ischemic nephropathy



When dealing with disease,

- Measure, don't guess
 - Glomerular filtration rate
 - Urinalysis
 - Renal imaging
 - Renal biopsy
