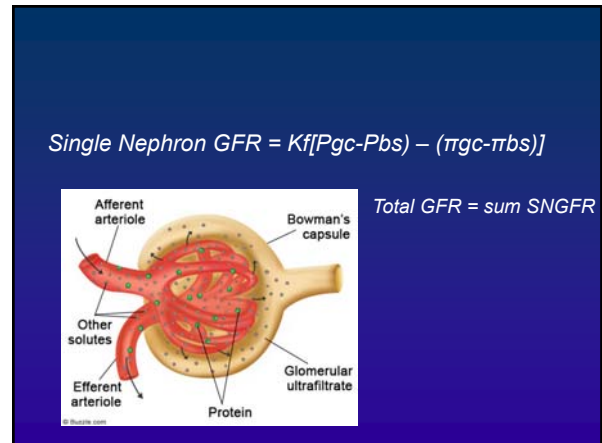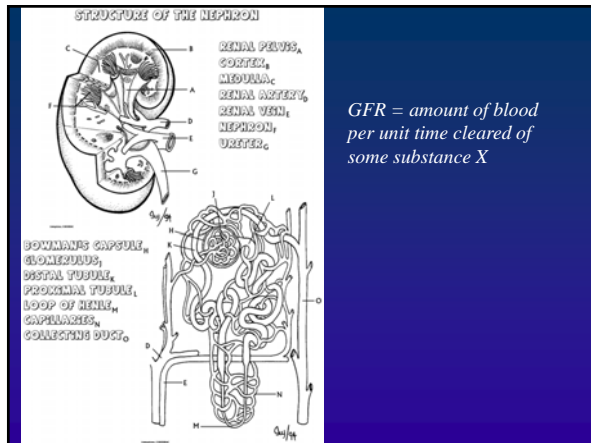# Renal Tests

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Renal Tests

1. What is glomerular filtration rate
2. Estimation of glomerular filtration rate
3. Difference b/w GFR and CrCl
4. Limitations of creatinine
5. Urine protein vs. albumin excretion
6. Urinalysis

GFR = amount of blood per unit time cleared of some substance X

Single Nephron GFR = Kf[Pgc-Pbs) – (πgc-πbs)]
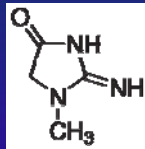
Total GFR = sum SNGFR

Characteristics of factor x so that its clearance = GFR

- Freely filterable
- Smaller than 60 kD (~ size albumin)
- Not reabsorbed or secreted by tubules

Such factors that meet these criteria

- Inulin
- Iothalamate
- Iodixinol
- We can use measure the clearance of these substances =gold standard measurement of glomerular filtration rate

Creatinine

BOWMAN'S CAPSULE_H
GLOMERULUS_I
DISTAL TUBULE_K
PROXIMAL TUBULE_L
LOOP OF HENLE_M
CAPILLARIES_N
COLLECTING DUCT_O

Creatinine clearance = GFR + secretion

$$\frac{(140\text{-age}) \times (ideal\ weight)}{72 \times creatinine}$$

$$\frac{Urine\ volume\ (ml) \times urine\ creatinine\ concentration}{Serum\ creatinine \times time\ (minutes)}$$

Normal GFR

- Woman= 100 ml/min/1.73 m^2
- Man = 120 ml/min/1.73 m^2
- Lose 1 ml/min per year
- 80 year old man?
- 80 year old woman?

Limitations of creatinine clearance

- Includes both GFR and secretion
- May overestimate GFR when GFR is low (due to secretion)
- Excellent for estimation of GFR in healthy individuals

HOW DO YOU GET GFR INFO FOR PATIENTS?

MDRD Trial

- Modification of Diet in Renal Disease
- 1000 adults with GFR 20-45 ml/min
- GFR measured with inulin clearance
- Trial of severe protein restriction vs. moderate protein restriction

MDRD GFR equation

- Levey AS, Bosch JP, Lewis JB, Greene T, Rogers N, Roth D. A more accurate method to estimate glomerular filtration rate from serum creatinine: a new prediction equation. Modification of Diet in Renal Disease Study Group Ann Intern Med. 1999 Mar 16;130(6):461-70.
- http://mdrd.com/

MDRD Equation to Predict of GFR
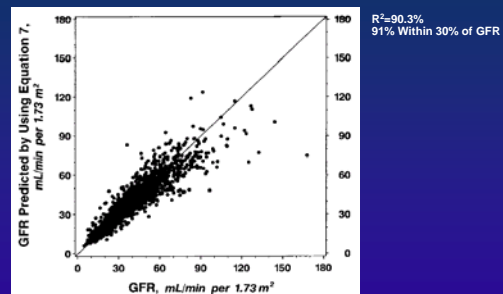
- Prediction based on age, gender, race and serum creatinine

- $GFR/1.73\ m^2 = 186 \times [P_{cr}]^{-1.154} \times [age]^{-.203} \times [.299\ if\ female] \times [1.192\ if\ black]$

www.kidney.org
nephron.com/cgi-bin/MDRD.org

What does lab report?

- Does not report GFR values > 60
- Noone in MDRD trial had GFR value > 60

MDRD Equation Predicts GFR

$R^2=90.3\%$
91% Within 30% of GFR

CKD-Epi formula

- *eGFR* = $133 \times min(Scys/0.8, 1)^{-0.499} \times max(Scys/0.8, 1)^{-1.328} \times 0.996^{Age} \times 0.932$ [if female]

GFR

Measurement of 24 hours or timed creatinine clearance does not improve accuracy over the estimate of GFR provided by equation.

Collection may be useful in people consuming vegetarian diets, taking creatine supplements, or in states of malnutrition, amputation, or muscle wasting/muscle building

Body surface area

- 5'10'' 70 kg male
- Adjusts for differences in GFR due to metabolic rate

- Dose meds:
- MDRD GFR/1.73 m^2 X pt's BSA/1.73 m^2

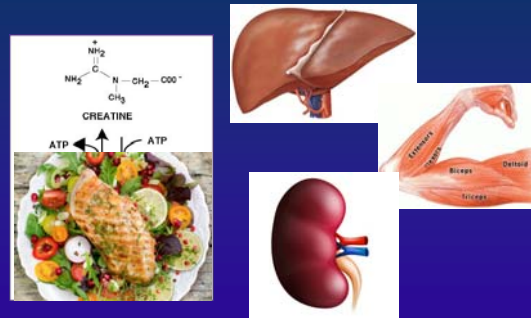45 ml/min/1.73 m^2 x 2.3 m^2/1.73 m$^{2=}$

$\qquad$ 60 ml/min

Drug dosing

- Should be based on absolute GFR
- Absolute GFR will be same as GFR indexed for BSA for people ~ 1.73 m^2

- May be markedly different in very small people or morbidly obese people

Other factors affecting GFR

- All equations dependent on creatinine

Creatinine=phosphate bus

Creatinine-byproduct of creatine

Creatinine high when GFR normal	Creatinine should be low if GFR normal
• High muscle mass	• Malnutrition
• Physically fit	• Low muscle mass
	• Liver failure

Cystatin C

- cystatin C (formerly gamma trace, post-gamma-globulin or neuroendocrine basic polypeptide), a protein encoded by the CST3 gene, is mainly used as a biomarker of kidney function

- 77.24 X cys$^{-1.2623}$

Definition of CKD

Criteria
1. Kidney damage for ≥3 months, as defined by structural or functional abnormalities of the kidney, with or without decreased GFR, manifest by *either*
• Pathological abnormalities; or • Markers of kidney damage, including abnormalities in the composition of the blood or urine, or abnormalities in imaging tests
2. GFR <60 mL/min/1.73 m² for ≥3 months, with or without kidney damage

Abbreviation: GFR, glomerular filtration rate
Reproduced with permission.[1]

Stage	Description	GFR (ml/min/1.73 m²)
1	Kidney Damage with Normal or ↑ GFR	>90
2	Kidney Damage with Mild ↓ GFR	60-89
3	Moderate ↓ GFR	30-59
4	Severe ↓ GFR	15-29
5	Kidney Failure	<15 or Dialysis

KDIGO classification system 2009

Normal urine protein excretion ~ 100 mg/day
< 10% albumin
Tamms Horsfall protein (uromodulin)
Proteins that slough off from PT
Breakdown products of immunoglobulins

150 mg protein
Albumin has increased and is now
30% of total protein excretion

250 mg protein
Albumin excretion has increased even more
Now 50% of total protein excretion

Screening

- **Serum creatinine-to estimate GFR**
- **Random urine albumin-to-creatinine ratio**
  - Albumin + water
  - Creatinine + water

  - Albumin excretion per unit time
  - Creatinine excretion per unit time

Urine albumin-to-creatinine

- **Normal urine creatinine ~ 1 gram/day**
- **Normal urine protein/creatinine ratio = < 200 mg/gram creatinine (<0.2 g/g)**
- **Normal urine albumin/creatinine ratio = < 10 mg/gram creatinine (< 0.01g/g)**

Urine studies

- Albumin/creatinine ratio = 3 mg/g = Normal
- Albumin/creatinine ratio 30 mg/g = microalbuminuria
- Albumin/creatinine ratio 300 mg/g = macroalbuminuria (dipstick +)

What is prevalence of chronic kidney disease in U.S. population?

- A. 3%
- B. 5%
- C. 10%
- D. 15%

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Among adults age 60+ years, what is lifetime risk of CKD?

A. One in ten
B. One in five
C. One in three
D. One in fifteen

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What is the cost of ESRD in U.S.?

- A. 15 billion annually
- B. 30 billion annually
- C. 500 million annually
- D. 250 million annually

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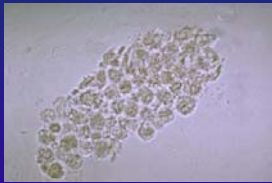- D. 250 million annually

Who To Test for Chronic Kidney Disease?
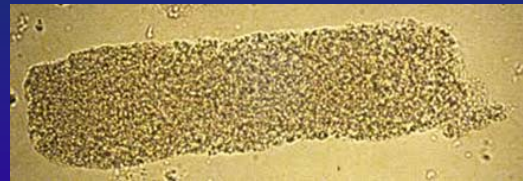
Regular testing of people at risk

- Diabetes
- Hypertension
- Relative with kidney failure

Urinalysis

- Specific gravity –above 1.010-prerenal
- TNTC =too numerous to count

Granular casts = tubular necrosis (kidney ischemia)

Maltese crosses