Renal Tests

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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 = $K_f(P_{gc}-P_{bs}) - (\pi_{gc} - \pi_{bs})$

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 clearance = GFR + secretion

\[(140 - \text{age}) \times (\text{ideal weight}) / 72 \times \text{creatinine}\]

\[\text{Urine volume (ml)} \times \text{urine creatinine concentration} / \text{Serum creatinine} \times \text{time (minutes)}\]

Normal GFR

- Woman = 100 ml/min/1.73 m²
- Man = 120 ml/min/1.73 m²
- 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

- http://mdrd.com/

MDRD Equation to Predict Of GFR

- Prediction based on age, gender, race and serum creatinine
- GFR/1.73 m² = 186 x [Pcr]-1.154 x [age]-.203 x [.299 if female] x [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

![Graph showing the correlation between predicted and actual GFR values.]

- R²=90.3%
- 91% within 30% of GFR

CKD-Epi formula

- \( eGFR = 133 \times \min(\text{Scys}/0.8, 1)^{-0.499} \times \max(\text{Scys}/0.8, 1)^{-1.328} \times 0.996^{\text{Age}} \times 0.932 \) [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 m² × pt’s BSA/1.73 m²
  - 45 ml/min/1.73 m² × 2.3 m²/1.73 m² = 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 m²
- 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:
- High muscle mass
- Physically fit
Creatinine should be low if GFR normal:
- Malnutrition
- 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

National Kidney Foundation – Kidney Disease Outcomes Quality Initiative (NKF-K/DOQI)
Stages of Chronic Kidney Disease

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>GFR (ml/min/1.73 m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kidney Damage with Normal or ↑ GFR</td>
<td>&gt;90</td>
</tr>
<tr>
<td>2</td>
<td>Kidney Damage with Mild ↓ GFR</td>
<td>60-89</td>
</tr>
<tr>
<td>3</td>
<td>Moderate ↓ GFR</td>
<td>30-59</td>
</tr>
<tr>
<td>4</td>
<td>Severe ↓ GFR</td>
<td>15-29</td>
</tr>
<tr>
<td>5</td>
<td>Kidney Failure</td>
<td>&lt;15 or Dialysis</td>
</tr>
</tbody>
</table>

Abbreviation: GFR, glomerular filtration rate

KDIGO classification system 2009

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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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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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