Chronic Renal Failure

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Definition of Chronic Renal Failure

Chronic Renal Failure can be defined as a progressive decline in renal function with attendant fluid, electrolyte, and metabolic abnormalities which, if left untreated, will progress to death or end-stage requiring dialysis.
## Estimation of Renal Function

<table>
<thead>
<tr>
<th>Serum Creat.</th>
<th>GFR</th>
<th>%Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 mg%</td>
<td>120 ml/min.</td>
<td>100%</td>
</tr>
<tr>
<td>2.0 mg%</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>4.0</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>6.0</td>
<td>15-20</td>
<td>10-15</td>
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Cockcroft-Gault Formula

\[
GFR = \left(140 - \text{age}\right) \times \left(\frac{\text{weight kg.}}{72}\right) \times 0.85 \times \text{Serum Creat.} \quad \text{Females}
\]
24-Hour Urine Collection

GFR = \frac{\text{Total Urinary Creatinine mg/da}}{\text{Serum Creatinine mg\%}} \times 1440 \text{ min/da}

Easier Formula:

GFR = \frac{\text{Total Urine Creatinine mg/da}}{\text{Serum Creatinine}} \times 0.07
Remnant Kidney Model

- Renal Mass
  - Adaptations: Hemodynamic, Structural
    - Hemodynamic
      - Autoregulation, Vasodilatation
        - Autoregulation
          - BP
        - Vasodilatation
          - P GC, Glomerular Cap Wall Tension
            - P GC
              - Glomerular Cap Radii
                - Further Glomerular Sclerosis
Creatinine

• The Serum Creatinine level represents a balance between Muscle Metabolism and Renal Excretion
Causes of Elevated Serum Creatinine

- Renal Failure
- Muscle Trauma Rhabdomyolysis
- Muscular Dystrophies
- Cimetidine
- Trimethoprim
- Goulash
Blood Urea Nitrogen (BUN)

- Urea Nitrogen is formed in the Liver via the Urea Cycle
- Severe Liver Disease will lead to a falsely LOW BUN level, due to impairment of the Urea Cycle
Causes of Elevated BUN

- Dehydration
- Renal Failure
- Congestive Heart Failure
- Sepsis
- High Protein Diet
- Upper GI Bleed
- Steroids
- Tetracycline
Diabetes Mellitus

- Most common cause of Chronic Renal Failure
- 40% of IDDM will develop some form of Renal disease
- Renin-Angiotensin System is a major factor of the Pathogenesis
- Nephrotic Range Proteinuria and large kidneys, strong correlation with diabetic retinopathy and diabetic renal disease
Diabetes and Chronic Renal Failure

Renal Effect of Diabetes:

1. Large, Medium, and Small Vessel Athrosclerosis
2. Renal Artery Stenosis
3. Diabetic Proteinuria
4. Type IV Renal Tubular Acidosis
5. Papillary Necrosis
6. Neurogenic Bladder
7. Cystitis
8. Pyelonephritis
9. Acute Renal Failure Following contrast for angiography of CT
Hypertension

• Second most common cause of Chronic Renal Failure. Most common in African-Americans
• Small contracted kidneys and non-nephrotic range proteinuria
• Left-Ventricular Hypertrophy
• A major risk factor for complications of hypertension-renal failure, Stroke, CHF, MI
Clomerulonephritis/Nephrotic Syndrome

- Third most common cause of chronic renal failure
- History of significant proteinuria and systemic symptoms:
  - Lupus
  - Wegners
  - IgA Nephropathy
  - Alport’s Syndrome
Polycystic Kidney Disease

- Massive sized kidneys with multiple cysts
- Normal Blood count
- Hepatic cysts
- Berry Aneurysms 5%
- Flank pain and urinary tract infections
Stages of Kidney Disease

Stage 1 - GFR > 90 ml/min.
Stage 2 - GFR 60-89 ml/min.
Stage 3 - GFR 30-59 ml/min.
Stage 4 - GFR 15-29 ml/min.
Stage 5 - GFR < 14 ml/min.
Anemia of Chronic Renal Failure

- Normocytic Normochromic
- More Pronounced in Tubular-Interstitial Disease than in Glomerular Disease
- Due to decreased production of Erythropoietin
Anemia of Chronic Renal Failure (2)

- Patients with Polycystic Kidney Disease or Renal cell Cancer may have normal blood counts
- Other types of anemia i.e. B-12 or Folate def. May be superimposed
- Treatment is by supplementation with Erythropoetin
Renal Bone Disease

- High levels of Phosphorus from impaired renal excretion can be prevented by Phosphorus restriction in the diet and the use of Calcium Acetate or CaCO3 to bind Phosphorus in the gut.
- Supplemental dosed of Vitamin D3 are given to suppress the production of PTH.
Secondary Hyperparathyroidism

- Phosphorus increases, suppressing PTH.
- Calcium decreases, suppressing PTH.
- Vitamin D3 increases, increasing serum calcium.
- PTH increases, leading to calcium release from bone, phosphorus excretion in the kidney, and calcium absorption in the gut.
- Serum calcium increases, negatively affecting PTH levels.

Diagram:
- Phosphorus (↑)
- Calcium (↓)
- Vitamin D3 (↑)
- PTH
- Calcium release from bone
- Phosphorus excretion in the kidney
- Calcium absorption in the gut
- Serum calcium (↑)
Renal Bone Disease

- Untreated Bone Disease Can lead to:
  - Osteomalacia
  - Osteoporosis
  - Osteofibrosis cystica
  - Calciphylaxis-malignant soft tissue calcifications
  - Aluminum Bone Disease
  - Amyloid Bone disease
  - Adynamic Bone Disease-Over treatment of bone disease
Uremic Bleeding

• Usually Occurs at a BUN >150mg%
• Multifactorial:
  - Anemia
  - Abnormal von Willebrandt Factor
  - Increased levels of Endothelial Derived Relaxation Factor (EDRF)
  - Decreased Platelet adhesion
Uremic Bleeding (2)

- Platelet count, Prothrombin Time, Partial Thromboplastin Time are all normal
- Bleeding time is Elevated
Common Sources of Bleeding in Uremia (2)

- G.I-ulcers
- Arteriovenous malformations (AVM)

Treatment:
- Dialysis
- Arginine Vasopressin (DDAVP)
- Cryoprecipitate
- Estrogen
Central Nervous System Effects

• Uremic encephalopathy is rare unless the BUN > 150mg% unless there is an underlying CNS problem present.
• Peripheral neuropathy
• Autonomic neuropathy
• Myoclonic jerks
• Insomnia
Mortality in CRF

- Most Common Cause of death: Coronary artery disease followed by sepsis, stroke, GI Bleeding
- An Elevated Serum Creatinine is as significant Cardiac Risk Factor as the presence of Diabetes or a prior MI
- Most Accurate Predictor of premature death in a dialysis patient is a serum Albumin less than 3.5gm/dl
  - 21 TIMES the risk as compared to other predictors
What Works to Slowdown the Progression of Diabetic Renal Disease?

- Strict Glucose control
- Strict BP control-Home BP Monitoring
- ACE-I Type 1 DM Captopril Trial (Lewis, NEJM, 1993)
- ARBs Type 2 DM RENAAL, IDNT (NEJM 2001)
- Statin Use
- B-Blockers
- Aspirin
Slowing Down the Progression of Chronic Renal Disease

- Blood Pressure Control - the most important element - use of ACE-I or ARBs
- Glucose Control in Diabetics
- Anemia control - Erythropoietin
- Phosphorus control
- Acidosis control
- Lipid control - HMG Co-Reductase Inhibitors (Statins)
Indication for Chronic Dialysis

- GFR < 10-15 ml/min
- Uremia-Encephalopathy, pericarditis, anorexia, intractable nausea or vomiting, bleeding
- Pulmonary Edema/CHF refractory to diuretics
- Refractory Electrolyte Problems-hyperkalemia
- Refractory Metabolic Acidosis
Annual Mortality Rate of Patients on Dialysis

Dialysis Mortality Rates In Industrial Nations

- U.S.: 23.6%
- Canada: 19.3%
- Australia: 15.8%
- France: 11%
- Germany: 10%
- Japan: 9.7%
Reasons for Poor Survival on Dialysis

- Late Referral to Nephrologist
- Late in Starting Dialysis
- Treating Complications of Renal Failure vs. Early Initiation of Dialysis
- Shorter Times on Dialysis
- Poor Nutrition