Chronic Kidney Disease
Detection, Prevention and Pharmacologic Management

Michelle Shields, RN, MSN, CRNP
Renal and Electrolyte Associates, Inc.
November 7, 2014

The Prevalence of CKD in the General Population


26 Million CKD Patients

CKD Incidence
1 in 9 Adults
3 times that of cancer
600 times that of AIDS

Coresh et al. JAMA Nov 7, 07; 298(17):2038-2047.
Expected Remaining Lifetimes (Years)

Life expectancy of NHANES participants with or without CKD, 1999–2004
Figure 1.16 (Volume I)

Cardiovascular Disease (CVD) Mortality
General Population versus ESRD Patients
Medicare costs are 2.7 times greater for CKD patients than for non-CKD patients

![Graph showing Medicare costs for CKD and non-CKD patients](image)

Based on data from USRDS 2002; costs based on diagnostic codes obtained from billing data; patients > 67 years of age


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Risk of hospitalization, CV events, and death increases as GFR declines

![Graph showing risk of hospitalization, CV events, and death](image)

*eGFR=estimated glomerular filtration rate
Age-standardized rates per 100 person-years
N=1,120,295 ambulatory adults

Cause of Death in the US in 2000:
Kidney Failure vs Cancer Deaths (in Thousands)

<table>
<thead>
<tr>
<th>Disease</th>
<th>Deaths (Thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung Cancer</td>
<td>157</td>
</tr>
<tr>
<td>Kidney Failure</td>
<td>99</td>
</tr>
<tr>
<td>Colon Cancer</td>
<td>57</td>
</tr>
<tr>
<td>Breast Cancer</td>
<td>42</td>
</tr>
<tr>
<td>Prostate Cancer</td>
<td>12</td>
</tr>
</tbody>
</table>


How do we Impact this Epidemic??

- Early Referral to Nephrology
- Risk Factor Modification
- Improve Co-morbid Disease Management
- Early treatment of complications
- Early education on Dialysis Option Modalities

Chronic Kidney Disease

- Previously known as Pre End stage, ESRD, Chronic Renal Insufficiency
- Progressive decrease in renal function or decline in GFR
- Manifested by elevation of serum creatinine and blood urea nitrogen for > 3 months
- Normal serum creat 0.5-1.4mg/dL
- Normal BUN 5-20 mg/dL
Chronic Kidney Disease
- Old records showing long-standing elevation of BUN and creatinine
- Small echogenic kidneys on ultrasound (except in diseases where kidneys become enlarged over time - Diabetes, Polycystic kidney disease, HIV)
- Presence of severe anemia
- Uremic symptoms

Goals of Management in CKD
- Early identification and management of co-morbid conditions.
- Early recognition of kidney disease
- Early referral to nephrology
- Early management of complications of CKD
- Empower patients through education to make informed decisions in regards to their disease process, ability to impact disease progression and dialysis modality choice

Early Recognition of Kidney Disease
- Identifying those at risk
- Screening: creatinine and proteinuria
- Detection of Kidney Disease
- Staging of Chronic Kidney Disease
Framingham Heart Study
Risk factors for CKD

- 30 years before diagnosis of CKD:
  - 76% more likely to have HTN
  - 71% more likely to be obese
  - 43% more likely to have elevated triglycerides
  - 35% more likely to have diabetes

Identifying those at risk for CKD

Patients at Risk
- Older age, first degree relative with CKD or hereditary kidney disease, reduced kidney mass, low birth weight, racial or ethnic status, low income or education

Initiating Factors
- DM, HTN, Autoimmune Ds, infections, UTI, Urinary stones, Urinary tract obstruction, drug toxicity

Progression Factors:
- Proteinuria, HTN, DM, smoking, Obesity
Identifying those at risk for CKD

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- Older age, first degree relative with CKD or hereditary kidney disease, reduced kidney mass, low birth weight, racial or ethnic status, low income or education

Initiating Factors:
- DM, HTN, Autoimmune Ds, infections, UTI, Urinary stones, Urinary tract obstruction, drug toxicity

Progression Factors:
- Proteinuria, HTN, DM, smoking, Obesity


Early Recognition of Kidney Disease

- Identifying those at risk
- Screening: creatinine and proteinuria
- Detection of Kidney Disease
- Staging of Chronic Kidney Disease
Screening for Proteinuria

- **At risk**
  - Screen with albumin specific dipstick
  - If positive obtain albumin-creatinine ratio
    - If ratio is < 30 mg/g recheck at periodic health evaluation
    - If ratio is > 30 mg/g Diagnostic Evaluation

- **Not at risk for CKD**
  - Standard dipstick
    - If ratio is > = 1 protein obtain protein-creatinine ratio
    - If ratio is < 200 mg/g recheck at periodic health evaluation
    - If ratio is > 200 mg/g Diagnostic evaluation

Early Recognition of Kidney Disease

- Identifying those at risk
- Screening: creatinine and proteinuria
- Detection of Kidney Disease
- Staging of Chronic Kidney Disease

Estimate Kidney Function

- Looking at creatinine alone is inaccurate
- Inulin clearance is gold standard measurement of glomerular filtration rate (GFR), but not practical
- Estimates of kidney function are the best indices for the level of kidney function.
  - Cockcroft-Gault Equation
  - Abbreviated MDRD (The Modification of Diet in Renal Disease)
  - CKD-EPI (Chronic Kidney Disease epidemiology Consortium)
Case Study

- 70 yo woman comes to ER with complaints of lethargy, fatigue, and recent fall.
- PMH: DM type 1, HTN
- Recent shingles outbreak started on acyclovir 800 mg every 4 hours.
- Creatinine in ER 1.5,
- Renal dosing of acyclovir, q 12 hours.

Estimate of GFR

- Creatinine 1.5
### MDRD Estimated Creatinine Clearance

<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Race</th>
<th>Creat</th>
<th>eGFR</th>
<th>ml/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 yo</td>
<td>Male</td>
<td>AA</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60 yo</td>
<td>Male</td>
<td>AA</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 yo</td>
<td>Female</td>
<td>White</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70 yo</td>
<td>Female</td>
<td>White</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### MDRD Estimated Creatinine Clearance

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</tr>
</thead>
<tbody>
<tr>
<td>20 yo</td>
<td>Male</td>
<td>AA</td>
<td>1.5</td>
<td></td>
<td>77</td>
</tr>
<tr>
<td>60 yo</td>
<td>Male</td>
<td>AA</td>
<td>1.5</td>
<td></td>
<td>61</td>
</tr>
<tr>
<td>40 yo</td>
<td>Female</td>
<td>White</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
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<td>61 ml/min</td>
</tr>
<tr>
<td>40 yo</td>
<td>Female</td>
<td>White</td>
<td>1.5</td>
<td>41 ml/min</td>
</tr>
<tr>
<td>70 yo</td>
<td>Female</td>
<td>White</td>
<td>1.5</td>
<td>36 ml/min</td>
</tr>
</tbody>
</table>

### Slow Progression of Kidney Disease

- Identify reversible causes
  - Decreased renal perfusion: hypovolemia, hypotension
  - Urinary tract obstruction or infection
- ACE-I, ARB
- Avoid volume depletion
- Avoid nephrotoxic agents
  - IV Contrast
  - Aminoglycosides, Amphotericin
  - NSAIDS, COX 2 inhibitors
  - Cyclosporin, Tacrolimus
- Risk Factor Reduction
- Management of Co-morbid conditions
Goals of Management in CKD

- Early recognition of kidney disease
- Early referral to nephrology
- Risk Factor Modification
- Early identification and management of co-morbid conditions.
- Early management of complications of CKD
- Empower patients through education to make informed decisions in regards to their disease process, ability to impact disease progression and dialysis modality choice

Risk Factor Modification

- Smoking Cessation
- Weight reduction
- Exercise and Nutrition Counseling
- Cardiovascular Risk Reduction
  - LDL < 100mg/dL
  - HDL > 40mg/dL
  - Triglycerides < 150
  - Stress testing for those at risk for CVD

Risk Factor Modification

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- Weight reduction
- Exercise and Nutrition Counseling
- Cardiovascular Risk Reduction
  - LDL < 100mg/dL
  - HDL > 40mg/dL
  - Triglycerides < 150
  - Stress testing for those at risk for CVD
Risk Factor Modification

- Cardiovascular Risk Reduction
- Evaluation of 10 year CV Risk

Stone et al. 2013 ACC/AHA blood cholesterol guidelines

Treatment for CV Risk

Table 5. High-Moderate and Low-Intensity Statin Therapy (Used in the RCTs reviewed by the Expert Panel)

<table>
<thead>
<tr>
<th>High-Intensity Statin Therapy</th>
<th>Moderate-Intensity Statin Therapy</th>
<th>Low-Intensity Statin Therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily dose from LDL-C target, average by approximately 50%</td>
<td>Daily dose from LDL-C target, average by approximately 30% to 50%</td>
<td>Daily dose from LDL-C target, average by approximately 30% to 50%</td>
</tr>
</tbody>
</table>

Stone et al. 2013 ACC/AHA blood cholesterol guidelines
KDIGO Clinical Practice Guidelines for lipid management in CKD.

- Follow Recommended AHA treatment with a statin for adults aged 50+ with eGFR < 60 ml/min
- Statins not recommended in the dialysis populations as the magnitude of any relative reduction in risk appears to be minimal in the dialysis population.
  - Higher doses of statins not safe on dialysis
  - Maintain current dose of statins when initiating dialysis
  - Lipid measurements not recommended.

KDIGO, Kidney Disease: Improving Global outcomes.
Kidney International (2014) 85, 1303-1309

When to refer to Nephrology?

- eGFR < 60 ml/min/1.73 m
- Multiple Risk Factors
- Heavy or Increasing proteinuria
- Uncontrolled hypertension
- Rapid progression or Acute Renal Failure
  - Target decline in GFR < 4 ml/min/1.73 m per year.


Early Nephrologist Referral Improves Outcomes

- Impact on mortality
- Impact on serum chemistries at start of dialysis

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Management of Co-morbid Conditions:

Diabetes

[Graph showing data related to diabetes and hypertension]

USRDS, 2012
2012 KDOQI update on Diabetes in CKD
Treatment Recommendations

- Target hemoglobin A1c (HbA1c) of 7.0% to prevent or delay progression of diabetic kidney disease (DKD)
- Not treating to an HbA1c target of <7.0% in patients at risk of hypoglycemia.
- Lowering low-density lipoprotein cholesterol with statin-based therapies reduces risk of major atherosclerotic events, but not all-cause mortality, in patients with CKD including those with diabetes.
- Suggest using an ACE-I or anARB in normotensive patients with diabetes and albuminuria levels >30 mg/g who are at high risk of DKD or its progression.


Management of Diabetes

- ADA diet, weight reduction
- Yearly microalbumin
- Caution use of diabetic agents
- Glyburide, Glipizide, Glimepiride, Tolazemide, Chlorpropamide: high risk of decreased clearance and persistent hypoglycemia
- Metformin - increased risk of lactic acidosis?
  - Lactic Acidosis (LA) is a rare complication in Type 2 DM with incidence of 6/100,000 patient-years
  - Metformin possesses clinical effects including glucose reduction, weight loss, risk of death and cardiovascular disease reduced by 1/3 compared to non-CKD population.
  - Increased risk of LA with AKI.


Management of Co-morbid Conditions:

Hypertension
Blood Pressure Is Poorly Controlled in CKD

- ≥140/90 mm Hg
- <130/85 mm Hg
- <140/90 mm Hg

62%
11%
27%

Hypertension and CKD

- JNC-8 recommendations
  - Age ≥ 60 initiate treatment to ≥ 150/90
  - Age < 60 initiate treatment to ≥ 140/90
  - In the nonblack population, initial treatment should include thiazide diuretic, CCB, ACE-I, ARB.
  - In the AA population, thiazide, CCB
  - With CKD ≥ 18 years old, initial ACE-I or ARB
  - Titrate within one month.
  - Do not use ACE-I/ARB together
  - Lifestyle modifications including low sodium diet, weight loss, physical activity, smoking cessation

JAMA. Doi:10.1001/jama.2013
Combined angiotensin Inhibition for the treatment of Diabetic Nephropathy

VA NEPHRON-D

Multicenter, double-blind, randomized controlled study designed to test whether combination therapy with ACE-I/ARB would decrease the rate of progression of CKD compared to ARB alone.

- Losartan 100mg /day to lisinopril 10-40mg/day
- Patients with type 2 diabetes and urinary albumin to creatinine ratio of 300 mg/dL
- Study was stopped early
  - No benefit with respect to mortality (HR 1.04, 95%CI p=0.75)
  - Increased risk of hyperkalemia (6.3 events per 100 person years vs 2.6 events monotherapy)
  - Increased risk of acute kidney injury 12.2 vs 6.7 events per 100 person years, P<0.001

Fried, LF et al, NEJM 2013: 369: 1892-1903

BP measurement

<table>
<thead>
<tr>
<th>Blood Pressure Measurement Techniques</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-office</td>
<td>Two readings, 5 minutes apart, sitting in chair. Conforms elevated reading in contralateral arm.</td>
</tr>
<tr>
<td>Ambulatory BP monitoring</td>
<td>Indicated for evaluation of “white coat hypertension.” Absence of 10-20 percent BP decrease during sleep may indicate increased CVD risk.</td>
</tr>
<tr>
<td>Patient self check</td>
<td>Provides information on response to therapy. May help improve adherence to therapy and is useful for evaluating “white coat hypertension.”</td>
</tr>
</tbody>
</table>

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Management of Complications of CKD
- Nutrition
- Anemia
- Acidosis
- Hypertension
- Metabolic Bone Disease

Management of Complications of CKD
- Malnutrition common in CKD:
  - Early referral to Dietician recommended
  - Education through the stages
  - CKD stage 1 - 3: calorie reduction for ideal body weight, protein restriction
  - CKD stage 3 – 5: calorie reduction for ideal body weight, Potassium, Phosphate, Protein, Sodium, Fluid restriction
  - Renal Formulated MVI
Malnutrition at Start of Dialysis
Associated with Increased Mortality


Case Study

- Discharge labs: alb 2.0, K 3.4, creat 1.2.
- She presents to the ER with weakness, palpitations. Cardiac arrest in the ER.
- Admission labs:

Acidosis

- Caused by retention of hydrogen ions in the kidneys.
- Physiologic response is to release calcium from bones to buffer
- Treatment: sodium bicarbonate:
  - Dose: 650 mg  Starting Dose: 1 tab TID
  - Affects absorption of many medications, take 1 hour before/2 hours after most medications
  - Adverse effects: sodium load, caution with CHF, hypervolemia, hypertension, metabolic alkalosis, edema
Anemia in CKD

- Kidneys secrete erythropoietin which stimulates bone marrow to produce RBC.
- Production declines as CKD progresses leading to anemia.
- Destruction of RBC increases as uremia progresses.
- Iron deficiency increases as CKD progresses.
- Increase blood loss due to uremic platelet dysfunction.

Evaluation of anemia includes:

- Hgb annually in CKD 3.
- Every 6 months in CKD 4.
- Every 3 months CKD 5 ND.
- Monthly in CKD HD or PD.

Anemia in CKD

- Diagnosis:
  - Hgb < 13 g/dL, males, < 12 g/dL, females adults.
  - < 11 g/dL children age 0.5–5 years.
  - < 11.5g/dL in children 5–12 years.
  - < 12.0 g/dL in children 12–15 years.

- Evaluation: CBC and differential, and platelet count, absolute reticulocyte count, serum transferrin saturation (TSAT), ferritin, Vitamin B12, and folate levels.

- Initial treatment:
  - Oral iron therapy for TSAT is 20% and ferritin is 100 ng/ml in CKD ND; consider IV if nonresponsive.
  - IV iron therapy for TSAT is 30% and ferritin is 500 mg/ml CKD 5 HD/PD.

Iron product Comparison

<table>
<thead>
<tr>
<th>Iron Preparation</th>
<th>Unit Dose</th>
<th>Elemental Iron Content</th>
<th>Oral Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferrous gluconate</td>
<td>300mg</td>
<td>34mg</td>
<td>300mg 3–4 x day</td>
</tr>
<tr>
<td>Ferrous Sulfate</td>
<td>300mg</td>
<td>60mg</td>
<td>300mg 3–4 x day</td>
</tr>
<tr>
<td>Ferrous Sucrose</td>
<td>628mg</td>
<td>231mg</td>
<td>628mg 3–4 x a day</td>
</tr>
<tr>
<td>Ferrous Succinate</td>
<td>200mg</td>
<td>66mg</td>
<td>200mg 5–4 times a day</td>
</tr>
<tr>
<td>Ferrous Fumarate</td>
<td>300mg</td>
<td>99mg</td>
<td>300mg 2–3 x day</td>
</tr>
<tr>
<td>Iron polysaccharide</td>
<td>150mg</td>
<td>15mg</td>
<td>150mg 1–2 x day</td>
</tr>
<tr>
<td>Ferrous Succinate</td>
<td>100mg</td>
<td>30mg</td>
<td>100mg 3–4 x day</td>
</tr>
</tbody>
</table>

Daily requirements 200mg elemental iron/day.
### IV Iron replacement

<table>
<thead>
<tr>
<th>Iron Dextran (Infed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50mg elemental iron per 1mL</td>
</tr>
<tr>
<td>50-100mg x 10 sessions</td>
</tr>
<tr>
<td>CKD, HD, PD</td>
</tr>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sodium ferric gluconate (Ferrelecit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>62.5 mg elemental iron/5mL</td>
</tr>
<tr>
<td>125mg x 8 sessions</td>
</tr>
<tr>
<td>HD &amp; PD</td>
</tr>
<tr>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Iron sucrose (Venofer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20mg elemental iron per 1mL</td>
</tr>
<tr>
<td>100mg x 10 sessions</td>
</tr>
<tr>
<td>CKD, HD, PD</td>
</tr>
<tr>
<td>No</td>
</tr>
</tbody>
</table>

### CKD Anemia Management

- **Erythropoietin Stimulating Agent (ESA):**
  - Address all correctable causes of anemia
  - Utilize only to avoid red blood cell transfusion
  - For adult CKD ND patients with Hb concentration 10.0 g/dL, we suggest that the decision whether to initiate ESA therapy be individualized based on the rate of fall of Hb concentration, prior response to iron therapy, the risk of needing a transfusion, the risk related to ESA therapy and the presence of symptoms attributable to anemia.
  - For adult CKD 5D patients, we suggest that ESA therapy be used to avoid having the Hb concentration fall below 9.0 g/dL by starting ESA therapy when the hemoglobin is between 9.0–10.0 g/dL
  - Pediatric CKD patients, we suggest that the selection of Hb concentration in which starting allows consideration of potential benefits (e.g., improvement in quality of life, school attendance/performance, and avoidance of transfusion) and potential harms.
  - In general, we suggest that ESAs not be used to maintain Hb concentration above 11.5 g/dL (115 g/L) in adult patients with CKD.

### Epoetin alfa (Procrit)

- **Starting Dose:** 50-100u/kg SQ once a week
- **Pharmacology:**
  - Metabolized: unknown
  - No adjustment renal impairment
  - Excretion: urine 10%
  - Halflife: 4 – 13 hours
  - Mechanism of Action: stimulates erythro progenitor division
- **Adverse Reactions:**
  - Increased Mortality, tumor progression, Headache, Vomiting, Diarrhea, Constipation, Thromboembolism, MI, CVA, HTN, Septin, Edema
- **Contraindications:**
  - Hypersensitivity to albumin
  - Uncontrolled HTN, CHF, or CAD
  - Hemolytic anemia
  - Known Pure Red Cell Aplasia
Darbopoetin Alfa (Aranesp)

- **Starting Dose:** 0.75 mcg/kg SQ q 2 weeks
- **Pharmacology:**
  - Metabolism: unknown
  - Elimination: urine minimal
  - Half Life: SQ 49 hours in CKD
  - IV 21 hours in ESRD
- **Adverse Reactions:**
  - Increased Mortality, tumor progression, Headache, Vomiting, Diarrhea, Constipation, Hypertension, Thrombocytosis, MI, CVA, HTN, Seizures, Edema
- **Contraindications:**
  - Hypersensitivity to albumin
  - Uncontrolled HTN, CHF or CAD
  - Hemolytic anemia
  - Known Pure Red Cell Aplasia
  - Caution if iron deficiency, B12 or folate deficiency

FDA Blackbox Warning

Management of Complications of CKD

Metabolic Bone Disease
Normal Mineral Metabolism

- Low Ca+
- Parathyroid Glands
- 1,25(OH)2 D3 (Vitamin D)
- Bone
- 25 hydroxyvitamin D
- Ca2+ reabsorption
- PO43- excretion
- Serum Ca2+ and PO43- homeostasis


Abnormal Mineral Metabolism in CKD

- Low Ca+
- Parathyroid Glands
- 1,25(OH)2 D3 (Vitamin D)
- Bone
- 25 hydroxyvitamin D
- Ca2+ reabsorption
- PO43- excretion
- Serum Ca2+ and PO43- homeostasis


Management includes replacement of 1,25 (OH)2 D

- Low Ca+
- Parathyroid Glands
- 1,25(OH)2 D3 (Vitamin D)
- Bone
- 25 hydroxyvitamin D
- Ca2+ reabsorption
- PO43- excretion
- Serum Ca2+ and PO43- homeostasis


Low Ca+
Stimulus for PTH Release
Hypocalcemia
Hyperphosphatemia
Vitamin D deficiency

25 hydroxyvitamin D
Vitamin D Therapy and Survival Advantage in Patients on Dialysis

Design
- Historical cohort study
- 37,173 patients received IV vitamin D compounds
- 13,864 patients received no IV vitamin D

Results
- Adjusted 2-yr survival advantage of 20% for IV vitamin D use
- Benefit of IV vitamin D use seen in 48 of 49 strata, even in patients with low iPTH and elevated Ca and P

Vitamin D Hormone Safety Profiles

Side Effects of FDA Approved D Hormone Therapies

calcitriol
desmocolcitol
paricalcitol

<table>
<thead>
<tr>
<th></th>
<th>Active</th>
<th>vs. P</th>
<th>Desmocolcitol</th>
<th>Active</th>
<th>vs. P</th>
<th>Paricalcitol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypercalcemia</td>
<td>64%</td>
<td>52%</td>
<td>4%</td>
<td>0%</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>Hyperphosphatemia</td>
<td>56%</td>
<td>NA</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>10% - 2%</td>
</tr>
<tr>
<td>Elevated Ca x P</td>
<td>31%</td>
<td>23%</td>
<td>9%</td>
<td>0%</td>
<td>12%</td>
<td>6%</td>
</tr>
</tbody>
</table>

1 paricalcitol values are based on two consecutive incidences recorded throughout the trial
2 desmocolcitol and calcitriol values are based on a single incidence recorded throughout the trial

Metabolic Bone Disease

Interventions
- 25 hydroxyvitamin D < 30 begin ergocalciferol/cholecalciferol.
- iPTH above goal, begin activated Vitamin D
  - Calcitriol, Doxercalciferol or Paricalcitol
- Phosphate > 4 begin nutrition counseling, consider phosphate binder
  - Calcium based
  - Non-Calcium based
Nutritional Vitamin D
Ergocalciferol D2/cholecalciferol D3

- Vitamin D deficiency common
  - NHANES found 41% of adult participants deficient
  - May contribute to development of osteoporosis and increase risk of fractures. Many extraosseous advantages.
- Deficiency caused by malabsorption, inadequate sunlight, impaired conversion to active form.

Requirements:
- RDA: based on age 1-70 yo, 600iu/d; 71 yo 800iu/d
- Pregnancy: 800iu/day
- CKD 3-5 ND: based on level 1000-2000i/d or 50,000 weekly for 6-8 weeks.
- CKD 5D: recommendations vary, follow calcium levels closely

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    - Calcium based
    - Non-Calcium based

Elevated Serum Phosphorus Increases Mortality Risk

<table>
<thead>
<tr>
<th>Serum phosphorus concentration (mg/dL)</th>
<th>Relative risk of death*</th>
</tr>
</thead>
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<td>&lt;3</td>
<td>Referent Range</td>
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<td>3-4</td>
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<td>8-9</td>
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<td>&gt;9</td>
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</tbody>
</table>

*Multivariable adjusted

Calcium Acetate (Phoslo)

- **Dosage Form**: 667mg
- **Starting Dose**: 1334mg qAC; titrate to Phosphorus < 6
- **Pharmacology**:
  - Mechanism of action: binds intestinal phosphate
  - Metabolism: other
  - Excretion: feces
- **Caution**: Impairs absorption of many other medications
- **Adverse Reaction**: Hypercalcemia
- **Contraindication**: Renal calculi

Sevelamer (Renvela)

- **Dosage Form**: 800mg
- **Starting Dose**: 800-1600mg qAC; titrate to Phosphorus < 6
- **Pharmacology**:
  - Mechanism of action: binds intestinal phosphate
  - Metabolism: other
  - Excretion: feces
- **Caution**: Hypophosphatemia
- **Adverse Reaction**: Nausea, vomiting, abdominal pain, constipation, obstruction, ileus
- **Contraindication**: Intestinal Obstruction, Severe Constipation, Major GI tract surgery

Lanthanum (Fosrenol)

- **Dosage Form**: 250, 500, 750 or 1000mg
- **Starting Dose**: 750 - 1500mg qAC
- **Pharmacology**:
  - Mechanism of action: binds intestinal phosphate
  - Metabolism: other
  - Excretion: bile
- **Adverse Reaction**: Nausea, vomiting, abdominal pain, constipation, obstruction,
- **Contraindication**: Intestinal Obstruction

- **Inflammatory bowel disease**
Sucroferric oxyhydroxide (Velphoro)

- **Dose:** 500mg, three times daily with meals.
- **Must be chewed**
- **Pharmacology:** 500mg iron binds intestinal phosphate.
- **Adverse Reactions:** GI
  - N/V, constipation, diarrhea, black stools
- **Drug interactions:**
  - Cannot be used with levothyroxine or vitamin D.
  - Caution use in patients with gastric bypass, gastric absorption issues, hepatic disorders, hemochromatosis

Patient Education in CKD

- Education begins in primary care
- Continues through referral to Nephrology
- CKD Stage 1-3: CKD, risk factor reduction, co-morbid disease management, CKD progression
- CKD Stage 4-5: Complications of CKD, Signs/symptom management, Transplant, Dialysis Options Education, Fistula First/Vein preservation
- Nurse Educator and staff nurses empower patient to make a difference in the progression of their CKD.

How do Primary Care and Specialty Nurse Practitioners Impact Progression of CKD?

- Early recognition of kidney disease
- Early referral to nephrology
- Risk Factor Modification
- Early identification and management of co-morbid conditions.
- Early management of complications of CKD
- Treatment Options
- **Empower patients through education to make informed decisions in regards to their disease process, ability to impact disease progression and dialysis modality choice.**
Goals of Management in CKD

- Early recognition of kidney disease
- Risk factor modification
- Early identification and management of co-morbid conditions
- Early management of complications of CKD
- Early referral to nephrology
- Empower patients through education to make informed decisions regarding their disease process, ability to impact disease progression and dialysis modality selection.

Questions?