Nutrition for People with Kidney Disease

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Topics

• Brief review: nephron anatomy, kidney functions, identifying kidney disease
• Look beyond the ABCs
• Possible interventions for lowering urine albumin (albuminuria)
• Brief review of CKD complications
• Review nutrient profiles of the food groups
• Steps for dietary intervention in CKD
Anatomy review: the nephron
CKD is reduced kidney function and/or kidney damage

• Chronic Kidney Disease
  • Kidney function
    • Glomerular filtration rate (GFR) < 60 mL/min/1.73 m² for > 3 months with or without kidney damage
  • AND/OR

• Kidney damage
  • > 3 months, with or without decreased GFR, manifested by either
    • Pathological abnormalities
    • Markers of kidney damage, i.e., proteinuria (albuminuria)
      • Urine albumin-to-creatinine ratio (UACR) > 30 mg/g

The kidneys maintain homeostasis

1. Regulatory function
   • Control composition and volume of blood
     ▪ Maintain stable concentrations of inorganic anions such as sodium (Na), potassium (K), and calcium (Ca)
   • Maintain acid-base balance

2. Excretory function
   • Produce urine
   • Remove metabolic wastes
     ▪ Including nitrogenous waste
The kidneys have other functions

3. Hormone function
   - Produce renin for blood pressure control
   - Produce erythropoietin which stimulates marrow production of red blood cells
   - Activate 25(OH)D to 1,25 (OH)\(_2\)D (active vitamin D)

4. Metabolic function
   - Gluconeogenesis
   - Metabolize drugs and endogenous substances (e.g., insulin)
Diabetic kidney disease:

Hyperglycemia causes hyperfiltration, followed by albuminuria and THEN reduced filtration (lower GFR)

- Reference: Adapted from Friedman, 1999
Most would be happy with these ABCs

T.C. is a 57 year old man diagnosed with hypertension in 2003, and diagnosed with diabetes in 2005.
• He does not smoke or drink alcohol.
  ▪ A1C 7.2
  ▪ Blood pressure 136/82
  ▪ LDL 102
  ▪ Weight 209#, height 74” (BMI 26.8)
T.C. has kidney damage and normal kidney function

KIDNEY DAMAGE
- Urine albumin-to-creatinine ratio (UACR) 1,356
- Normal is 30 or less

KIDNEY FUNCTION
- Serum creatinine 1.0
- Estimated glomerular filtration rate (eGFR) > 60
Interventions for reducing urine albumin

- Achieve good control of diabetes early; may help prevent albuminuria
- Control blood pressure
- Reduce sodium intake
- Reduce weight (if obese)
- Reduce protein intake, if excessive
- Achieve tobacco cessation
- Treat infections
Blood pressure control is KEY

• Hypertension:
  • Target blood pressure < 140/90.
  • Angiotensin converting enzyme inhibitors (ACE) or angiotensin receptor blockers (ARBs) are commonly prescribed.
  • ACEi and ARBs reduce urinary excretion of albumin and potassium.
  • Limit sodium to 2,300 mg per day.
  • Avoid salt substitutes.
Many foods contribute to sodium intake

Reference: Dietary Guidelines for Americans, 2010
Step 1: Choose and fix foods with less salt and sodium
Blood pressure medications may lower urine albumin and increase risk for hyperkalemia

- These medications include:
  - Angiotensin converting enzyme inhibitors (ACE)
    - Name ends with “PRIL”
  - Angiotensin receptor blockers (ARBs)
    - Name ends with “SARTAN”
- Limit dietary potassium when serum level is elevated.
- Reference ranges vary; some labs use 3.5-5.0 as normal
Lower sodium items like canned soups may have potassium chloride instead of salt.

- **1 cup, prepared with water**
  - Sodium: 815 milligrams
  - Potassium: 207 milligrams

- **Veg soup, low Na**
  - Sodium: 491 milligrams
  - Potassium: 549 milligrams

Check ingredient list for potassium chloride in lower sodium items.
Most Americans eat too much protein

*What We Eat in America, NHANES 2009–2010*

- **Women**
  - RDA
  - Daily Value
  - 20-29
  - 30-39
  - 40-49
  - 50-59
  - 60-69
  - 70 plus

- **Men**
  - RDA
  - Daily Value
  - 20-29
  - 30-39
  - 40-49
  - 50-59
  - 60-69
  - 70 plus

**Average 20 and older:**
- Women: 68 g
- Men: 99 g

High protein diets are **not recommended**

- **Animal protein** intake may be a risk factor for increased urine albumin excretion in hypertension and diabetes.
- Protein may increase GFR and renal blood flow rates. Animal protein may have greater effect than plant protein.
- Dietary protein is a source of nitrogen, phosphorus (P), potassium (K), and metabolic acids that need to be filtered and excreted by the kidneys. Some may have added sodium.

Most protein-rich foods contain phosphorus and potassium; some have added sodium

<table>
<thead>
<tr>
<th></th>
<th>Amount</th>
<th>Protein (g)</th>
<th>Sodium (mg)</th>
<th>Phosphorus (mg)</th>
<th>Potassium (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat</td>
<td>1 ounce</td>
<td>7.0</td>
<td>145</td>
<td>62</td>
<td>105</td>
</tr>
<tr>
<td>Poultry</td>
<td>1 ounce</td>
<td>8.2</td>
<td>24</td>
<td>56</td>
<td>70</td>
</tr>
<tr>
<td>Fish &amp; seafood</td>
<td>1 ounce</td>
<td>6.5</td>
<td>51</td>
<td>59</td>
<td>82</td>
</tr>
<tr>
<td>Beans &amp; peas</td>
<td>¼ cup</td>
<td>4.0</td>
<td>2</td>
<td>60</td>
<td>182</td>
</tr>
<tr>
<td>Egg</td>
<td>1 large</td>
<td>6.3</td>
<td>62</td>
<td>86</td>
<td>63</td>
</tr>
<tr>
<td>Egg white*</td>
<td>1 large</td>
<td>3.6</td>
<td>55</td>
<td>5</td>
<td>54</td>
</tr>
<tr>
<td>Nuts, seeds</td>
<td>½ ounce</td>
<td>3.3</td>
<td>16</td>
<td>70</td>
<td>93</td>
</tr>
<tr>
<td>Milk</td>
<td>1 cup</td>
<td>8.3</td>
<td>103</td>
<td>247</td>
<td>382</td>
</tr>
<tr>
<td>Soymilk, fortified*</td>
<td>1 cup</td>
<td>6.4</td>
<td>153</td>
<td>250</td>
<td>284</td>
</tr>
</tbody>
</table>

Data from [http://www.nal.usda.gov/fnic/foodcomp/cgi-bin/list_nut_edit.pl](http://www.nal.usda.gov/fnic/foodcomp/cgi-bin/list_nut_edit.pl)

Step 2: Eat the right amount and type of protein

- The RDA for protein is 0.8 g/kg.

- A spontaneous decrease in protein intake may occur as estimated glomerular filtration rate (eGFR) declines.

- CKD patients may report an aversion to certain animal proteins.
CKD complications and risk for CVD increase as kidney function declines

- Step 3: Choose foods that are heart healthy.
- Fewer functioning nephrons may mean:
  - Blood pressure is harder to control
  - Anemia may develop due to inadequate erythropoietin
  - Inadequate activation of vitamin D (abnormal calcium and phosphorus metabolism) that may lead to bone disease and vascular calcification
  - Toxins build up in the blood, including acid (hydrogen), nitrogen, phosphorus and potassium
  - More frequent low sugars for people with diabetes
CBC and iron studies may be ordered

- Anemia:
  - Damaged kidneys are unable to synthesize sufficient erythropoietin for red cell production.
  - Anemia may cause fatigue and reduced appetite.
  - Taste for meat may decline.
  - May need supplemental oral iron between meals.
  - Supplemental iron should be taken separately from calcium-based phosphate binding medication.
  - Erythropoiesis–stimulating agents and parenteral iron are used more commonly in people on dialysis.
• Abnormal Mineral Metabolism:
  • Damaged kidneys are unable to activate sufficient vitamin D.
  • Abnormal levels of vitamin D, calcium, phosphorus, parathyroid hormone and fibroblastic growth factor–23 may develop.
  • Different types of renal bone disease may develop.
  • Vascular calcification is a cardiovascular risk factor.
  • Limit dietary phosphorus as needed.
  • Added phosphorus is absorbed more efficiently than natural phosphorus.
  • Avoid foods and beverages with added “phos”.
  • Supplemental vitamin D and phosphate binding medication may be prescribed.
  • Active vitamin D may increase both serum calcium and phosphorus levels.
  • Take binders with meals.
Serum bicarbonate < 22 mEq/L may indicate chronic metabolic acidosis

- Metabolic Acidosis
  - Damaged kidneys are unable to produce enough bicarbonate and cannot excrete excess acid.
  - Accelerates muscle degradation.
  - Reduces albumin synthesis.
  - Exacerbates bone disease.
  - May impair glucose tolerance.
  - Animal protein is a source of metabolic acid.
  - Eating less protein may increase serum bicarbonate.
  - Supplemental base such as sodium bicarbonate may be prescribed. Monitor blood pressure closely when used.
COUNSELING
# Exchanges

<table>
<thead>
<tr>
<th>Diabetic Exchanges</th>
<th>Carbohydrate (g)</th>
<th>Protein (g)</th>
<th>Fat (g)</th>
<th>Calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starch</td>
<td>15</td>
<td>0–3</td>
<td>0–1</td>
<td>80</td>
</tr>
<tr>
<td>Fruit</td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>60</td>
</tr>
<tr>
<td>Milk</td>
<td>12</td>
<td>8</td>
<td>0–8</td>
<td>100–160</td>
</tr>
<tr>
<td>Other carbohydrates</td>
<td>15</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
</tr>
<tr>
<td>Non–starchy veg.</td>
<td>5</td>
<td>2</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>Meat/meat substitutes</td>
<td>-</td>
<td>7</td>
<td>0–8+</td>
<td>45–100</td>
</tr>
<tr>
<td>Fats</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>45</td>
</tr>
<tr>
<td>Alcohol</td>
<td>Varies</td>
<td>-</td>
<td>-</td>
<td>100</td>
</tr>
</tbody>
</table>

# Selected nutrient in the USDA Food Pattern

<table>
<thead>
<tr>
<th>Food Group</th>
<th>Protein (g)</th>
<th>Sodium (mg)</th>
<th>Phosphorus (mg)</th>
<th>Potassium (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grains (1 oz.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole</td>
<td>2.4</td>
<td>87</td>
<td>85</td>
<td>91</td>
</tr>
<tr>
<td>Refined</td>
<td>2.2</td>
<td>153</td>
<td>33</td>
<td>29</td>
</tr>
<tr>
<td>Vegetables (1/2 cup)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dark-green</td>
<td>1.6</td>
<td>30</td>
<td>39</td>
<td>229</td>
</tr>
<tr>
<td>Red &amp; orange</td>
<td>0.7</td>
<td>41</td>
<td>25</td>
<td>214</td>
</tr>
<tr>
<td>Beans &amp; peas</td>
<td>8.0</td>
<td>3</td>
<td>119</td>
<td>363</td>
</tr>
<tr>
<td>Starchy</td>
<td>1.7</td>
<td>5</td>
<td>43</td>
<td>286</td>
</tr>
<tr>
<td>Other</td>
<td>0.9</td>
<td>57</td>
<td>21</td>
<td>162</td>
</tr>
<tr>
<td>Fruit and juices (1/2 cup)</td>
<td>0.7</td>
<td>3</td>
<td>17</td>
<td>213</td>
</tr>
<tr>
<td>Milk (1 cup)</td>
<td>8.3</td>
<td>103</td>
<td>247</td>
<td>382</td>
</tr>
<tr>
<td>Meat &amp; beans (1 oz.)</td>
<td>6.9</td>
<td>93</td>
<td>63</td>
<td>91</td>
</tr>
<tr>
<td>Oils (1 tsp.)</td>
<td>0</td>
<td>13</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Added sugars</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Solid fats</td>
<td>0</td>
<td>16</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Type of carbohydrate may matter in diabetic kidney disease

<table>
<thead>
<tr>
<th>Carbohydrate choice</th>
<th>Nutrients of concern for CKD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>Protein, sodium, phosphorus, potassium</td>
</tr>
<tr>
<td>Processed grains</td>
<td>Sodium</td>
</tr>
<tr>
<td>Whole grains</td>
<td>Phosphorus, potassium</td>
</tr>
<tr>
<td>Legumes</td>
<td>Protein, phosphorus, potassium</td>
</tr>
<tr>
<td>Starchy vegetables</td>
<td>Potassium</td>
</tr>
<tr>
<td>Fruit</td>
<td>Potassium</td>
</tr>
<tr>
<td>Sweets and added sugars</td>
<td>May have added phosphorus</td>
</tr>
</tbody>
</table>
Most adults exceed the RDA for phosphorus

Average 20 and older:

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-29</td>
<td>1,190 mg</td>
<td>1,650 mg</td>
</tr>
</tbody>
</table>

*What We Eat in America*
NHANES 2009–2010

Step 4: Choose foods with less phosphorus

- **Natural phosphorus**
  - 40–60% absorbed
  - Dairy products
  - Meat, poultry, fish
  - Soy (soy milk, tofu)
  - Nuts and seeds
  - Dried beans and peas
  - Whole grains

- **Added phosphorus**
  - > 90% absorbed
  - Food additives
  - Dietary supplements
  - Calcium fortification

## Many products may have added phosphate

<table>
<thead>
<tr>
<th>Category</th>
<th>Example Products</th>
<th>Phosphate Additives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baked goods</td>
<td>Self-rising flour, cake mix, waffle mix, pancake mix, muffin mix, reduced sodium mixes</td>
<td>Monocalcium phosphate, Dicalcium phosphate, Calcium acid phosphate</td>
</tr>
<tr>
<td>Beverages</td>
<td>Dry mixes, fruit juices, soymilk</td>
<td>Tricalcium phosphate</td>
</tr>
<tr>
<td>Cereals</td>
<td>Cooked cereals, extruded dry cereals</td>
<td>Tricalcium phosphate</td>
</tr>
<tr>
<td>Dairy</td>
<td>Grated cheese, instant puddings</td>
<td>Monocalcium phosphate</td>
</tr>
<tr>
<td>Fruit &amp; vegetables</td>
<td>Canned fruits and vegetables</td>
<td>Monocalcium phosphate</td>
</tr>
<tr>
<td>Potatoes</td>
<td>Baked potato chips</td>
<td>Monocalcium phosphate</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>Vitamin-mineral supplements, enteral products, prescription and over-the-counter tablets</td>
<td>Tricalcium phosphate, Dicalcium phosphate</td>
</tr>
</tbody>
</table>

Reference: Adapted from [http://www.foodadditives.org/phosphates/phosphates_used_in_food.html](http://www.foodadditives.org/phosphates/phosphates_used_in_food.html)
Use ingredient list to find added phosphorus; look for PHOS

- Phosphorus is not required on Nutrition Facts labels.
- Nutrition Facts labels may list phosphorus, and the % Daily Value used is 1,000 mg.
- Read ingredients for “PHOS” additives.
- Choose a different food if PHOS is listed.
Chicken may be a source of added sodium, phosphorus and potassium

Na = Sodium   P = Phosphorus    K = Potassium
Step 5: Choose foods that have the right amount of potassium (when needed)

- Potassium-rich foods
- Salt substitutes
- Herbs and dietary supplement (examples)
  - Noni juice (56 mmol/L)
  - Alfalfa
  - Dandelion
  - Horsetail
  - Nettle
- Medications:
  - K supplements
    - KCl, K citrate
  - Impair excretion
    - ACEi
    - ARBs
    - K+-sparing diuretics
  - Nonsteroidal anti-inflammatory drugs
- Potassium food additives

Which is best to treat hypoglycemia in DKD?

<table>
<thead>
<tr>
<th>Beverage</th>
<th>Serving</th>
<th>Sodium (mg)</th>
<th>Phosphorus (mg)</th>
<th>Potassium (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet Cola</td>
<td>12 oz.</td>
<td>28</td>
<td>32</td>
<td>28</td>
</tr>
<tr>
<td>Cola</td>
<td>12 oz.</td>
<td>15</td>
<td>37</td>
<td>7</td>
</tr>
<tr>
<td>Lemon-lime soda pop</td>
<td>12 oz.</td>
<td>33</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Milk, 1%</td>
<td>8 oz.</td>
<td>107</td>
<td>232</td>
<td>366</td>
</tr>
<tr>
<td>Milk, 1%, protein-fortified</td>
<td>8 oz.</td>
<td>127</td>
<td>245</td>
<td>397</td>
</tr>
</tbody>
</table>

Nutrient analysis from USDA National Nutrient Database for Standard Reference
http://ndb.nal.usda.gov/ndb/search/list
## Prepare foods from scratch

<table>
<thead>
<tr>
<th>Breakfast</th>
<th>Amount</th>
<th>Sodium (mg)</th>
<th>Phosphorus (mg)</th>
<th>Potassium (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pancake, plain, homemade</td>
<td>4 inch</td>
<td>167</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>Pancake, white flour, complete</td>
<td>4 inch</td>
<td>239</td>
<td>127</td>
<td>66</td>
</tr>
<tr>
<td>Pancake, whole-wheat, incomplete</td>
<td>4 inch</td>
<td>252</td>
<td>164</td>
<td>123</td>
</tr>
<tr>
<td>Hotcake (fast food)</td>
<td>One (of 3)</td>
<td>178</td>
<td>129</td>
<td>86</td>
</tr>
<tr>
<td>Egg, white, raw, fresh</td>
<td>1 large</td>
<td>55</td>
<td>5</td>
<td>54</td>
</tr>
<tr>
<td>Egg, yolk, raw, fresh</td>
<td>1 large</td>
<td>8</td>
<td>66</td>
<td>19</td>
</tr>
<tr>
<td>Commodity dry egg mix</td>
<td>2 Tbsp.</td>
<td>100</td>
<td>78</td>
<td>64</td>
</tr>
<tr>
<td>Egg substitute</td>
<td>¼ cup</td>
<td>119</td>
<td>43</td>
<td>128</td>
</tr>
<tr>
<td>Scrambled egg (fast food)</td>
<td>One (of 2)</td>
<td>98</td>
<td>133</td>
<td>71</td>
</tr>
</tbody>
</table>

### Enhanced and fortified foods may have sodium, phosphorus, and potassium

<table>
<thead>
<tr>
<th>Food</th>
<th>Amount</th>
<th>Sodium (mg)</th>
<th>Phosphorus (mg)</th>
<th>Potassium (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pork tenderloin</td>
<td>100 g (3 oz.)</td>
<td>57</td>
<td>267</td>
<td>421</td>
</tr>
<tr>
<td></td>
<td></td>
<td>48</td>
<td>227</td>
<td>358</td>
</tr>
<tr>
<td>Pork tenderloin, enhanced</td>
<td>100 g</td>
<td>231</td>
<td>316</td>
<td>567</td>
</tr>
<tr>
<td>Soymilk</td>
<td>1 cup</td>
<td>124</td>
<td>126</td>
<td>287</td>
</tr>
<tr>
<td>Soymilk with added calcium</td>
<td>1 cup</td>
<td>90</td>
<td>151</td>
<td>156</td>
</tr>
<tr>
<td>Soymilk, chocolate</td>
<td>1 cup</td>
<td>129</td>
<td>124</td>
<td>347</td>
</tr>
<tr>
<td>Orange juice</td>
<td>½ c.</td>
<td>1</td>
<td>21</td>
<td>248</td>
</tr>
<tr>
<td>Orange juice with added calcium</td>
<td>½ c.</td>
<td>2</td>
<td>59 *</td>
<td>222</td>
</tr>
</tbody>
</table>

* Phosphorus content varies among brands, depending upon calcium compound used (calcium phosphate, calcium citrate, etc.).
Hypoglycemia

Unexplained improvement in diabetes control and/or increased frequency of hypoglycemia may indicate CKD is progressing.
Treat hypoglycemia without adding potassium or phosphorus

- Review medication list for ACEi or ARB.
  - If prescribed, discuss use of glucose tablets or low-potassium juice to treat hypoglycemia.
- Avoid colas and other beverages with added phosphoric acid.
- Milk is a natural source of phosphorus and potassium.
- Chocolate is a natural source of potassium.
Any “juice” can treat hypoglycemia, even those low in potassium

![Graph showing potassium content in various juices](image_url)
T.C.’s kidney disease progressed rapidly

**UACR**

**GFR**
The Steps for Eating Right

• Carbohydrates still count:
  • Choose low potassium juice to treat hypoglycemia.
  • Whole grains have more phosphorus and potassium than refined grains.
  • Not all of the phosphorus in whole grains is absorbed (vs. added “phos”).

1. Choose and fix foods with less salt and sodium:
  • Check for ingredient label for sodium.
  • Some lower sodium items may use potassium chloride as sat substitute.

2. Eat the right amount and type of protein:
  • Eat smaller portions of protein foods.
  • Protein is a source of phosphorus, potassium, metabolic acid and nitrogenous waste. Many processed proteins have added sodium, too.
3. Choose foods that are heart healthy.
   • Bake, roast, or stew foods instead of frying.
   • Trim fat from meat and remove skin from poultry before eating.

4. Choose foods with less phosphorus.
   • Many packaged foods have added phosphorus. Check for “phos”.
   • When treating lows consider: colas have phosphoric acid, milk substitutes and bottled teas may have added “phos”, milk has natural phosphorus.

5. Limit dietary potassium when serum level is elevated.
   • ACE or ARB use increases risk for hyperkalemia.
   • Use glucose tablets or low potassium juice to treat hypoglycemia.
Visual Aids
Visual Aids (cont.)

Reference: http://nkdep.nih.gov/resources.shtml
NEW for Primary Care Providers

Making Sense of CKD
A Concise Guide for Managing Chronic Kidney Disease in the Primary Care Setting

JULY 2014

Thank You!