NUTRITION CONSIDERATIONS FOR PATIENTS WITH DIABETES AND ADVANCED KIDNEY DISEASE
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Spring 2017
In compliance with the accrediting board policies, the American Diabetes Association requires the following disclosure to the participants:

Becca Wallschlaeger, MS RDN:

Disclosed no conflict of interest
OBJECTIVES

- Recognize kidney disease is a growing epidemic, much like diabetes, and obesity
- Understand relationship between diabetes and kidney function
- Identify nutrition changes for people living with diabetes and advanced kidney disease
- Understand kidney replacement options and the nutrition implications of each
OVERVIEW

- Background
- Anatomy and Physiology of Renal Organ System
- Diabetic Kidney Disease
- Nutrition Implications and Changes in Advanced Kidney Disease
- Kidney Replacement Options
- Nutrition and Diabetes in Kidney Replacement
KIDNEY DISEASE FACTS

- More than 20 million (or more than 10%) US adults are estimated to have CKD and most are undiagnosed
- Kidney disease is the 9th leading cause of death in US
- In the US, diabetes and hypertension are the leading causes of kidney failure, accounting for 72% or about $\frac{3}{4}$ of new cases
- The number of kidney failure cases in the US population has more than tripled since 1990

Centers for Disease Control and Prevention, CKD Initiative, 2015
Figure 1.1 Prevalence of CKD by stage among NHANES participants, 1999-2014

DETECTION OF CKD IN DIABETICS

Primary Care Detection of CKD in Patients with Type 2 Diabetes Mellitus by CKD Stage 2012

ADD-CKD Cohort

Percentage of T2DM Patients with CKD Detection

CKD Stage


Centers for Disease Control and Prevention, 2015
Percentage with CKD Stage 3 or 4 Who Were Aware of Their Disease by CKD Stage and Diabetes 1999-2012

National Health and Nutrition Examination Survey


Centers for Disease Control and Prevention, CKD Initiative, 2015
HEALTHY PEOPLE 2020—DM & CKD

- Goal: Reduce the disease burden of DM and improve the quality of life for all people who have, or are at risk for, DM
- 16 Objectives

- Goal: Reduce new cases of CKD and its complications, disability, death, and economic costs
  - Nearly 25% of the Medicare budget is used to treat people with CKD and ESRD.
- 14 Objectives

Office of Disease Prevention and Health Promotion, Healthy People 2020, 2017
Table 2.2 HP2020 D-12 Increase the proportion of persons with diagnosed diabetes who obtain an annual urinary microalbumin measurement: Target 37.0%

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Data Source: Special analyses, Medicare 5 percent sample. Medicare patients with diabetes mellitus, aged 65 & older. Abbreviations: D, diabetes mellitus.
**Kidney Physiology**

- Filters Blood
  - Glomerular Filtration
  - Tubule Secretion
  - Tubule Resorption
- Removes Toxins
- Regulates Extracellular Homeostasis
  - Acid/base
  - Electrolytes
  - Fluids
- Blood Pressure Control
- Makes Erythropoietin
- Vitamin D Metabolism
**Kidney Anatomy**

- **Parts of the Nephron**
  - **Nephron**
  - **Glomerulus**
  - **Tubule**
  - **Urine Out**
  - **Filtered Blood Out**
  - **Unfiltered Blood In**

- **Kidney Cross Section**

- **One Nephron**

- **Unfiltered Blood In**
STAGES OF CKD

- **Stage 1:** eGFR $\geq 90$ ml/min/1.73m$^2$ and ACR $\geq$ 30 mg/g
- **Stage 2:** eGFR 60-89 ml/min/1.73m$^2$ and ACR $\geq$ 30 mg/g
- **Stage 3:** eGFR 30-59 ml/min/1.73m$^2$
- **Stage 4:** eGFR 15-29 ml/min/1.73m$^2$
- **Stage 5:** eGFR $< 15$ ml/min/1.73m$^2$

National Kidney Foundation, KDOQI Guidelines
ADVANCED KIDNEY DISEASE

- Stage 4 or GFR <30 mL/min
- Quality vs quantity – clearance

Symptoms
- Fluid build up
- Loss of appetite
- Changes in sleep
- Changes in concentration

Monitoring
- Urine
- Blood
Diabetes and Progression of Kidney Disease

- Hyperglycemia
- \(\uparrow\) Filtration rate
- Leaking
- Loss of protein
  - Microalbuminuria (early stages)
  - Macroalbuminuria (nearing ESRD)
- Loss of filtering
- Waste build up
- Dialysis/Transplant
GLUCOSE CONTROL AND MICROALBUMINURIA

- KDOQI Guideline 2
  - “Intensive treatment of hyperglycemia prevents elevated albuminuria or delays its progression”
- Recommend: HbA1c of ~ 7% to prevent or delay progression of microvascular complications of diabetes (Diabetes Control and Complications Trial)
- Recommend: Not treating to HbA1c <7% in patients at risk of hypoglycemia
- ADVANCE Trial
DIABETES CONTROL AND COMPLICATIONS TRIAL

B  Cumulative Incidence of Microalbuminuria

- **Conventional**
- **Intensive**

**No. Evaluated**
- Conventional: 352 351 348 349 346 345 262 171 103 79
- Intensive: 363 361 358 354 352 351 276 186 106 91

ADVANCE TRIAL

- 11,140 participants
- Randomly assigned
  - Intensive glucose-lowering strategy
  - Standard glucose control

Measures
- ESRD Risk
- Microalbuminuria
- Macroalbuminuria

Results:
- HbA1c level was 6.5% in intensive group, and 7.3% in standard group
- Significant reduction in ESRD risk by 65%, microalbuminuria in intensive group
- Significant reduction in microalbuminuria by 9%
- Significant reduction in macroalbuminuria by 30%
**Renal Insufficiency & Diabetic Changes**

- Insulin metabolism
  - Glomerulus
  - Peritubular Capillaries

- Impaired renal function = impaired insulin metabolism

- Prolonged half-life of circulating insulin
RENAL DIET

- KDOQI guidelines
- Academy of Nutrition and Dietetics Position
- DASH Diet
- Diabetic Diet
- Typical Concerns
  - Sodium
  - Potassium
  - Phosphorus
  - Calcium
  - Protein
ACADEMY OF NUTRITION AND DIETETICS

- Evidence Analysis Library
- CKD Guideline
- CKD Toolkit
- Based on KDOQI Guidelines
- Medical Nutrition Therapy
DASH DIET

- 1,500-2,300 mg sodium/day
- Grains: 6-8 servings/day whole grains or sweet potatoes
- Vegetables: 4-5 servings/day
- Fruit: 4-5 servings/day
- Dairy: 2-3 servings/day (Low- or Non-Fat)
- Lean Protein: ≤ 6 oz/day
- Nuts, Seeds, Beans: 4-5 servings/week
- Fats & Oils: 2-3 servings/day (unsaturated)
- Sweets: ≤ 5/week
DIABETIC DIET

- Consistent meal times; avoid skipping meals
- Reduce sugar and sweets
- Consistent meal composition
  - My Plate
- Include a lean protein source at meals and snacks
- Choose high-fiber foods
- Eat less fat
Meal Planning - Plate Method

- Eat 3 meals and 0-2 snacks daily.
- Choose at least 3-4 food groups at meals and up to 1-2 food groups at snacks.
- **Yellow** groups are carbohydrate. Carbohydrate gives energy and raises blood sugar.
- Include both carb and non-carb food groups each meal.

### Meat/Protein
- 1-2 eggs
- 2 Tbsp peanut butter
- 1 ounce low fat butter
- ¼ cup cottage cheese
- 1-2 oz low fat turkey sausage
- 2-3 ounces chicken or turkey
- ½ cup cooked beans (legumes)
- 2-3 ounces tuna or salmon
- 2-3 ounces lean beef or pork
- ¼ cup nuts

### Starch/Grain
- (15 g carb)
- 1 small tortilla
- 1 slice whole wheat bread
- 1/2 cup cooked oatmeal
- ¼ cup dry cereal
- ½ English muffin whole grain
- ¼ cup whole wheat pasta
- 1/3 cup cooked brown rice
- ½ medium baked potato
- ½ cup peas/corn/beans
- 6-8 crackers whole grain
- ½ hamburger bun, whole grain

### Milk/Yogurt
- (15 g carb)
- 1 cup skim 1%
- 1 cup low fat yogurt (plain, light, Greek)

### Fruit
- (15 g carb)
- 1 small apple/orange
- 1 cup berries
- Small banana
- 1 cup melon
- ½ cup fruit juice
- 2 T dried fruit

### Non Starchy Vegetables
- Asparagus
- Lettuce
- Carrots
- Broccoli
- Cauliflower
- Tomatoes
- Mushrooms
- Onion
- Cucumber
- Celery
- Spinach
- Green Beans
- Salsa
- Zucchini, yellow squash
KDOQI GUIDELINES: PROTEIN

- GFR < 50 mL/min per 1.73 m²
  - 0.8 gram protein/kg/day (IBW if BMI > 30 kg/m²)
  - Ensure adequate caloric intake to prevent malnutrition

- GFR < 20 mL/min per 1.73 m²
  - 0.2-0.5 gram protein/kg/day (IBW if BMI > 30 kg/m²)
  - Keto acid analogs
  - Vitamin/Mineral supplementation

- Diabetic Nephropathy
  - 0.8-0.9 gram protein/kg/day (IBW if BMI > 30 kg/m²)
  - Prevent hypoalbuminemia

- Dialysis
  - 1.2 gram protein/kg/day (IBW if BMI > 30 kg/m²)
Restricting Dietary Protein

Chronic kidney disease progression: a retrospective analysis of 3-year adherence to a low protein diet

Felipe Rizzetto, Viviane de Oliveira Leal, Leonardo Soares Bastos, Denis Fouque & Denise Mafra

- 321 enrolled patients; 2008-2013
- Provided with KDOQI guidelines
- Followed every 3 months by RD
- Diet records with analysis
- Adherence defined 90-110% of diet prescription
  - Motivation additionally self-measured by patient
    - Excellent, very good, fair, poor
- 4 groups
  - DM adhered
  - DM did not adhered
  - Non-DM adhered
  - Non-DM did not adhered
Results:

- Adherence: 49.2% (25% DM 23% non-DM)
- Significant improvement in fasting glucose in group 1
- Creatinine levels decreased significantly in adherent groups
- E-GFR increased significantly year-to-year in adherent groups with albumin in normal range (>3.8 mg/dL)
- No protein-energy wasting found
- Limitation: did not evaluate blood pressure or proteinuria
KDOQI Guidelines: Potassium (K)

- No restrictions until K is > 5.5 mg/dL
  - < 2.4 gram/day if hyperkalemic
- Restrict K intake to 3-4 g/day CKD
- Restrict K intake to 2-3 g/day ESRD
- Misc: multivitamins, sports drinks, salt alternatives, diuretics/blood pressure medications

Common Sources
- Dairy
- Nuts
- Produce
- Dried fruits
- Processed foods
KDOQI Guidelines: Phosphorus

- Restrict if serum level is > 4.6 mg/dL
- 800-1,000 mg/day
- RDA healthy population: 700-1250 mg/day
- Average intake: 1400-2000 mg/day
- Common sources:
  - Dairy
  - Meats/Eggs
  - Nuts
  - Whole grains
  - Processed foods
THE PHOSPHORUS PYRAMID

D’ Alessandro et al, BMC Nephrology, 2015
# Phosphate Binders

**Table 1. Non-calcium based binders**

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<tr>
<th>Brand Name</th>
<th>Generic Name</th>
<th>Available Dosage Forms</th>
<th>Maximum Dose per Day</th>
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<tbody>
<tr>
<td>Renagel</td>
<td>Sevelamer hydrochloride</td>
<td>800 mg tablet</td>
<td>16 tablets (12,800 mg)</td>
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<tr>
<td>Renvela</td>
<td>Sevelamer carbonate</td>
<td>800 mg tablet 800 mg powder packet 2.4 gram powder packet</td>
<td>16 tablets (12,800 mg)</td>
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<tr>
<td>Fosrenol</td>
<td>Lanthanum (Chewable tablets)</td>
<td>500 mg 750 mg 1000 mg</td>
<td>4500 mg</td>
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<tr>
<td>Velphoro</td>
<td>Sucroferric oxyhydroxide</td>
<td>500 mg chewable tablet</td>
<td>6 tablets (3000 mg)</td>
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<td>Auryxia</td>
<td>Ferric citrate</td>
<td>210 mg tablet</td>
<td>12 tablets (2520 mg)</td>
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*Currently none are available as generic*

**Table 2. Calcium content of calcium-based binders**

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<th>Brand Name</th>
<th>Elemental Calcium</th>
<th>Pill Dose</th>
<th>Maximum dose per day</th>
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<td>Calcium acetate</td>
<td>167 mg</td>
<td>667 mg</td>
<td>9 tabs (6003 mg or 1503 mg of elemental calcium)</td>
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<td>(PhosLo, Eliphos)</td>
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<td>Calcium carbonate</td>
<td>250 mg</td>
<td>650 mg</td>
<td>1500 mg of elemental calcium</td>
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SODIUM & FLUIDS

- Sodium
  - Based upon blood pressure and fluid balance
  - Stages 1-5 < 2.4 gram/day
  - Dialysis ≤ 2.0 gram/day

- Fluids
  - No restrictions Stages 1-3
  - Stage 4: output +1000 mL
  - HD: 1.5-2 L, depending on output and ID gains
  - PD: 1-3 L/day
DIALYSIS

- Kidney replacement therapy
- Access Types
  - Fistula: artery-vein connection in arm
  - Graft: use of plastic tube to join artery-vein in arm
  - Catheter: plastic tube inserted into large vein in neck
- Dialysis Modalities
  - Hemodialysis
    - In Center
    - Home
  - Peritoneal Dialysis
    - CAPD
    - Cyclic PD
- RD Assessment monthly-CMS requirement
  - Additional assessments “Care Conferences”
COMMON MEDICATIONS AND SUPPLEMENTS

- No herbal supplements!!!
- Phosphate Binders
  - Calcium-Based
  - Iron-Based
  - Aluminum-Based
  - Aluminum-Free
  - Magnesium-Based
- B-12/Folic Acid
  - MCV > 100 ng/mL
  - Serum levels < normal
- Vitamin D
  - Serum 25-hydroxy < 30 ng/mL (75 nmol/L)—ergocalciferol or cholecalciferol
  - iPTH > 600 pg/mL—Calcitriol
- Iron
  - Serum ferritin < 100 ng/mL
  - TSAT < 20%
Hemodialysis

- In-Center vs Home
- 3 days/week vs 5 days/week
- 3-4 hour sessions
- Increased variation in fluid shifts
- Typically more restrictive diet
- Increased protein needs
PERITONEAL DIALYSIS

- At home, usually while sleeping (cyclic) or ambulatory
- Daily
- 9-10 hour sessions
- Less variations in fluid retention
- Dextrose can cause unwanted weight gain
- Diet usually more liberal than HD
- Increased infection risk
- Increased protein needs
- Changes in appetite
EXERCISE RECOMMENDATIONS

- Diabetic vascular disease
- Minimizes catabolic effects of protein restrictions in CKD
- #1 cause of death in dialysis and transplant patients is CVD
- Increased risk of frailty in chronic illness and aging

American Heart Association Recommendations
- 150 min/week cardiovascular
- 2 days/week strength building
TRANSPLANT OPTIONS FOR DIABETICS

- Pancreas
- Islet Cell
- Simultaneous Pancreas Kidney
- Kidney
# UW Transplant Waiting Times

## Simultaneous Pancreas-Kidney (SPK)

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<th>ABO</th>
<th>Median Waiting Time (in days)</th>
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<td>AB</td>
<td>97</td>
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<td>B</td>
<td>53</td>
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## Solitary Pancreas

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<td>B</td>
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## Kidney

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<td>AB</td>
<td>609</td>
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<td>B</td>
<td>1847</td>
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Figure 7.1 Percentage of dialysis patients wait-listed and unadjusted kidney transplant rates, 1997-2014

Data Source: Reference Tables E4 and E9. Percentage of dialysis patients on the kidney waiting list is for all dialysis patients. Unadjusted transplant rates are for all dialysis patients. Abbreviations: Tx, transplant; pt yrs, patient years.

2016 Annual Data Report, Vol 2, ESRD, Ch 7
NUTRITION CONSIDERATIONS PRE-TRANSPLANT

- BMI
  - Pancreas < 30 kg/m²
  - SPK < 30 kg/m²
  - Kidney < 35 kg/m²
- Weight History
- Diet Restrictions
- Biochemical Data
- Activity level
  - Frailty Assessments
- Contraindications: BMI > 30-35 kg/m², A1c >/= 10%
Frailty Assessment

- Fried, et al

- Gait Speed: timed 4 meter walk
- Grip Strength: hand dynamometer
- Exhaustion: patient questionnaire
- Physical Activity: Minnesota Leisure Activity
- Weight change: within past year
Nutrition Concerns Following Transplant

- Hyperglycemia
- Hypophosphatemia
- Hyperkalemia
- GI upset
- Food Safety
- Hypertension
- Dyslipidemia
- Weight management
QUESTIONS & DISCUSSION

...and this dish is totally potassium-free!
REFERENCES


10. Office of Disease Prevention and Health Promotion, Healthy People 2020, 2017
