Optimizing Renal Nutrition from the Table to the ICU

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Peterborough Regional Dialysis
Faculty/Presenter Disclosure

• Faculty: Margaret Avery RD MSc.

• Relationships with commercial interests:
  – Speaker for Fresenius Kabi Intradialytic Parenteral Nutrition
Woods Hole Massachusetts

$13,900,000.
The Marine Biological Laboratory
"Research is to see what everybody else has seen, and to think what nobody else has thought." - Albert Szent-Györgyi, Hungarian Biochemist

After winning the Nobel Prize for his study on vitamin C and cell respiration, Dr. Szent-Györgyi set his sights on finding a way to defeat cancer.
Observational Studies

..support the conclusion made from *RCTs* and strengthen the level of evidence

*RCTs* prove that it will work but can’t prove it will work on your patients.

*Late in life, Szent-Gyorgyi*
**Journal Unpublished** Observational 100 patients  
April 2016  Margaret Avery RD MSc.  
“Percentage of Diabetes Mellitus and average BMI in adult HD patient population In center Unit, Peterborough Dialysis Unit”

### Research for Dr. Ian Jamison

<table>
<thead>
<tr>
<th>Patient Number</th>
<th>Date of Birth</th>
<th>Age</th>
<th>Blood Pressure</th>
<th>Weight kgs</th>
<th>Height</th>
<th>Body Mass Index</th>
<th>DM</th>
<th>Male Type 1/2 Diabetes</th>
<th>Female Type 1/2 Diabetes</th>
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<tbody>
<tr>
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<td>11-Jan-25</td>
<td>91</td>
<td>133/48</td>
<td>53.7</td>
<td>1.55</td>
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<td>2</td>
<td>10-Aug-35</td>
<td>80</td>
<td>141/52</td>
<td>86.1</td>
<td>1.7</td>
<td>29.79238754</td>
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</table>

**Total 43**  
Total male 23  
female 20  

**26% T1DM**  
74% T2DM
The objective of this review is to concisely assess the recent evidence in support of the renal diet on:

I. Reducing the intake of sodium and inorganic phosphate
II. Protein: the right “Whey” and the plant “Way”
III. Implications of omega 3 and multiple composition lipids
Current Renal Nutrition Research
As societies and dietary habits evolve, our evidence and recommendations should adapt and respond to such changes.
Traditional dietary management of Chronic Kidney Disease predominantly on quantity not quality, there is a tendency to restrict groups or colors of foods.
New approach
..have gradually moved from a single nutrient focus to whole foods and dietary patterns, for example a slant on plant-based pattern in early stages of CKD.
Global dietary changes

- toward Western diets, with convenience, fast, and ultra-processed foods.
ABOUT 80% OF THE “FOODS” ON SUPERMARKET SHELVES TODAY DIDN’T EXIST 100 YEARS AGO.

EAT. REAL. FOOD.

Source: Thankyourbody.com

The Farmacy
How does the CKD diet fit

There is an emphasis on restriction of sodium, potassium, and phosphorous at the expense of compromising overall diet quality.
1. Reducing the intake of sodium stages 1-5 CKD
Sodium reduction

Journal of Hypertension He et al 2009 Randomized double-blind crossover trial

“Effect of Modest Salt Reduction on Blood Pressure, Urinary Albumin, and Pulse Wave Velocity in White, Black, and Asian Mild Hypertensives”

Modest reduction in sodium/salt

Na++ → BP
Urinary albumin and improves large artery compliance
Reducing the Intake of Sodium

Salt Reduction and Urine Protein Excretion

**Randomised Cross-over**

<table>
<thead>
<tr>
<th>Reduced Salt Diet</th>
<th>Slow Sodium</th>
<th>Placebo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urinary Protein  (mg/24h)</td>
<td><img src="image" alt="Graph showing the decrease in protein excretion" /></td>
<td><img src="image" alt="Graph showing the decrease in protein excretion" /></td>
</tr>
<tr>
<td>Urinary Sodium  (mmol/24h)</td>
<td><img src="image" alt="Graph showing the decrease in sodium excretion" /></td>
<td><img src="image" alt="Graph showing the decrease in sodium excretion" /></td>
</tr>
</tbody>
</table>

**P < 0.01 compared to Slow Sodium Period.**
↑ Sodium ↑ Protein loss

High blood pressure has been shown to increase the amount of protein in the urine, which is a major risk factor for the decline of kidney function.
Salt and Fluid Retention

How does your sandwich stack up on sodium?

- Top slice of bread: 200 mg
- 1 teaspoon mustard: 120 mg
- 1 leaf of lettuce: 2 mg
- 1 slice of cheese: 310 mg
- 6 thin slices of turkey: 690 mg

Total = 1,522 mg per whole sandwich
A small amount of salt is essential for the normal physiological functioning of the human body.

- adults need just **1 gram/day** and
- adults currently consume between **7 and 10 grams/day**, far more than needed.

**Exception to the rule**
The importance of oral sodium replacement in ileostomy patients
All stages of kidney disease

2000-1500 mg of sodium per day as an adequate intake range level

Most Sodium Comes from Processed and Restaurant Foods

- Processed and restaurant foods: 77%
- Naturally occurring: 12%
- While eating: 6%
- Home cooking: 5%
Queens University Medical Grand Rounds Dr. Rachael Holden Associated professor in Nephrology revealed on Nov.14, 2013

“How our love of sodium has made Phosphate the New Sodium”

..an emerging health concern that is an unintended consequence of reducing dietary sodium: the stealth introduction of phosphate salts into the food chain.
Two types of Phosphate

Organic

Inorganic
Dietary Phosphate has two fates:

- It can be eliminated, passing through the intestine unabsorbed, or it can be absorbed. If absorbed, it is either eliminated by the kidney or retained and deposited in the tissues. While phosphate is a key component of healthy bone, excessive phosphate absorption leads to calcification where it ought not occur: in our blood vessels.
Elevated tissue phosphate levels trigger a fascinating but lethal process in blood vessels in which smooth muscle cells in the blood vessel wall change their gene expression and transform into bone making cells (osteoblasts). Once this occurs, calcium-phosphate (bone) is deposited in the wall of the vessel leading to many cardiovascular diseases.
Inorganic Phosphate
Phosphates in whole-muscle and prepared meats maintain juiciness, stabilize texture, reduce microbial growth, and extend shelf life.
Cheeses benefit from the ability of phosphate to help emulsification, act as creaming and buffer agents, and modify melt quality.
Enjoy every single moment.

94 mg phosphate in 50-g serving

590 mg phosphate in 50-g serving
Dr. Holden revealed that the food industry has replaced the sodium in food to garner the coveted Heart and Stroke Foundation’s H&SF healthy choice label, with another salt that is equally harmful: phosphate.

**Case Study of Prepared Dinners**
*Dr. Rachel Holden*

Two prepared dinners, both containing chicken, rice and vegetables.

*Healthy Choice* is low sodium, so it gets Heart & Stroke approval.

*Lean Cuisine* fails to earn the low sodium status because it has 610mg of sodium (1/4 of the daily recommended consumption).

Guess how *Healthy Choice* lowers sodium? They add phosphate. Since phosphate is not regulated, the amount is unknown and it is simply buried in the list of ingredients as ‘sodium phosphate’.
Inorganic Phosphate

How many sources of Phosphate?

FAST FOOD FRIES®

INGREDIENTS: POTATOES, VEGETABLE OIL (SUNFLOWER, COTTONSEED, SOYBEAN, AND/OR CANOLA), MODIFIED FOOD STARCH, RICE FLOUR, SALT, DEXTRIN, CORNSTARCH, LEAVENING (SODIUM ACID PYROPHOSPHATE, SODIUM BICARBONATE) DEXTROSE, XANTHAN GUM, ANNATO (COLOR) DISODIUM DIHYDROGEN PYROPHOSPHATE.
Inorganic Phosphate

Inorganic Phosphorus
Ingredient Use in Restaurant Foods

Dicalcium Phosphate
Hexametaphosphate
Monocalcium Phosphate
Phosphoric Acid
Pyrophosphate
Sodium Acid Pyrophosphate
Sodium Aluminum Phosphate
Sodium Phosphate
Sodium Tripolyphosphate
Tricalcium Phosphate
Organic versus Inorganic Phosphorus

Organic forms such as Phytate

- Slower rate of absorption
- Generally less bioavailable
- Bioavailable when digested or degraded by enzymatic action

Inorganic Phosphate Salts

- Rapidly absorbed
- Highly bioavailable
- Rapidly dissociates in gut acidity
- No enzymatic degradation

Plant

Organic
40-60%

Animal

Advances in Nutrition Journal Calvo et al 2014

“Assessing the Health Impact of Phosphorus in the Food Supply: Issues and Considerations”
Phosphate’s role in the body

- 30% energy production and
- 70% bone and mineral
- Nutrition marker
So what is the solution...

Bowl of cereal

Any Questions?

Organic
Apple and Grapefruit

INGREDIENTS: APPLE, GRAPEFRUIT

INGREDIENTS: ENRICHED FLOUR (WHEAT FLOUR, NIACIN, REDUCED IRON, THIAMIN MONONITRATE [VITAMIN B₁], RIBOFLAVIN [VITAMIN B₂], FOLIC ACID), CORN SYRUP, SUGAR, SOYBEAN AND PALM OIL (WITH TBHQ FOR FRESHNESS), CORN SYRUP SOLIDS, DEXTROSE, HIGH FRUCTOSE CORN SYRUP, FRUCTOSE, GLYCERIN, CONTAINS 2% OR LESS OF COCOA (PROCESSED WITH ALKALI), POLYDEXTROSE, MODIFIED CORN STARCH, SALT, DRIED CREAM, CALCIUM CARBONATE, CORNSTARCH, LEAVENING (BAKING SODA, SODIUM ACID PYROPHOSPHATE, MONCALCIUM PHOSPHATE, CALCIUM SULFATE), DISTILLED MONOGLYCERIDES, HYDROGENATED PALM KERNEL OIL, SODIUM STEAROYL LACTYLATE, GELATIN, COLOR ADDED. SOY LECITHIN, DATEM, NATURAL AND ARTIFICIAL FLAVOR, VANILLA EXTRACT, CARNABO WAX, XANTHAN GUM, VITAMIN A PALMITATE, YELLOW #5 LAKE, RED #40 LAKE, CARAMEL COLOR, NIACINAMIDE, BLUE #2 LAKE, REDUCED IRON, YELLOW #6 LAKE, PYRIDOXINE HYdroCHLORIDE (VITAMIN B₆), RIBOFLAVIN (VITAMIN B₂), THIAMIN HYDROCHLORIDE (VITAMIN B₁), CITRIC ACID, FOLIC ACID, RED #40, YELLOW #5, YELLOW #6, BLUE #2, BLUE #1.
11. Protein: The right “Whey” and the plant “Way”

WHEY PROTEINS

- β-lactoglobulin: 35%
- α-lactalbumin: 12%
- glycomacropeptide: 12%
- proteose peptone: 12%
- immunoglobulins: 8%
- serum albumin: 5%
- lactoferrin: 1%
- lactoperoxidase: 0.5%
- minor proteins: 15%

CASEIN

- αs1-αs2-, β, κ casein

“BECAUSE SOY DIGESTS SLOWER THAN WHEY, BUT FASTER THAN CASEIN, IT MAKES A NICE BRIDGE BETWEEN THE TWO AND KEEPS A STEADY FLOW OF AMINOS TO YOUR MUSCLES.”
“Feeding critically ill patients the right “whey” thinking outside of the box.”
20 Amino Acids

Branch chain amino acids

Valine, leucine, and isoleucine

Larger hydrocarbon side chains are found in valine, leucine, and isoleucine.
Proteins are polymers of amino acids.

Essential Amino Acid Leucine
Anabolism is a process by which proteins are formed from amino acids.

Peptide bond

Only a single amino acid substitution can give rise to a malfunctioning protein as in the case of sickle cell anemia.
Whey protein clearly provides the biggest bag for your buck. Perhaps not surprising, HBV protein foods are the most energy efficient choices when aiming to maximally stimulate protein synthesis.

9 slices of bread /6 cups of rice /3 eggs

2-3g of Leucine maximally stimulates protein synthesis

Leucine → mTOR → S6K → Muscle Protein Synthesis
2-3g of Leucine maximally stimulates protein synthesis.

“Vegetarian compared with meat dietary protein source and phosphorus homeostasis in chronic kidney disease”
Diabetic guidelines for patients with CKD: 
**Phosphorous restriction** is now based on quality of the source

- Plant-based/muscle protein-based/ and phosphate additives in foods
  
  *Phosphate restriction - 1500mg /day*

- Portion sizes are still recommended for CHO counting
Feeding ill patients at PRHC Dialysis Unit we are at the top of the wave of optimal nutrition, we are leaders in the field.

100% high-quality whey protein powder/liquid supplements
Each serving provides 6 g /21.6g protein to help maintain muscle
Contains no fillers, sweeteners or artificial flavorings
Next Steps for our patients

1. Three in one IV bag safer and more economical.
2. Six month trial pending
3. Time we feed patient on dialysis
When to feed the patient...

Front line workers in dialysis frequently observe the functional decline hemodialysis patients.

The fundamental issue underlying the malnutrition that is seen in the ESRD population is that these patients are **catabolic**, rates of protein breakdown outstrip production of new body protein.

Underlying assumption that the major problem in such patients is simply inadequate intake, which is typically not the case.

When are they not catabolic
When is good time to feed on HD...promote protein synthesis

Figure 3

Rate of IDPN maybe higher here

Hemo Int Depner 2005: spKt/V predicted urea concentration (-) and measured urea concentration (.) during and after dialysis
3. Implications of omega 3 and multi composition lipids TPN
Lipid Bilayer

- Polar head
- Nonpolar tail
- Carbohydrate chain
- Glycoprotein
- External membrane surface
- Phospholipid bilayer
- Internal membrane surface
- Protein
- Cholesterol
- Cytoskeleton filaments
Time course of incorporation of EPA and DHA into human cell phospholipids Yaqoob et al 2000
Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are functionally the most important omega-3 polyunsaturated fatty acids (PUFAs). Oral supply of these fatty acids increases their levels in plasma and cell membranes.
Categorization of Oils

Relative not absolute scale

More Pro-inflammatory
- Safflower oil
- Medium chain triglyceride oil
- Coconut oil

Less Pro-inflammatory
- Soybean oil
- Olive oil
- Fish oil
Dysfunction in lipolysis ESRD

...not synthesis

Adipose tissue is a highly active **endocrine organ**

**Enzymatic activity**
- Hepatic Lipase
- Peripheral Lipase

**Lipid droplets**

Decreased enzymatic delipidation

atherogenic remnants
Contribute low levels of HDL/proinflammatory state
**Lipid Emulsions**

- Fatty acids provide energy
- In addition they may be involved in immune response and inflammation by influencing biological pathways, signal transduction and gene expression.
The capacity of n-3 PUFAs may migrate inflammatory processes by modulating the synthesis of eicosanoids, activating nuclear receptors and nuclear transcription factors and producing **resolvins**.

**SIDEBAR Note:**

**Omega 3 PUFA precursors**, they can orchestrate the timely resolution of inflammation in model systems. These resolving mediators offers exciting new targets for drug design.
Medium chain triglycerides

....are absorbed and transported directly to the liver where they are burned for energy......
MEDIUM-CHAIN FATTY ACIDS DO NOT REQUIRE CHYLOMICRONS FOR TRANSPORT OR CARNITINE FOR ENTRY INTO MITOCHONDRIA

PRIMARILY THE FATTY ACID OLIVE OIL IS LONG CHAIN.
In the dialysis population endogenous L-Carnitine (LC) has been shown to be deficient, although the benefit of carnitine supplementation remains unproven. HD patients may benefit from a lipid composition that contains medium chain triacylglycerols from coconut. Medium chain fatty acids enter the mitochondria by a carnitine-independent mechanism.
The Renal Dietitian team have organized a table on the flow of recommendations for the CKD diet pattern. There is also a sheet on Phosphorous and protein content of various foods included in your package.
# Diet Guidelines for the Management of Patients with CKD

*Reducing emphasis on quantity, but focusing on quality of CKD food pattern*

<table>
<thead>
<tr>
<th>Diet components/amounts/d</th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
<th>Stage 5</th>
<th>PD</th>
<th>IHD</th>
<th>HHD</th>
<th>NHD</th>
<th>ICU</th>
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<tbody>
<tr>
<td>Potassium</td>
<td>No Restriction</td>
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<tr>
<td>Plant-Based PHOS (40% absorption)</td>
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<td>Organic PHOS (60% absorption)</td>
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<tr>
<td>Inorganic PHOS (Food Additives) (95% absorption)</td>
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<td>Whole muscle proteins (higher % of BCAAs)</td>
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<tr>
<td>Plant based Proteins (lower % of BCAAs)</td>
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<tr>
<td>Multi Composition Fatty Acids (reduction in Omega 6)</td>
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<tr>
<td>Omega 3</td>
<td>No Restriction</td>
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**Legend**

- **No Restriction**
- **Individualized**
- **Restricted**

1. Sodium restriction not indicated in high output ostomy patients
2. The above table lists the daily recommended intake of CKD diet components

**References:**
- *Journal of Renal Nutrition* Large Prospective cohort September 2016
The key to halting progression of CKD might be in the produce market, not in the pharmacy.

Both Randomized trials One Stage 4 and the other Stage 2.

Although this study is promising, the short duration and use of only urinary markers as a surrogate outcome weaken the conclusions.
Thank You!

A discovery is said to be an accident meeting a prepared mind. ASG

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