

*** New Approaches to Dietary Phosphorus Management**

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*** Objectives**

- Identify the sources of dietary P
- Highlight several approaches to low P diet education
- Recognize the challenges of P control for dialysis patients
- Promote creative new approaches to improving P control

*** Phosphorus controls...**

- pH balance
- Energy production & storage
- Hormone secretion
- Vitamin utilization
- Oxygen delivery to tissues
- Growth, maintenance and repair of tissues and cells

***About CKD-MBD**

- Refers to irregularities with Ca, P, PTH, Vitamin D and FGF-23
- Causes bone abnormalities
- Causes vascular calcification decreasing elasticity of large arteries
- Leads to HTN, cardiac failure and DEATH

***Phosphorus is...**

- Essential to the proper functioning of the body
- Necessary for all cellular processes
- Found in the bone - it works with calcium to build bones

DIALYSIS ALONE CANNOT CONTROL THIS



Phosphorus Intake Recommendations


AGE	DRI	Normal P with High PTH	High P with High PTH
0-6 months	100 mg/day	≤100 mg/day	≤80 mg/day
7- 12 months	275 mg/day	≤275 mg/day	≤220 mg/day
1-3 years	460 mg/day	≤460 mg/day	≤370 mg/day
4- 8 years	500 mg/day	≤500 mg/day	≤400 mg/day
9-18 years	1250 mg/day	≤1250 mg/day	≤1000 mg/day

*** Sources of P**

Two main ORGANIC sources:

ANIMAL:

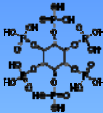
- Present within the cells as part of phosphoproteins, phospholipids, ATP, ADP, DNA, RNA
- Easily hydrolyzed
- 40-60% absorbed



*** Sources of P**

PLANT:

- Found in seeds, nuts, legumes, chocolate
- Associated with phytates
- Mammals lack phytase enzyme so the bioavailability of this P is low
- <40% absorbed



*Sources of P

INORGANIC source:

Food Additives:

- P is the main component of many preservatives and additives
- Salts that readily dissociate
- Not protein bound
- ~100% absorbed

*Additives

- Extend shelf life
- Improve color
- Enhance flavor
- Retain moisture
- Improve texture

*Additives

Common Sources:



- Beverages
- Enhanced or restructured meats
- Frozen meals
- Cereals, snack bars
- Instant products
- Processed and spreadable cheeses
- Refrigerated bakery products

* Additives

- Use has grown over the past 3 decades
- No set limit to how much phosphate additive can be used
- Phosphates are listed in the ingredient list, but there is no way to estimate quantity

* Additives in Organic Food

- Monobasic/dibasic/tribasic calcium phosphate
- Potassium phosphate
- Sodium phosphate
- Sodium acid pyrophosphate
- Tetrasodium pyrophosphate



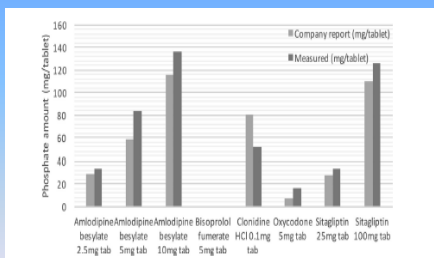
- P additives are also added to **MEDICATIONS** as a vehicle that aids in the delivery of the active drug ingredient



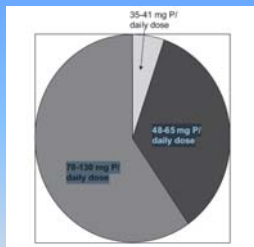
***Nelson et al., 2016**

- Used data from the Health Canada Drug Database to identify P containing meds taken by their HD patients
- 1744 formulations of 124 drugs
- 11% contained P salts
- Primarily CNS and cardiovascular meds

***Nelson et al., 2016**



- Determined 30% of HD patients were taking at least 1 med with P
- Median P intake from meds believed to be 111 mg/day



Calvo MS, Uribarri J. Contributions to Total Phosphorus Intake: All Sources Considered. *Semin Dial.* 2013;26 No. 1:54-61.

*TEACHING STRATEGIES



*P:Protein Ratio



- Higher for foods with a HIGH amount of P and LOW amount of protein (eg. soft drinks)
- Ratio is independent of portion size
- Helps balance P intake while ensuring adequate protein intake

*P:Protein Ratio	
Ratio Adjusted for Digestion & Absorption	Foods
1-5	Egg white, pork rinds, pork loin, chicken thigh, shrimp, cottage cheese
>5-10	Chicken breast, beef, veal, lamb, fish, turkey, beans, peas, tofu, peanut butter, soy milk*
>10 - 15	Whole egg, nuts, cream & soft cheese, navy & garbanzo beans,
>15	Seeds, cheddar & hard cheese, sour cream, yogurt, milk

***P:Protein Ratio**

Challenges:

- Charts are not consistent
- May or may not take into account the bioavailability of P
- Data isn't available for all foods
- Hard for patients to calculate

***Phosphate Education Program**

- Kuhlmann et al., 2007
- 1 P Unit = 100 mg P/serving
- Patients were trained with photo cards
- Estimate P content of foods and adjust P binder dose accordingly
- Serum P control improved

*Phosphate Education Program

Challenges:

- P content not easily available
- Hard to estimate the impact of P additives
- Patients may stop trying to limit P intake
- Teens

*The Vegetarian Diet

- Moe et al., 2010
- Compared vegetarian grain & soy based diet vs. a meat/dairy based diet
- Similar in calories, protein, calcium, phosphate and sodium content
- Randomly assigned subjects had CKD 3-4, normal P

*The Vegetarian Diet

The findings:

- Replacing meat protein with plant protein can lower serum P, urinary P excretion and decrease FGF-23
- Recommended at least 1 vegetarian meal per day

*The Vegetarian Diet



Challenges:

- Unknown impact of milling, soaking & sprouting and other changes in food manufacturing processes
- Unknown impact of probiotics
- Potassium content
- Kids

*Avoiding P Additives

- Sullivan et al., 2009
- 279 subjects with baseline serum P>5.5 mg/dL
- Intervention group of 145 received education on avoiding P additives
- After 3 mos. this group had 0.6 mg/dL greater decline in P compared to control group

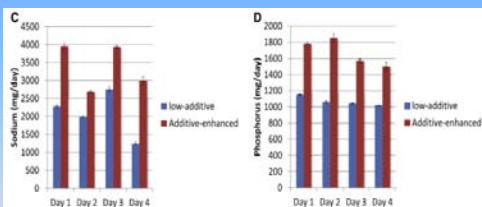
*Avoiding P Additives

- Carrigan et al.2014
- Compared the measured P in a low additive diet and an additive-enhanced diet of similar food items

* Avoiding P Additives


Low Additive	Additive-Enhanced
Tilapia (4 oz)	Canned salmon (2.8oz)
White Rice (4.4 oz)	White Rice (8.8 oz)
Butter (5 g)	Butter (10 g)
Fresh carrots (1 cup)	Canned carrots (1 cup)
Iceberg lettuce	Iceberg lettuce
Olive oil (2 Tbsp)	Olive oil (2 Tbsp)
Cider vinegar (1 Tbsp)	Cider vinegar (1 Tbsp)
Organic white roll (1)	Frozen biscuit (1)
Jell-O (4 oz)	Jell-O

* Avoiding P Additives



* Avoiding P Additives


- Authors estimated that clearing the extra P from additives would require:
 - +18 calcium acetate/day
 - +23 sevelamer HCl/day
 - +5 lanthanum carbonate/day
 - or +12 hours HD/week



Challenges:

- Patients have to READ fine print
- Additives are abundant in cheap, processed and fast foods
- Patients have to know how to cook

***Cooking Modalities**



- Vrdoljak et al., 2015
- Examined how thermal processing methods affecting the protein, calcium and P content of food
 - Boiling in water (100 C)
 - Steaming (100 C)
 - Frying in oil (170 C)
 - Roasting (air 180 C)
 - Stewing in oil (100 C) with water

***Cooking Modalities**

- Boiling in water and stewing in oil reduced P content the most
- Protein content of the food was preserved
- Soaking meat for 1 hour in cold water further reduced P

*Cooking Modalities

- Similar studies found P reduction of foods by boiling
 - 51% reduction for vegetables
 - 48% reduction for legumes
 - 38% reduction for meats

*The Phosphate Pyramid

♦ D'Alessandro et al., 2015



*The Phosphate Pyramid

Level	Foods included	Frequency
6	Colas, processed meats and cheeses, foods with P additives	avoid
5	nuts, egg yolk, hard cheeses	2-3/month
4	turkey, organ meats, shrimp, squid, salmon, soft cheeses	1/week
3	lamb, rabbit, ham, some wild fish, milk, yogurt	1/day
2	Cereals, legumes, pasta, rice	2-3/day
1	Sugar, olive oil, fruit, vegetable, egg whites	unlimited

Challenges:

- Not yet validated as a teaching tool
- Cultural specificity
- Frequency of consumption may be difficult to remember

* **One Last Study..**

- Jiang et al, 2015
- 97 PD patients with elevated serum P
- 48 patients in the intervention group
- Both groups received P binders

* **One Last Study..**

Intervention group taught to:

- Reduce intake of foods with high P:protein ratio
- Avoid P additives
- Cook by boiling or stewing
- Soak meats for 1 hour prior to cooking

***One Last Study...**

Subjects *excluded* based on:

- Malnutrition
- Poor education level
- Limited amount of time
- Poor family support

***The take away...**

- Choose plant based proteins, at least for 1 meal per day
- Boil foods, especially meats
- Avoid P additives
- Encourage foods with a low P:Protein ratio
- Adjust P binders based on the meal

- MDs - be aware of P additives in prescription meds
- RDs - collaborate, share ideas and materials, publish successful efforts