Hidden Phosphorus: It's Impact on the Renal and General Populations

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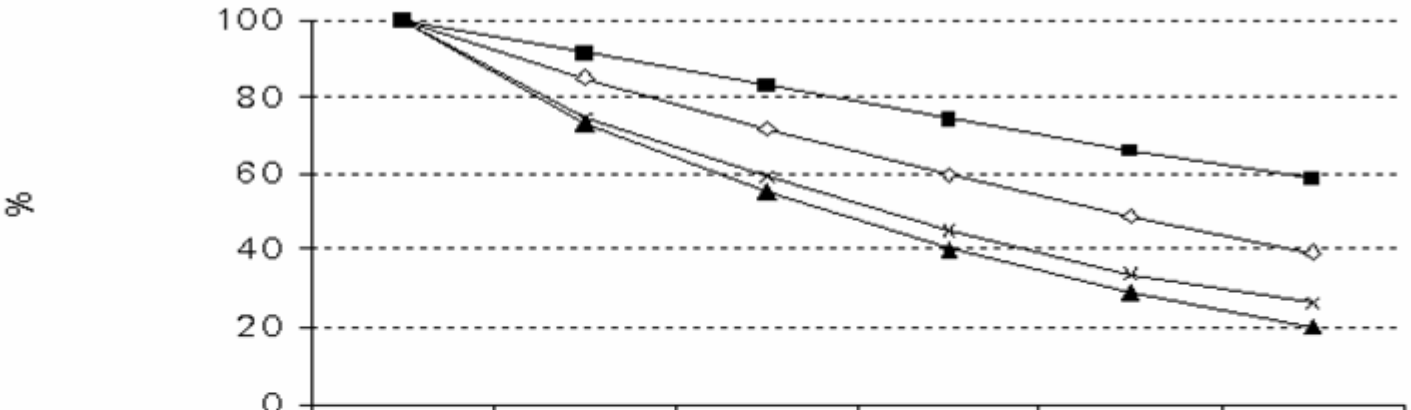
Today's Discussion

- Discuss the consequences of hyperphosphatemia in the general and Chronic Kidney (CKD) population
- Identify the uses for phosphate additives in foods and the foods containing phosphate additives
- Suggest ways to improve phosphate control.
- Introduce the concept of the Kidney Friendly shelf

Unadjusted 5-Yr Survival in ESRD Pts on Dialysis (1995-1999)

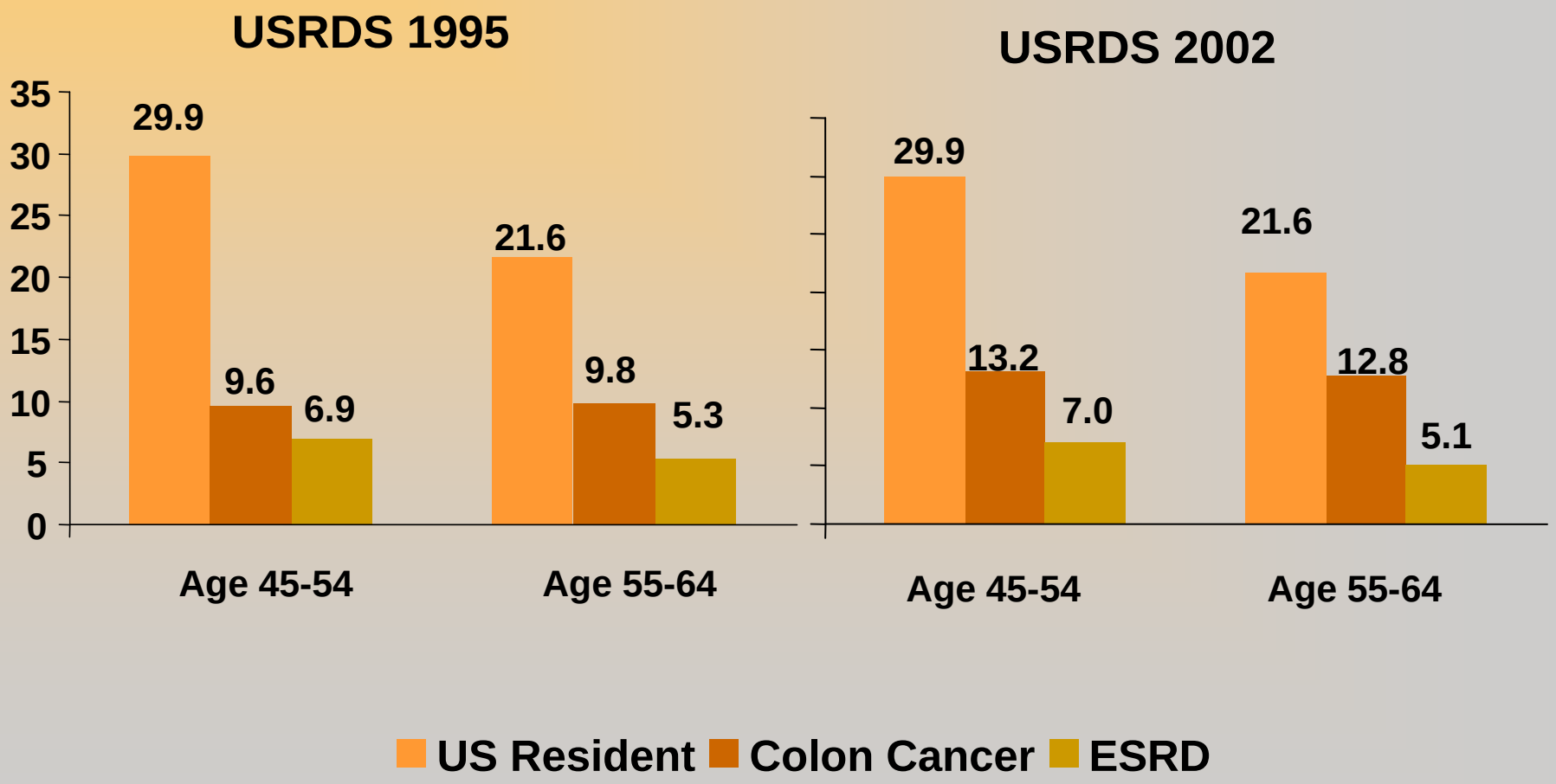


	Baseline	1 Year	2 Years	3 Years	4 Years	5 Years
18–65 Years Diabetic	100.0	84.6	72.0	59.8	49.1	39.7
18–65 Years Non-Diabetic	100.0	91.2	82.8	74.5	65.8	58.7
65 + Years Diabetic	100.0	72.8	55.3	40.1	29.1	20.2
65 + Years Non-Diabetic	100.0	74.3	58.9	45.0	34.0	26.3

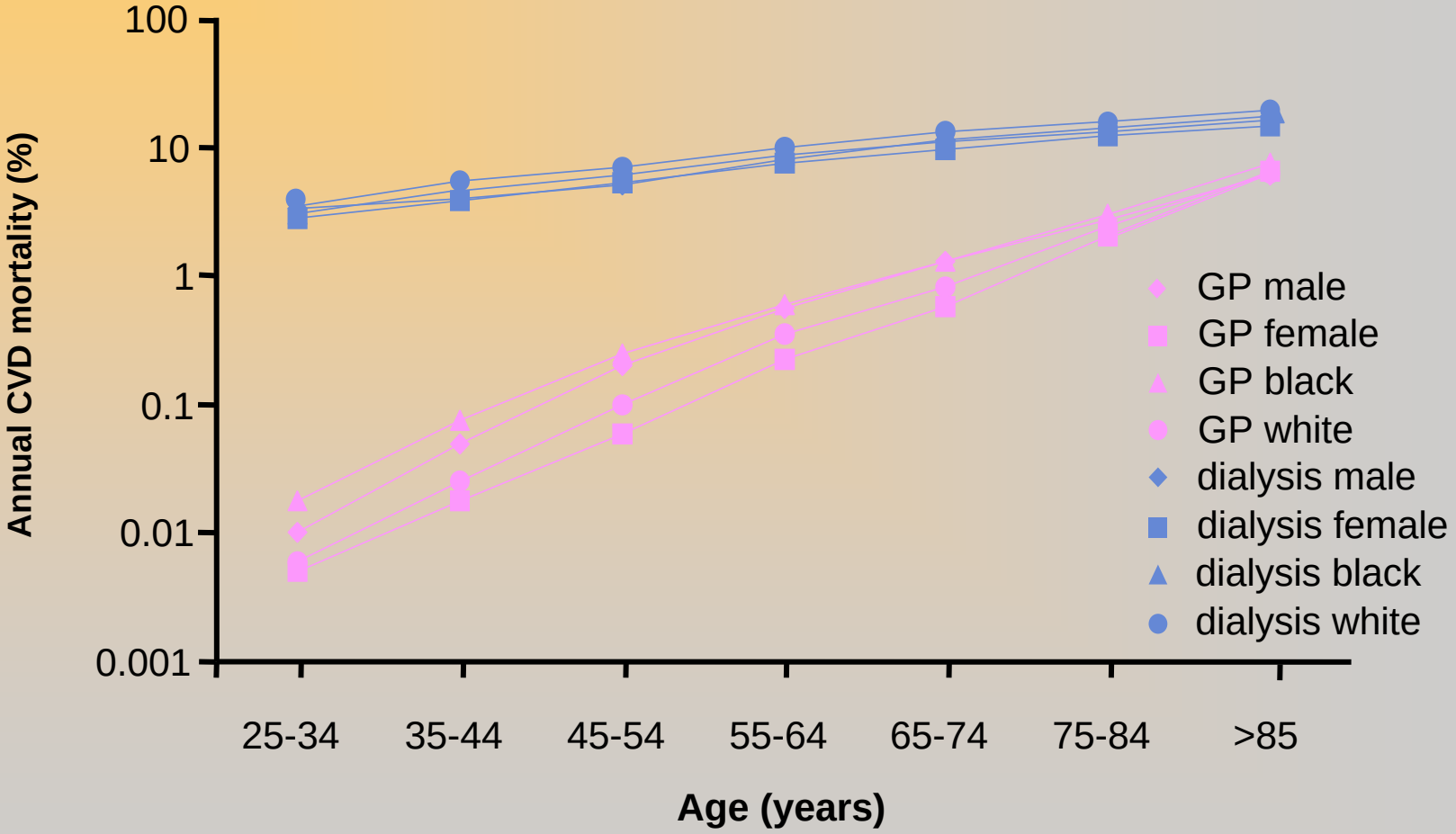
Survival Time

Source: Canadian Organ Replacement Register, CIHI.

Expected Remaining Lifetimes (years)



Cardiovascular Disease (CVD) Mortality General Population vs ESRD Patients



GP=general population

Foley RN, Parfrey PS, Sarnak MJ. Am J Kidney Dis 1998;32:S112-S119

Cardiovascular Calcification in Stage 5 Chronic Kidney Disease Patients on Dialysis

Identification, Prevalence and Outcomes

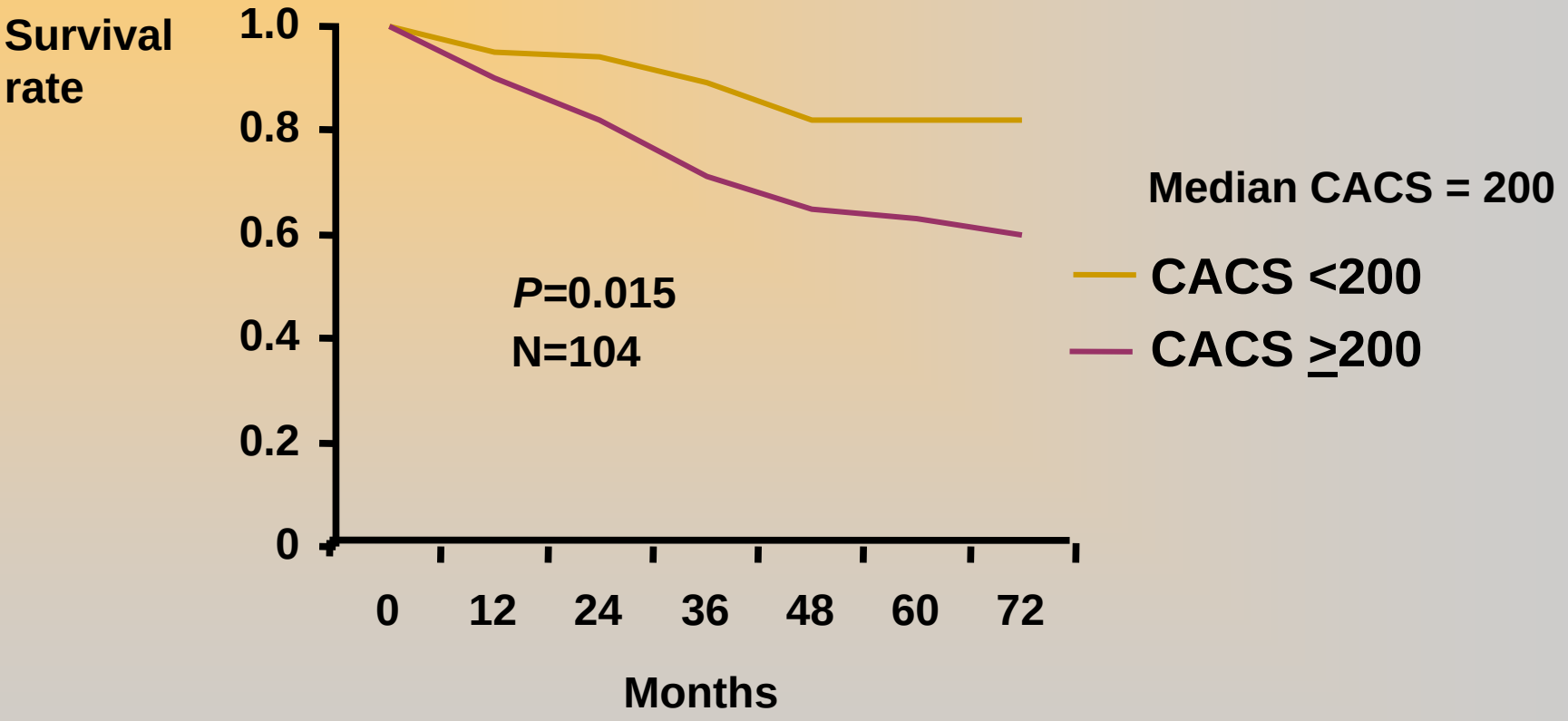
EBCT Scores and Cardiovascular Risk in the General Population

EBCT Score	Plaque Burden	Implication for CV Risk	Recommendations
<10	Minimal	Low	Reassurance, education
11-100	Definite, mild	Moderate	Counseling for primary prevention; daily ASA
101-400	Definite, moderate	Moderately high	Institute risk factor modification and secondary prevention
>400	Extensive	High	Institute aggressive risk factor modification

EBCT=Electron Beam Computed Tomography
CV=Cardiovascular

Rumberger JA, Brundage BH, Rader DJ, Kondos G. *Mayo Clin Proc*. 1999;74:243-252.

Coronary Artery Calcification Score and Survival in Chronic Hemodialysis



CACS=Coronary Artery Calcification Score

Matsuoka M, Iseki K, Tamashiro M, et al. *Clin Exp Nephrol*. 2004;8:54-58.

Cardiac Calcification in Adult Hemodialysis Patients

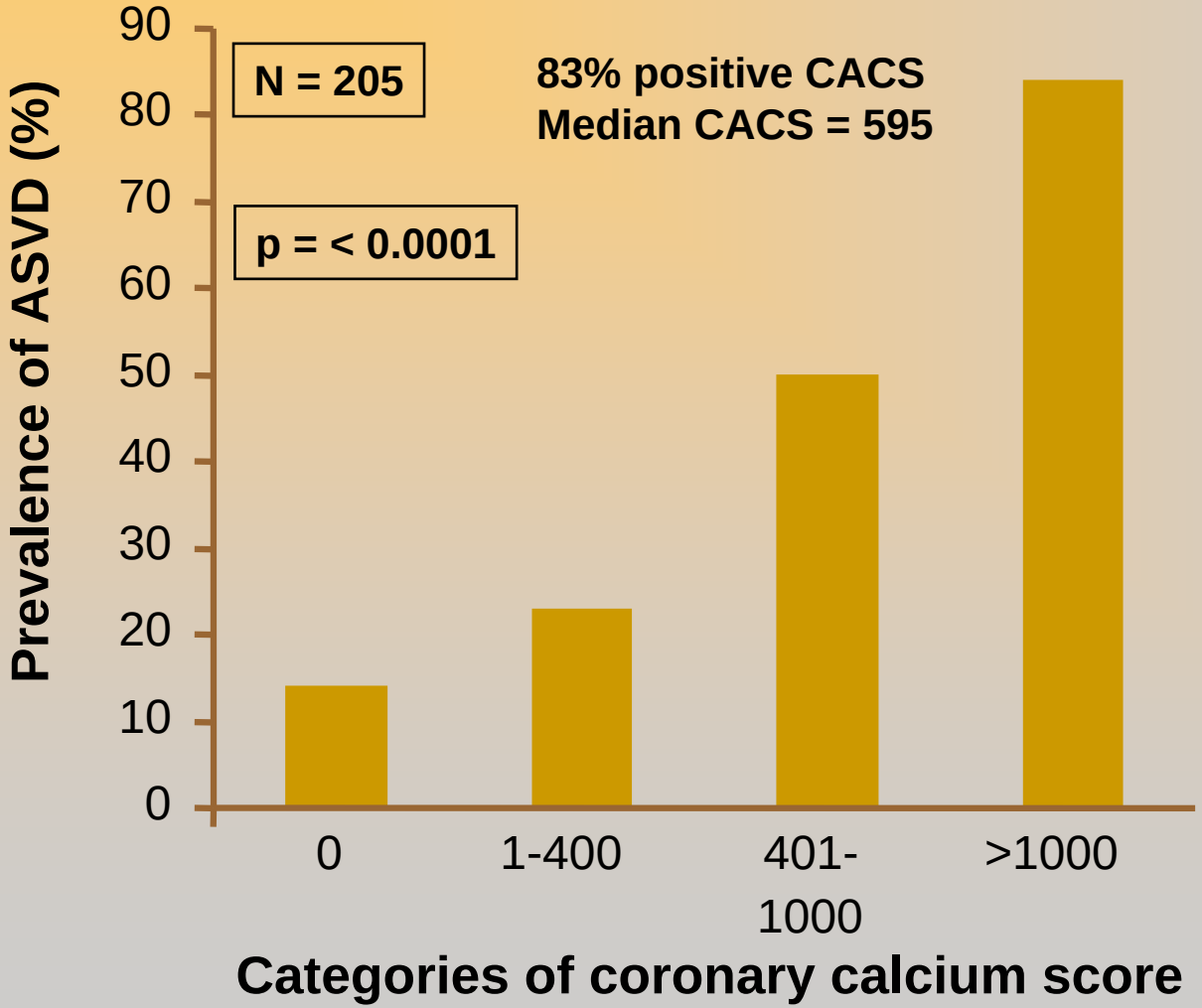
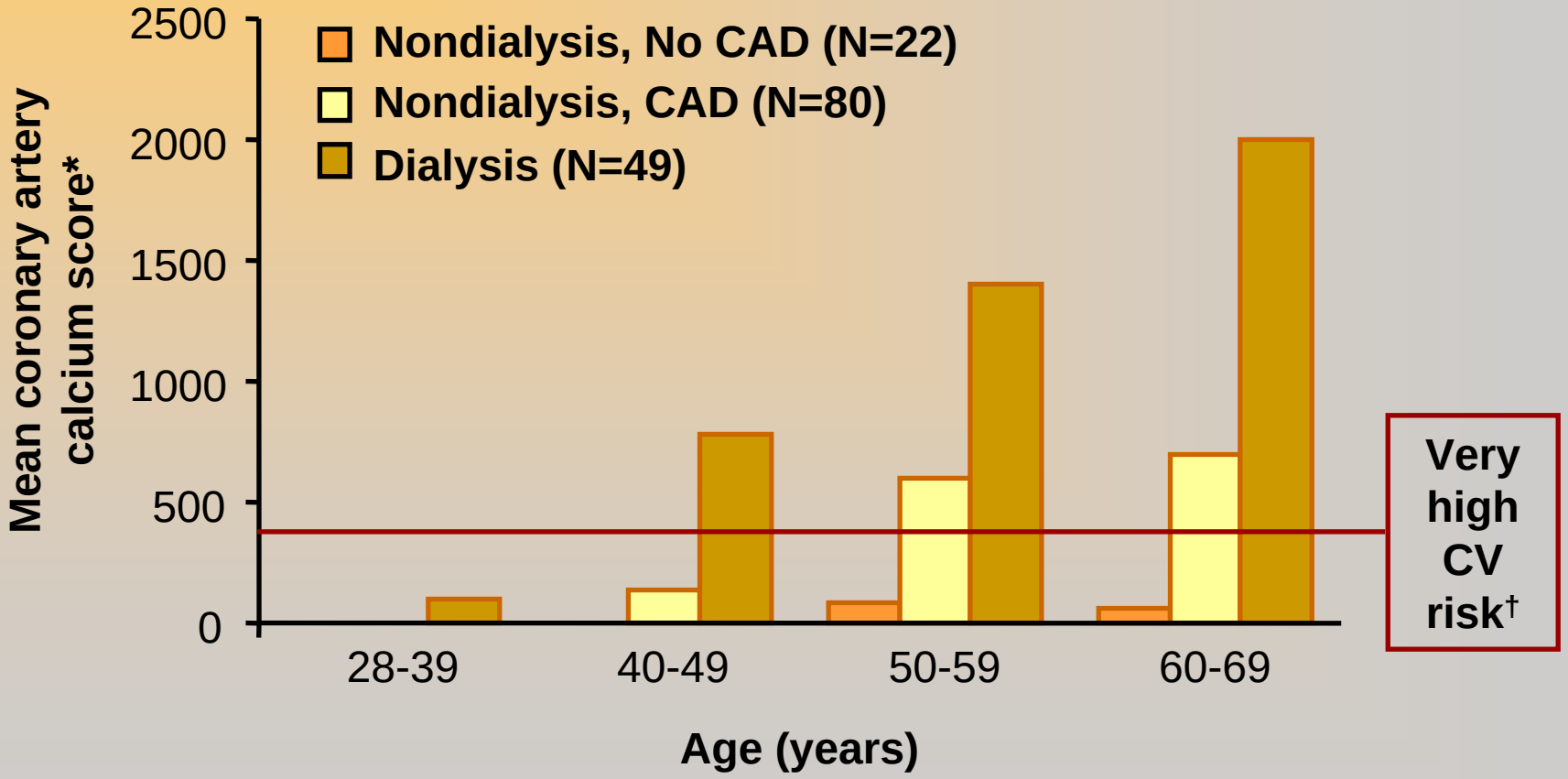


Figure 2.
The prevalence of atherosclerotic vascular disease by coronary artery calcium score category

ASVD = atherosclerotic vascular disease

Raggi P, Boulay A, Chasan-Taber S et al. J Am Coll Card 2002;39: 695-701

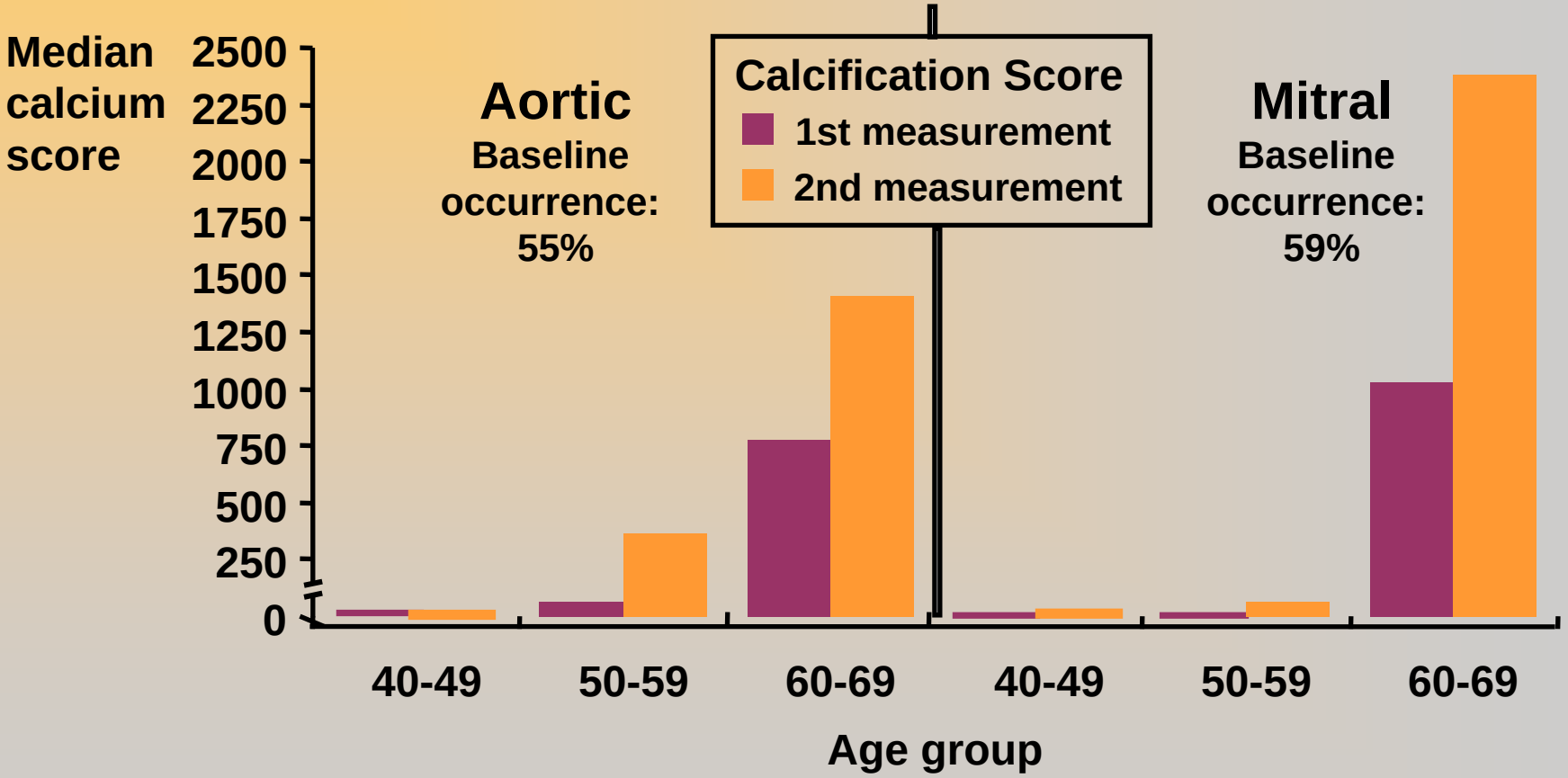
Risk of Cardiovascular Calcification is Increased in Dialysis Patients



***Determined by EBT**
CAD=coronary artery disease

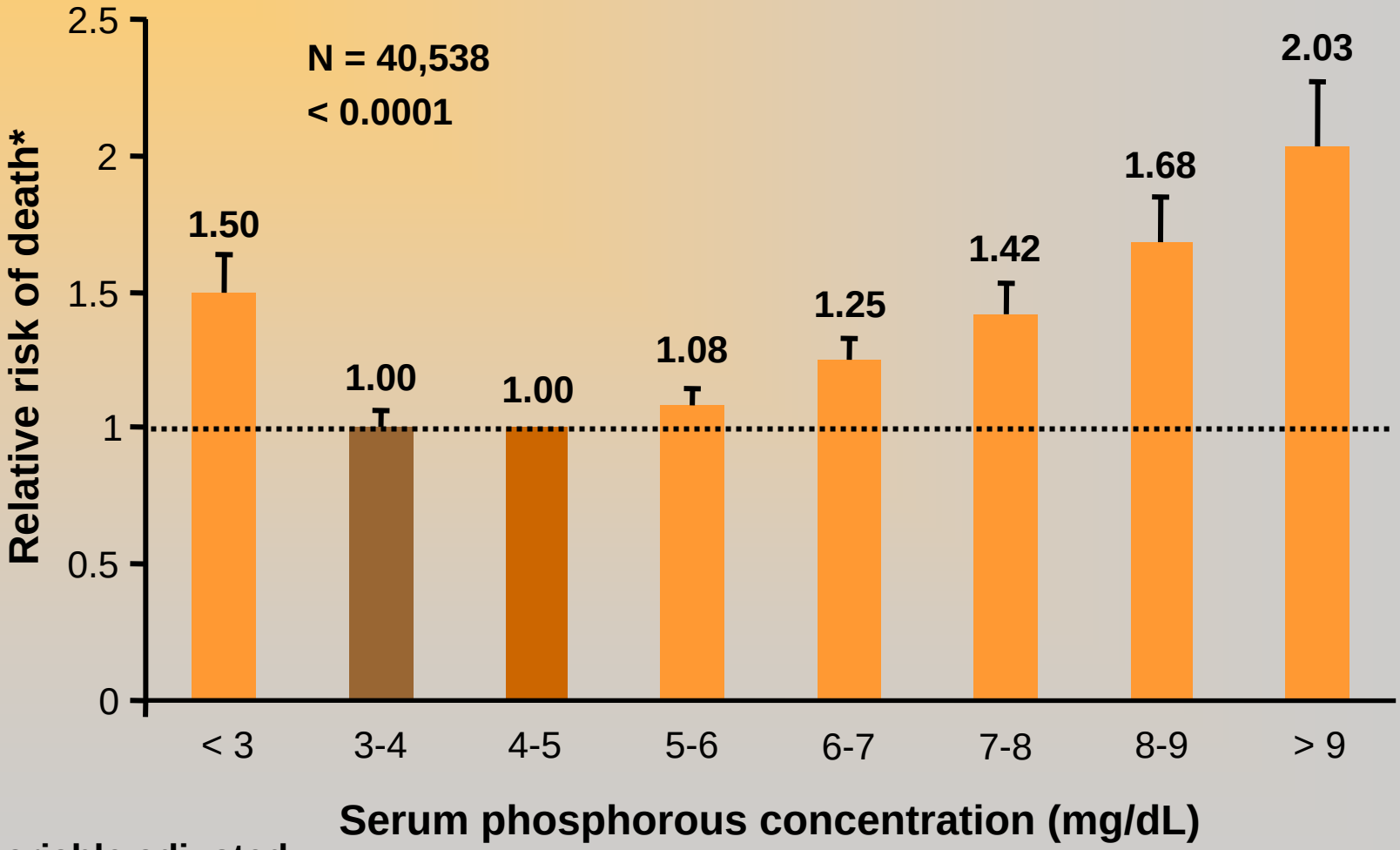
†Rumberger JA et al. Mayo Clin Proc 1999;74:243-252
Braun J et al. Am J Kidney Dis 1996;27:394-401

Rapid (<1Year) Progression of Valvular Calcification in Dialysis Patients



Adapted from Braun J, Oldendorf M, Moshage W, Heidler R, Zeitler E,Luft FC. *Am J Kidney Dis*. 1996;27:394-401.

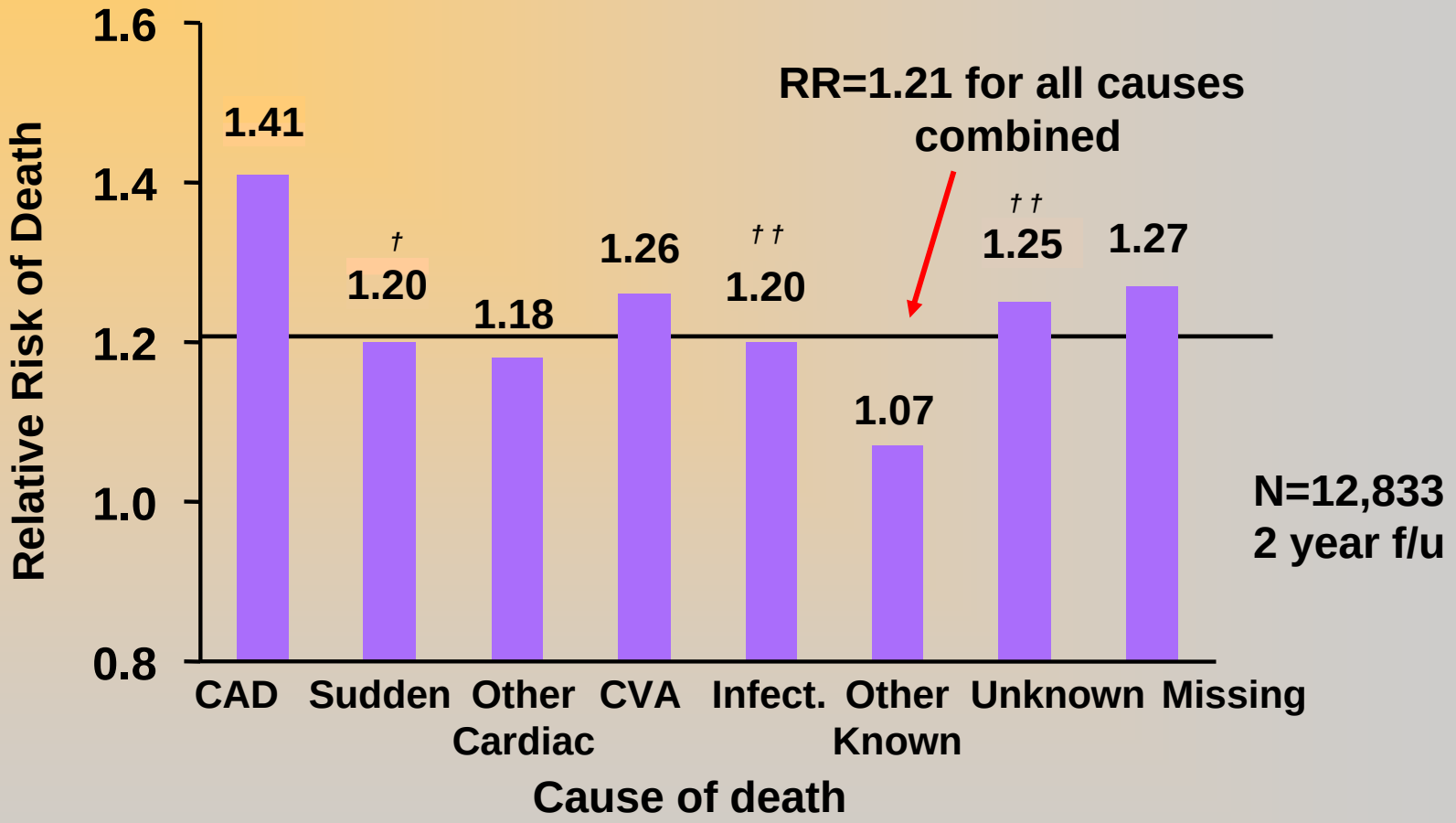
Elevated Serum Phosphorus Increases Mortality Risk



*Multivariable adjusted

Block G, Klassen PS, Lazarus JM et al. J Am Soc Nephrol 2004;15:2208-2218

Association of Elevated Serum PO_4 with Cardiac Mortality Risk in Chronic Hemodialysis Patients



*P<0.0005; †P<0.005; ††P<0.05 compared with RR of 1.0
CAD=coronary artery disease; CVA=cerebrovascular accident
RR=relative risk of mortality (for serum PO_4>6.5 mg/dL vs. 2.4-6.5 mg/dL; eight Cox models)

Ganesh SK, Stack AG, Levin NW, Hulbert-Shearon T, Port FK. *J Am Soc Nephrol*. 2001;12:2131-2138.

Current Strategies for PO4 control

- **Phosphate binders**
  - Aluminum based
  - Calcium based
  - Lanthanum carbonate
  - Sevelamer hydrochloride

- **Education:**
  - Avoid high phosphorus foods: dairy, legumes, nuts, cola, “pepper” style beverages
  - Choose low PO4 protein sources

Phosphate Salt Additives

Common Phosphate Additives

- **Phosphoric Acid**
  - Beverages
- **Calcium Phosphate**
  - Calcium supplement
- **Sodium Phosphate**
  - Polyphosphates have many uses

Phosphate Salt Additives

- **Stabilizer**
  - Adjusts pH: buffer and acid
  - Emulisfies
- **Protectant**
  - Flavor
  - Color
  - Spoilage
  - Product integrity
  - Prevents and promotes coagulation

Phosphate Salt Additives

- **Leavening agent**
- **Conditioner**
  - Meltability and pliability
- **Enhancer**
  - Flavor
    - Distinctive flavors associated with a brand
  - Color

Phosphate Salt Additives

- **Tenderizer**
- **Supplement**
  - Calcium, Phosphorus, Magnesium

Food Sources

- Beverages: canned and plastic-bottled iced teas, fruit drinks, punch drinks, flavored waters, bottled lemonade
- Restructured meats: chicken patties/nuggets
- “Instant” products: sauces and puddings
- Refrigerated bakery products
- Breakfast cereals and breakfast bars
- Enhanced meat products

Phosphate Additives Impact on the Renal Population

- **Additives are HIGHLY absorbable**
  - Normal diet only 60% of PO4 is absorbed
  - Additives are close to 100% absorbed
- **Increased need for binders**
  - Diet high in PO4 additives, more PO4 absorbed
- **Limits food choices**

Strategies for PO4 control: Phosphate Load

- **Binder dosing**
  - Based on Serum level or phosphate load?
  - Individualized for meals?
- **Better control with calculating phosphate load and individualizing binder needs/ meal**

Strategies for PO4 control: Phosphate Load

- Binder capacity:
  - **CaCO3**
    - 39 mg PO4/1 gm CaCO3
  - **CaAcetate**
    - 45 mg PO4/1 gm CaAcetate
  - **Mg**
    - Unknown
  - **Al**
    - 22.3 mg PO4/5 ml
  - **Sevelamer**
    - 64 mg PO4/800 mg
  - **Lanthanum Carbonate**

KDOQI Guidelines for Bone Metabolism and Disease. Table 22

Strategies for PO4 control: Education

- READ LABLES!
- “Do Not Buy” Poster
- Detailed Diet Recalls: Include where food is purchased and brands used.
- Grassroots effort to bring more attention to Kidney Friendly foods and the “Kidney Friendly Shelf”

The Kidney Friendly Shelf

- Grassroots effort started by Dr. William Pordy and other nephrologist to bring “Kidney Friendly” food to the millions who have CKD
- Had advantage to both the consumer and the grocer
- Increase demand in Kidney Friendly foods may help reduce PO4 additive containing foods

Strategies for PO4 Control: Dialysis

- Average HD session removes 800 mg PO4
- Daily dialysis increases PO4 removal
- Nocturnal Dialysis remove the most PO4 with the need for additional PO4 supplementation

Alterations in Ca:P ratio in the General Population

Effect of Phosphorus on the General Population

- 1988:
  MS Calvo, R Kumar, H Heath 3rd
  - 1st study : 8 men, 8 women
  - 8 days of 820 mg Ca, 930 mg P diet
  - Test diet: 420 mg Ca, 1660 mg P
  - Used common grocery store foods
  - RESULTS: For test diet: increase in PTH, PO4, plasma 1,25-dihydroxyvitamin D, and urinary hydroxyproline.

Effect of Phosphorus on the General Population

- 1990:
  MS Calvo, R Kumar, H Heath 3rd
  - 2nd study: 15 young women
  - Basal diet: 800 mg Ca, 900 mg P for 28 days
  - 10 Test diet:400 mg Ca, 1700 mg PO4 for 28 days
  - RESULTS: significant increase in PTH levels of Test diet subjects.

Effects on the General Population

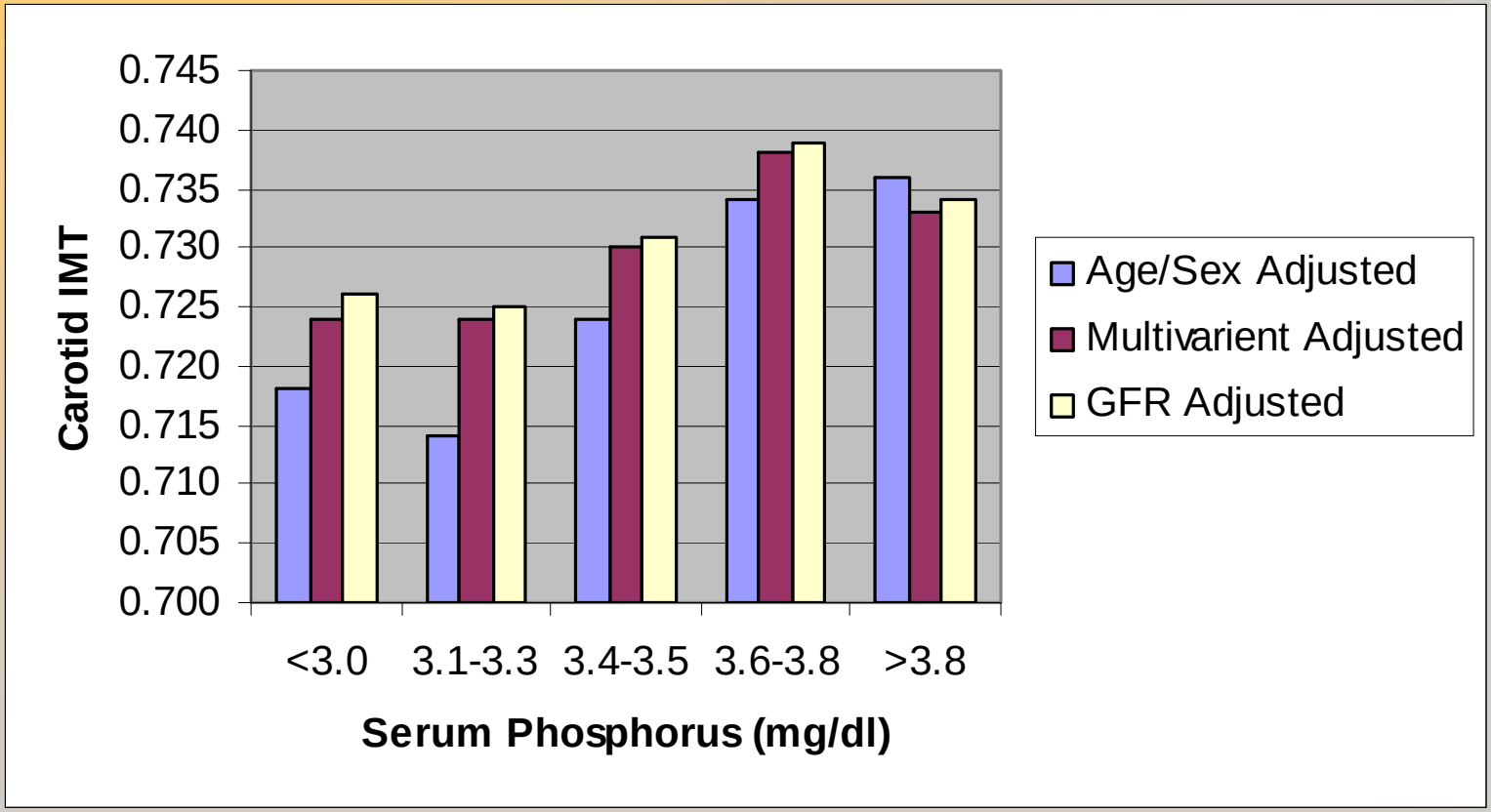
- Stephen Onufrak, et al, Phosphorus levels are associated with subclinical atherosclerosis in the general population, Atherosclerosis (2007)

- Analyzed data from Atherosclerosis Research in Community (ARIC) study to investigate relationship between serum P levels and carotid intima-media thickness (cIMT)

Subclinical Atherosclerosis

- Subjects 45-64 years of age from 4 regions of US between 1987-1989
- In this analysis, 10,688 subjects with normal renal fxn and dietary intake data
- Prior studies have shown that as cIMT increases, the risks for MI and stroke also increase

Carotid Intima-media Thickness



Conclusions

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- Phosphorus is not only a problem for the Renal population, but there is growing evidence that alterations in C:P intake may also cause long term problems in the general population
- The increase use of phosphate additives makes it harder for the patient and clinician to know which foods to limit in the renal population and increases the general population's exposure to excess phosphorus

Conclusions

- Strategies for improving PO4 control incorporate all of the healthcare team
  - Detailed diet recalls
  - Adjusting binder dose for PO4 load
  - Utilizing the multiple binders if necessary
  - Increasing the frequency of dialysis if necessary

Conclusions

- Not enough can be said about reading labels!!

QUESTIONS?