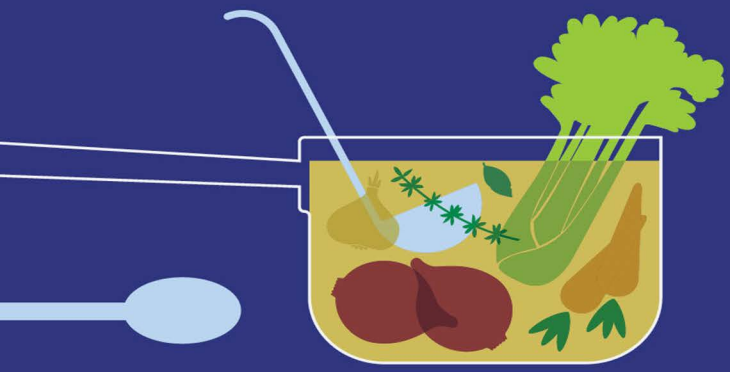
NKD

national kidney diet

Professional Guide

Third Edition



Academy of Nutrition and Dietetics Renal Dietitians Dietetic Practice Group

National Kidney Foundation Council on Renal Nutrition

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Introduction

Chronic kidney disease (CKD) is widespread in the United States, with approximately 37 million Americans living with CKD.[1] Kidney disease can arise from a variety of etiologies, such as polycystic kidney disease, lupus, nonsteroidal anti-inflammatory drug use, contrast dye, and glomerular diseases. The leading causes of CKD are diabetes mellitus (DM) and hypertension (HTN).

It is estimated that only 12% of those with HTN and DM are aware that they have CKD.[1] An emphasis has been placed on disease prevention in recent years with a 2019 Executive Order on Advancing American Kidney Health aimed to increase CKD awareness and encourage preventive measures to help slow CKD progression to end stage kidney disease. Dietitians play a key role in providing education on preventative measures for helping slow disease progression and should be well informed on nutritional considerations for those noted with a decline in kidney function.

Medical nutrition therapy (MNT) is an essential component in managing CKD. MNT can help prevent CKD progression and assist in preventing complications that can arise, such as mineral and bone disorders, dyskalemia, metabolic acidosis, and malnutrition, within any stage of CKD.[2] See Table 1.1 for the stages of CKD based on glomerular filtration rate.[3]

How to Use the National Kidney Diet Professional Guide and Handouts

Chapter 1 provides the foundational patient-education lens through which we recommend remaining chapters to be viewed. Please make time to read and refer to this chapter often. Chapter 2 presents an overview of crucial nutrients to assess for all stages of CKD. Chapters 3-5 provide further details on the management of each specific stage of CKD including in-center and home dialysis. Chapters 6-8 cover special topics such as renal supportive care, renal transplant nutrition, and diabetes and CKD comanagement. Finally, additional information is provided on nutrition diagnosis terminology and insurance coverage and reimbursement related to CKD.

Table 1.1 Stages of Chronic Kidney Disease[3]

Stage	Glomerular filtration rate (mL/min/1.73 m^2)	Description
1	≥90	Kidney damage with normal or increased glomerular filtration rate (GFR)
2	60-89	Mild decrease in GFR
3a	45-59	Mild-to-moderate decrease in GFR
3b	30-44	Moderate-to-severe decrease in GFR
4	15-29	Severe decrease in GFR
5	<15	Kidney failure

Several downloadable patient education materials have also been developed to allow individualized education for each patient:

- *Nutrition Tips for Chronic Kidney Disease (for People Not on Dialysis)* (provides an overview of information on diet for people with CKD, and is a great starting point when educating new patients)
- *Nutrition for Dialysis* (provides a summary of tips that address the specific nutrition needs of people on dialysis)
- *The Food Label and Chronic Kidney Disease* (addresses each section of the Nutrition Facts label as it relates to CKD, with tips for sodium, potassium, and phosphorus)
- *Grocery Guide for Kidney Disease* (includes a list of foods appropriate for patients with CKD)
- *Potassium Fruit and Vegetable Lists* (offers colorful pictorial lists of low- and high-potassium fruits and vegetables)
- *Taking Control of Phosphorus* (presents in-depth instructions on reading food labels for phosphorus, lists of high phosphorus foods, and appropriate substitutes)

- *Your New Protein Needs (for People Not on Dialysis)* (reviews animal vs plant-based protein sources, approximate protein content of common foods, and label-reading instructions)
- *Resources for Patients with Chronic Kidney Disease* (provides information on how to find a kidney-friendly RDN, as well as resources directing the reader to CKD-appropriate recipes, educational websites, and smartphone apps)

These handouts align with the updated KDOQI nutrition guidelines and are tailored with positive messaging that teaches patients about healthy foods that they can enjoy while meeting their nutrition needs for kidney disease. Additional National Kidney Diet patient education materials available at the Academy of Nutrition and Dietetics online store (www.eatrightstore.org) include Dish Up a Kidney-Friendly Meal For Patients with Chronic Kidney Disease (Not on Dialysis) and Dish Up a Dialysis-Friendly Meal for Patients with Chronic Kidney Disease on Dialysis. These two placemat-sized double-sided tear pads offer patient-friendly meal-planning advice, practical nutrition tips, positive messaging, and extensive lists of foods offering greater variety for patients.

References

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Chapter 1

The Education Process: Listening to and Talking *With* our Patients

Registered dietitian nutritionists (RDNs) practicing in all stages of chronic kidney disease (CKD) or transplant are uniquely positioned to actively listen to the patient and family, facilitate impactful nutrition counseling, and offer suggestions for lasting change and improved patient outcomes. These techniques are founded in motivational interviewing and are proven to be more effective than giving advice alone.[1] Recent research also finds that **for the best patient health outcomes, we align dynamic listening, thoughtful questions, and a focus on knowing the patient and family first,** before launching into education sharing.[2] And although we lean on the transtheoretical model or "Stages of Change" to mark the progress of our patient(s), it is important to remember that "change is not a linear progression through the stages; rather, most clients move through the stages of change in a spiral pattern."[3]

In this chapter, you will find examples of motivational interviewing-style questions that focus on active listening and especially on **eliciting the patient's feedback and their own motivation.** By using these types of questions and finding that the patient is willing to be engaged, you can then tailor what was gleaned from the interview session and can assist your patient in forming "patient-identified nutrition goals"[4] (or at least, a few, manageable daily objectives for healthy eating). As with any information exchange, using teach-back questions to assess information learned is an essential component of the patient's success (and yours too) and for any follow-up encounters.

Note: For those who may see a patient only once, it may be beneficial to provide them with resources for the future. Downloadable patient handouts available with this book include ways to meet with (or find) an RDN websites that promote kidney-friendly nutrition advice, and recipes for meals and snacks.

Counseling Tips

The following tips are useful during a nutrition counseling session:

1. Request permission to discuss a topic.
2. Use open-ended questions and understand readiness-to-change behavior.
3. Allow the **patient to be the teacher** (while you be the curious **listener**).
4. Assure the patient that ongoing support is available and offer further support targeted to the patient's level of readiness to change.
5. Assess the encounter by using teach-back methods.

Sample Questions

The following groups of sample questions can be used to elicit patient feedback, assess motivation, and determine readiness to change.

Introductory Permission Inquiry

"Would you mind spending just a few minutes talking about _____ and how you see it affecting your health?"

- what it is like going grocery shopping
- your ability to access nourishing foods
- eating fast food or going out with friends for food or drinks
- having to make dinner or meals for yourself or others, or how to cook in general

"When we talk about 'eating well,' can you tell me what is important to you?"

"How ready are you to change or modify your habit of _____?"

- ordering a better side dish with your meal?
- snacking after dinner?
- buying different types of foods?

Tip	Use something the patient has shared and ask if they are willing to amend the item or start a new habit.

"You've told me your _____ level is not in goal range. What does this mean to you?"

If the Patient is *Not Ready* to Change

"What might you want to know more about regarding _____?"

"What would it take to get you to think about a change in _____?"

> **Tip** If the patient has declined or avoided sharing many details, be mindful of their verbal and nonverbal feedback and cues, and respect the patient's wishes to not engage in further conversation. Do follow-up, if you are able, and employ the introductory permission questions again to ascertain readiness level.

If the Patient is *Unsure* About Change

"What are the good things you like about _____ (vegetables, fruit, whole grains, cooking for yourself, etc.)?"

"What does _____ (eating healthy, cooking at home, exercise, etc.) do for you?"

If the Patient is *Ready* to Change

"Here are some options for change (list options). What do you think would work best for you?"

"How do you see yourself starting these new habits or making these new choices?"

Examples of Teach-Back Questions

"Using your own words, can you share with me what you understood from our conversation?"

"How would you explain this information to your family members who couldn't be here today?"

Types of Change Talk

Box 1.1 reviews six kinds of *change talk* patients may verbalize in the context of motivational interviewing. You can use these statements to identify where in the process a patient might be on any given aspect of their goals and objectives.[5] Note that patients might be ready to change one behavior for the better, but in another area, they may still only have minimal desire to change.

Box 1.1 Six Kinds of Change Talk[5]

Desire	Statements about preference for change: • I *want* to … • I would *like* to … • I *wish* …
Ability	Statements about capability: • I could … • I can … • I might be able to …
Reasons	Specific arguments for change: • I would probably feel better if I … • I need to have more energy to play with my kids.
Need	Statements about feeling obliged to change: • I *ought* to … • I *have* to … • I really *should* …
Commitment	Statements about the likelihood of change: • I am *going* to … • I *will* … • I *intend* to…
Taking Steps	Statements about action taken: • I actually went out and … • This week I started …

Figure 1.1 reviews steps in motivational interviewing. Pay attention to the flow—it usually reveals that the patient has all four components before moving to the commitment stage and ultimately the change stage.[5]

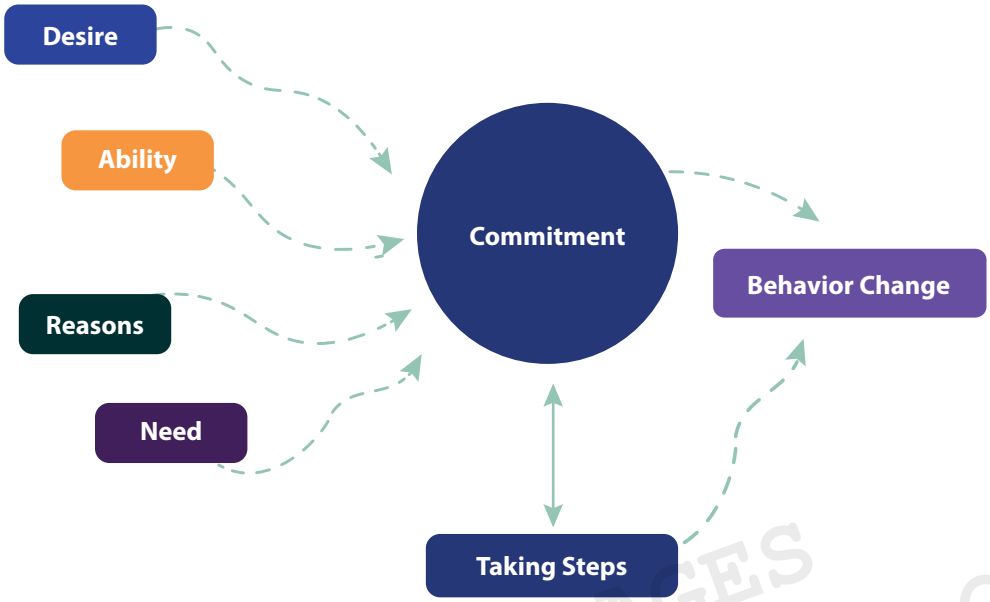

Figure 1.1 Practicing Motivational Interviewing[5]

Sample Questions

The following are additional sample questions you can use based on the types of change talk outlined above.[5]

"Why would you want to ____?" (desire)

- quit smoking
- eat healthy
- cook with herbs
- go for a walk

"How would you do it, if you decided to _____?" (ability)

- focus on eating well
- take medications as your doctor recommends

"What are the three best reasons, for you, to ____?" (reasons)

- snack on veggies and hummus
- cook at home more often
- select plant-based protein options

"How important is it for you to ____ ?" (need)

- take medications as directed
- eat healthy

Summary

RDNs are here to help patients and meet them where they are in the change process. Success is not defined by the handouts we give or the knowledge we attempt to impart, but rather by whether the patient felt truly heard. As we consider the diverse backgrounds and unique attributes that each patient brings, our ability to be culturally competent partners will allow for an inclusive and supportive change environment.

Further information on the above-mentioned strategies, tools, and question types can be found at the Academy of Nutrition and Dietetics Evidence Analysis Library.[6]

References

1. Rubak S, Sandbaek A, Lauritzen T, Christensen B. Motivational interviewing: A systematic review and meta-analysis. *Br J Gen Pract.* 2005;55(513):305-312.
2. VanBuskirk KA, Wetherell JL. Motivational interviewing used in primary care populations: a systematic review and meta-analysis. *J Behav Med.* 2014;37(4):768-780. doi:10.1007/s10865-013-9527-4
3. Prochaska JO, Norcross JC, Diclemente CC. Applying the stages of change. *Psychother Aust.* 2013;19:10-15.
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Chapter 2

Assessment of Nutrient Needs in Chronic Kidney Disease

Chapter 2 provides an overview of crucial nutrients and their recommendations in all stages of chronic kidney disease (CKD). Table 2.1 presents a summary of nutrition needs across the stages of CKD.[1,2] The subsequent chapters provide further details specific to the management and treatment of each stage of CKD.

Table 2.1 Nutrient Recommendations for Chronic Kidney Disease[1,2]

Nutrient	CKD Stages 1-5	In-Center Dialysis	Home Dialysis
Calories	25-35 kcal/kg LPD and VLPD may need at least 30 kcal/kg	25-35 kcal/kg	PD: 25-35 kcal/kg minus calories from the dialysate SDHD and NHD: 25-35 kcal/kg
Protein	CKD 1-2 (GFR >60): 0.8 g/kg CKD 3-5 with DM: 0.6-0.8 g/kg CKD 3-5 without DM (GFR <60): LPD 0.55-0.6 g/kg or VLPD 0.28-0.43 g/kg + KA	1.0-1.2 g/kg	
Sodium	<2,300 mg/day or <100 mmol/day		

Nutrient	CKD Stages 1-5	In-Center Dialysis	Home Dialysis
Potassium	Individualized to maintain serum levels within goal range; assess and correct nondietary causes while determining the need to adjust dietary potassium intake.		
Phosphorus	Individualized to maintain serum levels within goal range. Consider the bioavailability of phosphorus sources.		PD and SDHD: Same as earlier CKD stages. NHD: Usually not restricted; may need to be supplemented.
Calcium	800-1,000 mg/day or 20-25 mmol/day, if not taking active vitamin D analogs.	Adjust calcium intake (dietary calcium, calcium supplements, or calcium-based binders) with consideration of concurrent use of vitamin D analogs and calcimimetics to avoid hypercalcemia or calcium overload.	
Vitamin D	Consider vitamin D2 or D3 supplement to correct 25(OH)D insufficiency or deficiency. For nephrotic range proteinuria, it is reasonable to consider supplementation of vitamin D.	Consider vitamin D2 or D3 supplement to correct insufficient or deficient levels.	
Fluid	Individualized based on fluid status.	500-1,000 mL/day plus urine output (1,000 mL/day minimum).	PD: Maintain fluid balance and minimize dextrose as needed. SDHD and NHD: Monitor blood pressure and weight and adjust as needed.

Abbreviations: LPD, low protein diet; VLPD, very low protein diet, PD, peritoneal dialysis; SDHD, short daily hemodialysis; NHD, nocturnal hemodialysis; GFR, glomerular filtration rate; DM, diabetes mellitus; KA, ketoacid analog.

Energy

Energy sustains body functions including metabolism, protein synthesis, physical activity, circulation, and immune function. Energy is supplied by dietary protein, carbohydrates, and fats. Consider energy intake and expenditure when determining energy balance. Factors affecting energy management include age, gender, body composition, physical activity, and health requirements for wellness or healing. Understanding the patient's daily energy needs is an important first step in adopting a realistic nutrition and activity plan.

Accurately assessing energy needs in individuals with CKD is essential to keep the patient well-nourished and provide the best outcomes. Clinicians should assess weight status, physical activity, body composition, CKD staging, overall nutritional status, age, other comorbidities, and whether a low protein diet (LPD) or very low protein diet (VLPD) should be considered when estimating energy needs.

Tip Refer to Table 2.1 and the appropriate chapter to determine the energy needs for each stage of CKD.

Malnutrition is a common condition affecting those with progressive CKD. However, the clinical presentation in some individuals with CKD goes beyond what is typically seen from a mere deprivation of calories or protein. CKD individuals experience not only weight loss, but often a profound loss (ie, wasting) of the body's protein mass and fuel stores in the setting of chronic inflammation accompanied by consequences of uremia. This condition has been labeled protein energy wasting (PEW).[3]

The International Society of Renal Nutrition and Metabolism has established criteria for the diagnosis of PEW. On at least three occasions, spaced 2 to 4 weeks apart, a patient must exhibit findings in three of the four criteria listed in Box 2.1.[4] At least one of the findings in each category must be present to receive a diagnosis of kidney disease–related PEW.

Box 2.1 Diagnostic Criteria for Protein Energy Wasting[4]

Criteria	Category Findings
Body Mass Index (BMI)	BMI <23
	Total body fat percentage <10%
	Unintentional weight loss over time (>5% over 3 months or >10% over 6 months)
Serum Levels	Albumin <3.8 g/dL (bromocresol green)—not valid if low due to urinary or gastrointestinal protein loss, liver disease, or use of cholesterol-lowering medication
	Transthyretin (prealbumin) <30 mg/dL for dialysis patients
	Cholesterol <100 mg/dL
Muscle Mass	5% decrease in muscle mass over 3 months or 10% over 6 months
	Mid-arm muscle circumference area >10% below the 50th percentile for reference population
	Creatinine appearance
Dietary Intake	Unintentional low protein intake: <0.8 g/kg (dialysis) or <0.6 g/kg (CKD stage 2-5) for ≥2 months
	Unintentional low energy intake: <25 kcal/kg for ≥2 months

Protein

In CKD stages 1-2, protein needs are the same as in the general population, around 0.8 g/kg, and should be individualized based on nutritional status and lifestyle factors. The kidneys are still able to adequately filter most nutrients and end products of protein metabolism.

As kidney function declines to stage 3, excessive protein intake should be discouraged and a low protein diet considered when appropriate to help delay kidney disease progression and improve outcomes. In CKD stages 4 and 5, a very low protein diet with ketoacid analogs can also be considered in stable and well-nourished individuals to delay progression to dialysis.

Protein needs in end stage kidney disease (ESKD) on dialysis are considerably higher than earlier stages of kidney disease due to protein losses during the dialysis process and greater protein catabolism.

Tip Refer to Table 2.1 and the appropriate chapter to determine the protein needs for each stage of CKD.

Sodium

Sodium, along with chloride, is a principal ion in the extracellular compartment, including blood plasma, interstitial fluid, and transcellular fluid (cerebrospinal fluid and joint fluid).[5] Together, sodium and chloride are responsible for maintaining the balance of water in and around cells, proper nerve and muscle function, and maintenance of stable blood pressure. The body obtains sodium through food and beverages and loses sodium through sweat and urine. In healthy adults, the kidneys maintain sodium homeostasis by adjusting the amount excreted in urine. When sodium balance is disturbed, either through dietary intake or decline in kidney function, the total amount of sodium in the body is affected.

Individuals with CKD typically have higher blood pressure than individuals with normal kidney function. Individuals with CKD may be particularly sensitive to high salt intake, with increased blood pressure that may be explained by the reduction in the ability to excrete the sodium load due to decline in kidney function. Providing education for reducing sodium intake in those with CKD has the potential for lower blood pressure, improvement in cardiovascular disease, decrease in fluid volume overload, reduced endothelial damage, improvement in proteinuria, reduction in inflammation, and delayed CKD progression.[1]

Tip Individuals with CKD or with proteinuria should avoid excessive sodium intake, with a daily goal of less than 2,300 mg per day or 100 mmol per day.

Potassium

Potassium is the most abundant intracellular cation in the body and plays a major role in nerve transmission, muscle contraction, blood pressure regulation, and vascular tone. Adequate potassium intake is important for

the prevention of kidney stones, bone health, insulin regulation, and blood pressure control.[6]

The kidneys play a crucial role in maintaining serum potassium within normal range and are very efficient in handling large loads of potassium. Even with reductions in kidney function, serum potassium levels can remain within normal limits. As kidney disease progresses, it is more common to see issues arise with hyperkalemia, the greatest risk typically starting around CKD stage 4.[7] It is not recommended to restrict dietary potassium intake unless there is hyperkalemia.

When assessing serum potassium levels, it is helpful to look at trends, if available, and not just the current value. Trends will help identify if labs are stable, are improving, or need intervention for potassium management. Other potential causes of hyperkalemia—medications, recent illness or surgery, glycemic control, hydration, bowel issues (eg, constipation or gastrointestinal bleed), changes in dietary intake, metabolic acidosis, catabolic state, dialysate potassium, or difficulty with blood draw—should be considered and corrected when determining dietary intervention.

Tip When treating hyperkalemia, assess and correct nondietary causes while determining the need to adjust dietary potassium intake to maintain serum levels within goal ranges. Refer to the appropriate chapter to determine the potassium needs for each individual. See the patient education materials on the Potassium Fruit and Vegetable Lists, The Food Label and Chronic Kidney Disease, and the Grocery Guide for Kidney Disease.

Protein and Potassium

Plant-based proteins should not be discouraged and can be incorporated into eating patterns that are in line with daily protein goals. The benefits of including plant-based proteins for those with CKD include increased antioxidant intake, increased dietary fiber intake (which may also increase stool excretion of dietary potassium), reduction of renal acid load, and promotion of a healthy gut microbiome. Note that both animal and plant-based proteins can be rich sources of potassium. Educating individuals on their specific protein goals and why it is important to avoid *excessive* protein intake can help keep dietary potassium levels within goal.

Whole Grains and Potassium

Most intact or whole grains provide less than 200 mg of dietary potassium per serving.[8] Whole grains offer additional health benefits such as increased dietary fiber and antioxidants, and can help to regulate blood glucose levels. In addition, adequate dietary fiber intake may help with potassium removal via the stool. Elimination of intact and whole grains is discouraged due to loss of vitamins, minerals, and fiber.

Potassium Additives

Educating patients on how to identify potassium additives in food and supplements can reduce overall potassium intake. Potassium additives can be found in many packaged and processed foods (such as enhanced meat, poultry, and fish products) and can contribute significant amounts of potassium to the diet. Potassium (in the form of potassium chloride or potassium salts) may be used to replace sodium in lower-sodium packaged products. Salt substitutes are an example of products that replace sodium with potassium chloride. Education on potassium additive identification will go hand in hand with reducing processed foods that may also be high in sodium or phosphate additives.

Supplemental Potassium

Supplemental potassium may be used to prevent kidney stones, or in patients with hypokalemia. Use clinical judgment and assessment of individual needs to determine appropriateness.

Individuals with hyperkalemia should be evaluated for use of over-the-counter dietary supplements and herbal blends. Supplements may contain potassium or potassium-containing ingredients. These products do not have to state potassium content on the label. Individuals with hyperkalemia should be advised how to identify these products and educated on potential risks.

Food Label Education

For individuals with hyperkalemia who need to monitor dietary potassium, providing tips on how to identify high and low potassium levels on a food label may be helpful. For example, it can be suggested that a main meal

contain 600 mg potassium or less. A side dish, snack, or condiment should contain approximately 200 mg potassium or less per serving. These goals may need to be individualized but can act as a general overall guideline for those needing to monitor potassium intake.

Potassium content is required to be listed on all food labels. Individuals with hyperkalemia should be advised that there is a rounding rule for potassium on food labels. If the food item has less than 2% of the Daily Value (4,700 mg), then it can be declared as 0%.[9] This rule can lead to issues if the individual views these foods as "potassium free." For example, a 2 Tbsp serving of salsa that provides approximately 95 mg potassium can potentially be labeled as 0 mg of potassium per serving. Many people do not stick with the typical serving size, and someone who needs to monitor potassium intake may consume multiple portions of the seemingly "potassium free" food item.

Cooking Methods to Reduce Potassium in Foods

Several studies have shown that boiling foods results in a considerable reduction in potassium content. The potassium content of potatoes can be reduced by 50% to 75% if they are peeled, cubed, or shredded and then boiled (or double boiled) in a large volume of water.[10] **Soaking potatoes alone resulted in only a minor reduction in potassium content and is generally no longer recommended.** In addition, studies on legumes have found that soaked, then boiled, or canned legumes are significantly lower in potassium (less than 200 mg/serving). This may provide a significant benefit for individuals following a vegetarian or plant-based eating pattern who have ongoing issues with hyperkalemia.[11]

Medications and Potassium

The majority of patients with CKD are prescribed blood pressure medications, diuretics, or both. These medications can affect how the kidneys handle potassium and place the patient at risk for either hypo- or hyperkalemia. An increased risk of mortality has been shown to occur with both hypo- and hyperkalemia. Therefore, it is important to monitor for both conditions in those with CKD. Box 2.2 lists commonly prescribed medications that can affect serum potassium.

Box 2.2 Medications That Can Alter Serum Potassium

Angiotensin-Converting Enzyme Inhibitors (ACEIs)	Angiotensin Receptor Blockers (ARBs)	Aldosterone Antagonists	Loop Diuretics	Thiazide Diuretics
↑ *risk for hyperkalemia*	↑ *risk for hyperkalemia*	↑ *risk for hyperkalemia*	↑ *risk for hypokalemia*	↑ *risk for hypokalemia*
Benazepril (Lotensin)	Eprosartan (Teveten)	Amiloride (Midamor)	Bumetanide (Bumex)	Bendroflu-methiazide (Naturetin)
Captopril (Capoten)	Irbesartan (Avapro)	Spironolactone (Aldactone)	Furosemide (Lasix)	Chlorothiazide (Diuril)
Enaliapril (Vasotec)	Losartan (Cozaar)	Triameterene (Dyrenium)	Torsemide (Demadex)	Chlorthalidone (Tenoretic 100)
Lisinopril (Prinivil, Zestril)	Olmesartan (Benicar)			Hydrochloro-thiazide (Microzide)
Quinapril (Accupril)	Telmisartan (Micardis)			Indapamide (Lozol)
Ramipril (Altace)	Valsartan (Diovan)			Metolazone (Zaroxolyn)

In those with persistent hyperkalemia, the nephrologist may prescribe a diuretic or add a medication that helps to block intestinal absorption of potassium, such as a potassium binder.

Phosphorus

Phosphorus is a mineral essential for energy production and storage, bone mineralization, and cellular membrane structure. The goal of phosphorus management is to balance dietary intake with kidney output. This helps maintain homeostasis throughout all stages of CKD. Studies have demonstrated that high intakes of dietary phosphate are associated with cardiovascular disease, progression of vascular calcification, and complications related to mineral and bone disorder (MBD) even when serum

phosphorus levels are within the reference range. Therefore, excess dietary phosphorus may be harmful even in the absence of high serum phosphorus values.[1]

Phosphorus balance is directly affected by vitamin D and parathyroid hormone (PTH) levels, both of which are influenced by serum calcium. These lab trends should be monitored concurrently for low levels (eg, decreasing calcium and vitamin D in early CKD) or elevated levels (eg, rising PTH and phosphorus as CKD progresses). PTH levels begin to rise prior to any abnormalities in phosphorus and can be an early indicator of the need to modify phosphorus intake.

Tip Phosphorus needs vary considerably in CKD stages 3-5 and 5D. Refer to the appropriate chapter to determine the phosphorus needs for each individual. See the patient education materials on Taking Control of Phosphorus, The Food Label and Chronic Kidney Disease, and the Grocery Guide for Kidney Disease.

Types of Dietary Phosphate

Dietary phosphate is abundant in food and can be classified as either organic or inorganic. The bioavailability of phosphate differs between organic and inorganic food groups.

Organic: Phosphate found naturally in plant and animal foods such as dairy, plant or animal proteins, intact and whole grains.

- **Animal sources:** 40% to 60% of animal-based phosphorus may be absorbed. In animal foods, phosphorus is bound to proteins and phospholipids, which are mostly bioavailable.[1]
- **Plant sources:** 20% to 50% of phosphorus from plant-based foods (vegetables, beans and legumes, nuts and seeds, intact and whole grains) may be absorbed. In plant-based foods, phosphorus is bound to phytates.[1] Humans have very little phytase activity in the gut, making this form of phosphorus less likely to be absorbed. Phosphate is then excreted through the stool versus being absorbed into the bloodstream.

Inorganic: Phosphate found in food as an additive or preservative. Up to 100% of inorganic phosphate added to foods may be absorbed. These additives are used to control bacterial growth, enhance taste, improve texture, increase

shelf stability, and emulsify foods such as cheese and soup. Eating patterns rich in processed and fast foods have been shown to contain significant phosphorus loads, with some studies showing intake of up to 1,000 mg or more per day.[12] See Box 2.3 for examples of common foods with inorganic phosphate.[13]

Box 2.3 Foods That May Contain Added Phosphate[13]

Foods	Phosphate Function(s)
Meat, poultry, seafood, and plant-based meat alternatives	Preservative, loosens structure of protein, retains moisture, improves flavor
Soft cheese spreads; processed cheese; or fat-free cheese, cottage cheese, sour cream, and others with "phos" ingredients	Increases meltability and creaminess
Nondairy creamers and enriched milk substitutes	Calcium and phosphorus supplementation and anti-caking agent
Many bottled or canned beverages, energy or sports drinks, fruit punch, colas, and others	Acidifying agent
Powdered coffee, powdered drinks, seasoning packets, and food mixes	Prevents agglomeration or clumping
Shelf-stable food items (such as cereals and baked goods)	Inhibits growth of yeast, bacteria, fungi
Fast food, convenience food, and restaurant food	Browning, antimicrobial agent, reduces cooking time, retains moisture

Due to the higher bioavailability of phosphate additives and increased prevalence of convenience and processed food intake, emphasis on limiting foods with phosphate additives is a priority.

It is **no longer recommended to replace intact or whole grains with refined alternatives**. Whole grains offer additional health benefits such as increased dietary fiber and antioxidants, and can help to regulate blood glucose levels.

Medications Containing Phosphate

Prescription medications and over-the-counter medications as well as dietary supplements can be potential sources of inorganic phosphate. When possible, recommend dietary supplements and brands that do not contain added phosphates.

Food Labels and Nutrient Databases

Phosphorus is not required to be listed on the Nutrition Facts panel of the food label, so manufacturers often do not include this information. It can be helpful to teach individuals to look for obvious ingredients known to be rich sources of dietary phosphorus such as protein sources and phosphate additives.

When phosphorus is included on the Nutrition Facts panel, this number represents both organic and inorganic forms. Because it does not distinguish the breakdown of organic versus inorganic phosphorus, it is difficult to ascertain bioavailability. It is also important to note that many online databases providing nutrient analysis may only be representing organic phosphate in food items and therefore may underestimate phosphorus content.[14] Clinicians should take this into account when educating patients on reducing phosphorus intake. Teach patients to look for phosphate additives in the ingredients list and choose foods that contain the least number of these or none at all. An option for individuals who may be limited in their ability to read food labels is to instruct them to look for the words *natural* or *no additives* on the label. This currently indicates there are no additives that contain phosphate. Notably, there is a common misconception that organic foods do not contain added phosphates; this is untrue since phosphates are considered a natural ingredient and therefore are still commonly found in organic products.

Look for ingredients that include "phos" to identify phosphate additives. Examples include the following:

- **Phos**phoric acid
- Monosodium **phos**phate
- Monocalcium **phos**phate
- Dicalcium **phos**phate
- Disodium **phos**phate
- Sodium hexameta**phos**phate
- Trisodium **phos**phate
- Sodium tripoly**phos**phate
- **Phos**phorus oxychloride

When a food item is made from components containing multiple ingredients, the manufacturer can choose whether or not to list these ingredients if they are generally recognized as safe. For example, a turkey that contains added broth may only report

broth on the ingredient list and not provide information about the ingredients in the broth. In this instance, the sodium content per serving is the only indicator an additive containing sodium (likely sodium phosphate) was used in the broth.

Tip See the patient education handouts on Taking Control of Phosphorus and The Food Label and Chronic Kidney Disease for more information.

Because phosphate is added to or naturally occurring in many foods, a diet recall will be helpful in prioritizing areas on which to focus. Recommend limiting foods that are highest in phosphate additives (fast food, processed meats and cheeses, cereals, and beverages with added phosphates) as these are the most bioavailable, then discuss alternative options with patients. Remind the patient to limit consumption of naturally occurring phosphate foods.

Phosphate-Lowering Medications

As kidney function declines and MBD labs become altered, the nephrologist may prescribe medications to help manage serum phosphorus levels, such as phosphate binders or a phosphate absorption inhibitor.

Phosphate Binders

Phosphate binders work by attaching, or binding, to phosphate in the food, resulting in reduced intestinal absorption. Phosphate binders are intended to lessen the amount of absorbed phosphate but will not bind *all* dietary phosphate. Binders are typically prescribed to be taken with every meal. There are several types of binders on the market, as seen in Box 2.4.

Box 2.4 Phosphate Binders

Type	Examples
Calcium-based	Calcium acetate (Calphron, PhosLo, Eliphos, Phoslyra), calcium carbonate (Tums)
Metal-based	Lanthanum carbonate (Fosrenol)
Calcium-free, metal-free	Sevelamer carbonate (Renvela), sevelamer hydrochloride (Renagel)
Iron-based	Sucroferric oxyhydroxide (Velphoro), ferric citrate (Aryxia)

Phosphate Absorption Inhibitors

These novel medications are being developed to reduce paracellular intestinal phosphate absorption via inhibition of sodium-hydrogen ion exchange between cellular tight junctions in the gut.[2] This passive absorption is nonsaturable and is how the majority of phosphate is believed to be absorbed in CKD. Studies are underway to determine the safety and efficacy of these medications. Current reported side effects include loose stools or diarrhea due to reduced sodium absorption.

Calcium and Vitamin D

Calcium is the most abundant mineral in the body, with 99% of calcium stored in bones and teeth and the remaining 1% found in extracellular fluid, muscle, and tissue. Calcium metabolism is highly regulated in a tight feedback loop by the PTH and vitamin D endocrine system. In the general population, serum calcium levels do not fluctuate based on dietary intake. In patients with CKD, fluctuation may occur because of alterations in homeostasis and concurrent therapies. Serum calcium may remain in the reference range until later stages of CKD.[1]

Vitamin D is a fat-soluble prohormone required for bone growth and remodeling; inflammation reduction; regulation of cell growth; neuromuscular transmission; immune function support; and regulation of cell division, differentiation, and death. It is created by two inactive vitamin D precursors:

- Ergocalciferol, $25(OH)D_2$, is commonly available as a dietary supplement or food additive.
- Cholecalciferol, $25(OH)D_3$, is produced when skin is exposed to ultraviolet light, is found in a limited number of foods, and is available in supplement form.

Both of these forms of vitamin D must undergo two hydroxylations to become active hormones (one in the liver and the second in the kidneys) to form the physiologically active hormone $1,25(OH)_2D$.[2] Calcitriol, or $1,25(OH)_2D_3$, is the most active vitamin D metabolite with endocrine function, whereas total 25(OH)D is the most accurate indicator of bodily vitamin D status and is therefore the routine serum measure. See Figure 2.1 for an overview of calcitriol production.[15]

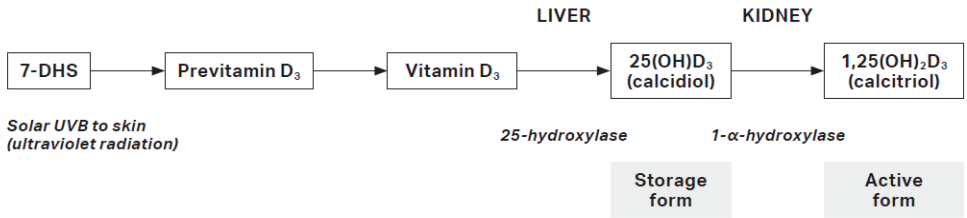

Figure 2.1 Calcitriol Production[15]

Calcitriol promotes calcium absorption in the intestinal tract and, along with PTH, maintains serum calcium concentration. As kidney function declines, these homeostatic mechanisms become compromised. When kidneys become less able to create calcitriol, intestinal calcium absorption decreases and results in excessive secretion of PTH in response to hypocalcemia. This medical condition is referred to as secondary hyperparathyroidism (SHPT). PTH secretion can also occur with inadequate dietary calcium intake, which can be another contributor to SHPT.

Of particular concern is the contribution of SHPT and nontraditional CKD-related cardiovascular risk factors to heart disease. Cardiovascular calcification increases as GFR declines and is associated with all-cause and cardiovascular mortality in CKD.[2]

Tip Calcium and vitamin D needs vary considerably in CKD stages 3-5 and 5D. Refer to the appropriate chapter to determine the needs for each individual.

Fluid

Fluid restriction is not typically necessary in the earlier stages of CKD but varies from person to person. Maintaining adequate fluid intake is required to eliminate urinary waste and solutes. As kidney function declines, there is a gradual loss of ability to concentrate urine. This limitation can result in fluid overload and hypertension in ESKD.

Tip Fluid needs vary considerably in CKD stages 3-5 and 5D. Refer to the appropriate chapter to determine the needs for each individual.

Summary of Changes

- In adults with CKD, it is recommended to limit sodium intake to less than 2,300 mg or less than 100 mmol per day.
- In individuals with hyperkalemia, **fruits, vegetables, intact and whole grains, and plant-based proteins should not be discouraged**. Instead, education should be provided on proper portions of these foods with meals, resolving other causes of hyperkalemia, and choosing foods that may be lower in potassium if appropriate.
- **There is little benefit to soaking potatoes or legumes.** Instead, they should be peeled, cut into small pieces, and boiled (or double boiled) in a large volume of water.
- Due to increased bioavailability of phosphate additives and the prevalence of convenience and processed food intake, emphasis on limiting these foods is a priority. **It is no longer recommended to replace intact or whole grains with refined alternatives.**

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Taking Control of Phosphorus

Phosphorus is in many foods and drinks. If your kidneys do not work well, you may get too much phosphorus. This can increase your risk of heart disease, bone disease, or death. To reduce the phosphorus in your diet, follow these tips.

1 Choose lower-phosphorus foods.

Phosphorus is found naturally in some foods. It can also be added to foods as a preservative. Phosphorus added to foods can be more harmful to your health than the natural phosphorus in foods.

Milk, dairy products, proteins, and whole grains contain natural phosphorus. These are healthy foods if used in the amounts recommended by your registered dietitian nutritionist (RDN).

2 Read ingredient lists.

Phosphorus is not always listed in the Nutrition Facts. This does not mean there is no phosphorus in that food or drink item.

To know if phosphorus is added to foods, look in the ingredients list for words with "**phos**," such as ***phos**phoric acid* or *sodium **phos**phate*. These are types of added phosphorus that may be harmful to your health. Limit these foods.

If the ingredients are hard for patients to see, a magnifier can help

Nutrition Facts

Serving Size 1/3 cup (40g)
Serving Per Container about 28

Amount Per Serving	
Calories	160
Calories from Fat	50
	% Daily Value*
Total Fat 5g	8%
Cholesterol 0mg	0%
Sodium 490mg	20%
Potassium 40mg	1%
Total Carbohydrate 26g	9%
Dietary Fiber 1g	4%
Sugars 1g	
Protein 3g	

Calcium 4%	•	Iron 6%
Thiamin 10%	•	Riboflavin 6%
Niacin 8%	•	Folic Acid 10%

Not a significant source of vitamin A and vitamin C

INGREDIENTS: ENRICHED FLOUR BLEACHED (WHEAT FLOUR, MIACIN, IRON, THIAMIN MONONITRATE, RIBOFLAVIN, FOLIC ACID) PARTIALLY HYDROGENATED SOYBEAN AND/OR COTTONSEED OIL, LEAVENING (BAKING SODA, SODIUM ALUMINUM PHOSPHATE, MONOCALCIUM PHOSPHATE), DEXTROSE, SALT.
CONTAINS WHEAT INGREDIENTS.

eat right. Academy of Nutrition and Dietetics

3 If you are on phosphorus binding medications, take these during each meal or snack, as directed.

- These medications help bind some phosphorus so less is absorbed by your body.
- They can bind only **some** of the phosphorus in foods and drinks. It is still important to make good food choices.

4 If you are on dialysis, be sure to do all your dialysis sessions.

- Dialysis helps remove some of the phosphorus in your blood.
- Do not miss any dialysis sessions and stay for the full time.

Foods Highest in Added Phosphorus:

- Fast food, convenience store or gas station food, and vending machine food
- Restaurant food
- Beverages such as colas, pepper-type sodas, many flavored waters and bottled teas, and many powdered drink mixes
- Processed cheeses (eg, Velveeta, Cheez Whiz, Kraft American, boxed macaroni and cheese, and cheese spreads)
- Processed meats (eg, hot dogs, salami, bacon, ham, sausage, and others)
- Enhanced proteins (eg, chicken, fish, seafood, and turkey with "**phos**" ingredients)
- Packaged foods with "**phos**" ingredients

What Can I Eat?

There is a huge variety of foods you can enjoy.

- Fresh foods, such as fruits, vegetables, whole grains, fresh meats, and plant proteins, are good choices.
- This chart lists higher-phosphorus foods on the left and better choices that are lower in phosphorus on the right.

	Higher Phosphorus	Lower Phosphorus
Drinks	Drinks with "**phos**" words in the ingredients list, such as colas or pepper-type drinks, energy or sports drinks, most bottled or canned teas or coffees, flavored waters, and fruit punch Beer and wine	Drinks without "**phos**" words in the ingredients list, such as most root beer, orange, or clear sodas, fresh lemonade, and water flavorings Coffee (made from coffee beans or powder) Tea (made from tea bags) or bottled teas without "**phos**" ingredients Water

Animal or plant proteins	Packaged foods with "**phos**" ingredients:
	• Processed meats like bacon, bologna, ham, hot dogs, salami, and sausage
	• Fresh-looking proteins with added "**phos**" solutions—often in chicken, fish, pork, seafood, and turkey
	• Chicken or fish sticks, nuggets, patties, or strips
	• Vegetarian or organic processed foods or meals
	• Egg substitutes
		Recommended amounts of:
		• Beans or lentils
		• Eggs or egg whites
		• Fresh lean beef, goat, lamb, mutton, veal, or wild game
		• "Natural" items without "**phos**" ingredients, such as:
		  o Chicken, fish, pork, seafood, and turkey
		  o Deli meats
		  o Packaged egg whites or egg substitutes
		  o Vegetarian or organic foods
		• Tempeh
		• Tofu

	Higher Phosphorus	Lower Phosphorus
Dairy	Any with added "**phos**" ingredients: • Nondairy creamers • *Enriched* almond or rice milk or other milk substitutes • Processed cheeses, such as Kraft American, Velveeta, Cheez Whiz, and cheese spreads • *Fat-free* cream cheese or sour cream Large portions or frequent use of cheese, dairy milk, creamers, yogurt, or ice cream	Butter (unsalted) or tub margarine Cream cheese (regular or low-fat) Sour cream (regular or low-fat) Whipped cream Any without "**phos**" ingredients: • *Unenriched* almond, cashew, hemp, oat, rice, or soy milks • Nondairy creamers (original or plant-based) • Half and half Small amounts of: • Cheese: cheddar, Colby, mozzarella, Swiss, or other natural cheeses • Cream • Milk • Yogurt (without "**phos**" ingredients)
Fast food, convenience store food, or vending machine foods	Grilled or fried chicken nuggets, sandwiches, strips, or wings Bratwursts, hot dogs, or sausages Pizza Sandwiches with ham, American cheese, or bacon Tacos French fries or other fried potatoes, biscuits, or macaroni and cheese	Hard-boiled eggs Fish filet sandwich (no cheese) Hamburger (no cheese or bacon) Tuna or egg salad sandwich (no cheese) Lettuce or mixed-greens salad (no chicken) Coleslaw, fruit, vegetables, popcorn, or tortilla chips
Frozen foods or dinners	Any frozen foods or meals with added "**phos**" ingredients, including organic foods	Any frozen foods or meals without "**phos**" ingredients, including organic foods

Ask your RDN if you have questions about foods you enjoy or what to eat.

Review

Can you find the added phosphorus?

INGREDIENTS

ENRICHED WHEAT FLOUR, WHEY, VEGETABLE OIL, WHOLE WHEAT FLOUR, WHEAT BRAN, WATER, CORN SYRUP, OAT FLOUR, DRIED EGG WHITES, SOY LECITHIN, MALTODEXTRIN, BUTTER (CREAM, SALT), SODIUM BENZOATE, BUTTERMILK, SUGAR, POTASSIUM CHLORIDE, CITRIC ACID, LACTIC ACID, YELLOW #5, PEPPER, MALTODEXTRIN, SODIUM CITRATE, SODIUM PHOSPHATE, RIBOFLAVIN, FOLIC ACID, VITAMIN B12.

1. What are 2-3 foods or drinks with added phosphorus that I eat often?

_____

_____

2. What are lower phosphorus foods I can enjoy instead?

_____

_____