In Brief

People with diabetes strive to keep blood glucose, blood pressure, and blood lipids within desirable ranges to prevent long-term complications such as chronic kidney disease. Once that complication has occurred, however, nutritional management becomes even more complex. The National Kidney Foundation has addressed "diabetic kidney disease" in recent guidelines. This article summarizes some of the nutritional strategies to prevent or delay progression to kidney failure.

Nutritional Challenges of a Dual Diagnosis: Chronic Kidney Disease and Diabetes

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Approximately 40% of patients with type 1 or type 2 diabetes will develop some level of renal impairment.[1] In addition, the U.S. Renal Data System reports that of people with chronic kidney disease (CKD) who are > 50 years of age, ~ 70% also have a diagnosis of diabetes, hypertension, or both, and the percentage rises to 90% in Medicare patients.[2] Optimal treatment of diabetic renal disease includes appropriate medical nutrition therapy (MNT), as well as the use of medications to control blood pressure and glucose levels. Registered dietitians (RDs) play an integral role in helping individuals develop realistic food plans when they are affected by these two medical conditions. This article reviews recommendations for these nutritionally complex patients and provides specific guidelines for clinical practice.

In 2002, the National Kidney Foundation created a five-stage CKD classification system based on the estimated glomerular filtration rate (GFR), or the ability of the kidneys to effectively filter waste products from the blood.[3] Stage 1 is defined as an estimated GFR, defined by the Modification of Diet in Renal Disease equation,[4] between the normal level of 120–125 ml/min/1.73 m^2 and 90 ml/min/1.73 m^2. Stage 5 encompasses end-stage renal disease (ESRD) and is defined as an estimated GFR of < 15 ml/min/1.73 m^2. Patients at this level must seek renal replacement therapy, such as dialysis or transplant. Use of the estimated GFR has been validated through evidence-based research and is based on patients' age, ethnicity, and serum creatinine level. It is estimated that > 8 million people have a GFR < 60 ml/min/1.73 m^2, placing them in CKD Stages 3–5.[3] (See Table 1 for the stages of CKD and nutritional interventions.)

Although the nutritional challenges of a duel diagnosis are daunting, it is possible to delay the progression to kidney failure, and MNT plays a significant role in this effort. To understand the nutritional challenges facing people with CKD, it is important to review some of the functions of normal kidneys. Healthy kidneys perform all of the following functions:

- Filter waste products and excess fluid (A diseased kidney leaks protein, which results in protein malnutrition. Uremic toxins can also accumulate and decrease the appetite.)
- Release the enzyme renin, which is important in blood pressure control
- Produce the hormone erythropoietin, which helps produce red blood cells, preventing anemia
- Activate vitamin D, increasing the intestinal absorption of calcium and phosphorus
- Maintain acid-base balance, which can also affect nutritional status

Common Goals

The nutrition recommendations for diabetes can be complicated, and the recommendations for CKD add

Table 1. Nutritional Interventions in the Stages of CKD

Stage	Description	GFR (ml/min/ 1.73 m^2)	Possible Nutrition Interventions
1	Kidney damage with normal or elevated GFR	≥ 90	• To slow risk of CVD, therapeutic lifestyle changes and reduced intake of saturated fat and sodium • Maintain blood glucose to hemoglobin A_{1c} (A1C) goal of < 7.0% • Protein at 0.8 g/kg of body weight or as needed to maintain protein status
2	Kidney damage with mild decrease in GFR	60–89	• Continue as above
3	Moderate decrease in GFR	30–59	• Continue as above, evaluating the progression of the disease • As intact parathyroid hormone or phosphorus increases, maintain controlled amount of phosphorus in the diet to achieve normal level • Have vitamin D levels checked and evaluate need for replacement therapy • Iron-rich foods or supplement adjunctive to erythropoietin therapy
4	Severe decrease in GFR	15–29	• Protein at 0.8 g/kg of body weight or as needed to maintain protein status • Potassium may need to be supplemented or restricted per patient need • Dietary phosphorus restricted to 800–1,000 mg/day, adjusting for protein intake • Sodium and fluids may need to be limited or adjusted to maintain fluid balance • Limit calcium obtained from the diet and from phosphate binders to 2,000 mg/day • Iron-rich foods or supplement adjunctive to erythropoietin therapy • Maintain blood glucose to A1C goal of < 7.0%. It may be necessary to adjust dosage of antidiabetic agents
5	Kidney failure	< 15 (or dialysis)	• When dialysis is started, protein is increased to a level needed to prevent malnutrition. • Potassium may need to be supplemented or restricted per patient need. • Phosphorus, sodium, and fluids may need to be limited or adjusted to maintain health. • Limit calcium obtained from the diet and from phosphate binders to < 2,000 mg/day. • Iron is supplemented at dialysis treatments. • Maintain blood glucose to an A1C goal of < 7.0%. It may be necessary to adjust dosage of antidiabetic agents.

Adapted from Ref. 3

further challenges. However, it is extremely important for RDs to help patients integrate both sets of recommendations and realize that they share common goals. These goals include controlling blood glucose and blood pressure to prevent further kidney damage and cardiovascular disease (CVD). Sodium guidelines as presented in the 2005 U.S. Dietary Guidelines (~ 2,300 mg/day) should be adequate for all healthy people and should be the maximum for those with diabetes and CKD.[4] This aids in blood pressure control.

Protein

Perhaps the most controversial nutrition issue in diabetes care in recent years has been protein intake. Knight et al.[5] found in the highly powered Nurses Health Study that a high protein intake, particularly high intake of nondairy animal protein, may exacerbate renal function decline in women with mild renal insufficiency.

Uribarri and Tuttle[6] hypothesize that high-protein diets are toxic to the kidney because they increase dietary content of advanced glycation end products (AGEs). AGEs are formed in the browning process, or Maillard reaction, when proteins combine with carbohydrates at high temperatures, denaturing the protein. Glycated proteins accumulate damage with time. For example, the increased rate of glycation of collagen during hyperglycemia is implicated in the development of complications of diabetes. Therefore, one goal to preserve kidney function would be to reduce AGEs in the diet. Uribarri and Tuttle[6] suggest that protein of animal origin is a major source of AGEs. Their recommendations include limiting protein intake to the recommended dietary allowance (RDA) of 0.8 g/kg per day, or about 10% of calories, emphasizing nonmeat proteins of high biological value that are low in AGEs and using cooking methods that minimize accumulation of AGEs, such as steaming, poaching, boiling, and stewing, instead of very high-heat methods, such as frying, broiling, or grilling. The American Diabetes Association (ADA) also recommends that people with diabetes and nephropathy limit their protein intake to the RDA.[7]

Meat proteins have been encouraged in CKD because of their high biological value. Proteins with high biological value contain all of the essential amino acids in generally the same amounts as required by the body. Meat, fish, poultry, dairy products, and eggs all contain proteins of high biological value. However, there is another way to measure protein quality: the protein-digestibility-corrected amino acid score. In this method, the amino acid score of a food is compared with the amino acid requirements of preschool-aged children and then are corrected for the digestibility of the protein. Using this score, casein (milk protein) and egg white are 1.0, soybean isolate is 0.99, and beef is 0.92. Thus, soy foods also can supply protein of high biological value.

Carbohydrates and Fats

It is still important to take in enough calories so that protein is used for anabolic processes and not for energy needs. If protein is limited to 10% of calories, then carbohydrates and fat will make up 90% of the diet. It is established that carbohydrates are the preferred source of fuel for the brain and central nervous system, yet carbohydrates do have the greatest influence on blood glucose. An issue in nutrition that is gaining support is the use of the glycemic index (GI) or glycemic load (GL) of foods. The GI ranks foods related to their effect on postprandial glycemia but may be affected by cooking method, fiber content, or mixture with other foods in the context of a meal. The GL is the product of the GI and the number of grams of carbohydrate in a particular serving, so it may be a more useful number, but there are few well-controlled clinical trials validating this concept. The ADA revised its MNT recommendations in 2006 to state that both the amount of carbohydrate and the type of carbohydrate affect blood glucose and that attention to the GI or GL can be helpful in controlling postprandial glucose levels.[7] Foods with a lower GI or GL include fruits, vegetables, and whole grains. However, these foods may be significant sources of potassium or phosphorus, so as kidney function decreases, careful manipulation of these nutrients will be necessary.

People with CKD have a risk of CVD 10–30 times higher than that of people without kidney disease, placing them in the highest risk category.[8] Therefore, just as in diabetes, CKD patients should follow the National Cholesterol Education Program Third Adult Treatment Panel (ATP III) guidelines stating that total fat be 25–35% of total calories, with saturated fat < 7% and trans fats < 1% of calories.[9] It is essential to limit saturated fats and avoid trans fats. Polyunsaturated fatty acids, such as omega-3, inhibit platelet aggregation and inflammation and affect blood lipids. An increase in monounsaturated fatty acids, such as olive and canola oils, favorably modifies lipid profiles and decreases cardiovascular mortality.[10] It is therefore important to include both poly- and monounsaturated fats in the diet. However, further research is needed to strengthen the link between these fatty acids and markers of diabetic kidney disease.

Although evidence in CKD patients is weak or opinion-based, patients who do take fish oil supplements as directed by their physician should do the following:

- Avoid brands made from halibut or shark liver oils to prevent vitamin A toxicity.
- Choose brands that contain 1–2 mg of vitamin E per gram of fish oil to prevent oxidation of the product.
- Alert physicians about any bleeding difficulties they experience and discontinue supplementation before undergoing any surgery.[11]

Micronutrient Assessment

At Stage 3 CKD, assessment of anemia, calcium, phosphorus, parathyroid hormone, albumin, cholesterol, and nutritional status should begin.[3] As GFR decreases, it becomes necessary to limit phosphorus to maintain serum levels within the normal range. Hyperphosphatemia carries serious consequences, including secondary hyperparathyroidism and soft tissue and vascular calcification.

Phosphorus additives are used liberally to enhance flavor, especially in meats and processed cheeses, refrigerated bakery products, and beverages. Although only ~60% of dietary phosphorus is absorbed, nearly 100% of phosphorus-containing additives are absorbed.[12] Because manufacturers are not required to list phosphorus content on the Nutrition Facts panel of their food labels, assessing the phosphorus content of patients' diets can be difficult.

Patients with high levels of phosphorus often need to take phosphate binders several times per day to meet their individual needs. Different formulations of phosphate binders are available, and their correct dosage is based on the results of laboratory analysis.

Fruits and vegetables are rich sources of potassium, which usually does not need to be limited until Stage 3 or 4 CKD and in fact sometimes require supplementation, depending on GFR status. Periodic blood chemistry tests will determine whether restriction or supplementation is necessary (Table 1).

Patients with CKD often feel overwhelmed when presented with the fact that they have to control both their blood glucose and their blood pressure levels, as well as balance macronutrients, sodium, phosphorus, potassium, and fluids. The support of an RD who understands both diabetes and CKD will help patients succeed.

Strategies that decrease the rate of decline of renal function include diabetes management measures to help improve glycemic control and the use of antihypertensive agents and sodium restriction to improve blood pressure. Cholesterol-lowering agents may be used in conjunction with ATP III dietary guidelines. Protein is limited to the RDA, and accumulating evidence suggests that cooking methods to reduce accumulation of AGEs may be indicated. As kidney function declines, phosphorus and potassium intake may be modified. In addition, steps to treat anemia may include dietary sources of heme iron or the use of pharmacological agents.

Six basic goals can be adapted from the National Kidney Foundation Kidney Disease Outcomes Quality Initiative Guidelines for Diabetes and Chronic Kidney Disease [13] to slow the progression to kidney failure:

- Intensive glycemic control
- Antihypertensive therapy, including pharmacological agents and a modified version of the Dietary Advances to Stop Hypertension diet, which the U.S. Department of Agriculture recommended in the 2005 Dietary Guidelines for Americans.[4] The diet may need modifications in protein and potassium content for patients with diabetes and CKD.
- Cholesterol-lowering therapy involving diet and pharmacological agents
- Dietary protein restriction, following the RDA of 0.8 g/kg based on a normal BMI
- Guidance and support from a nutrition professional to prevent malnutrition
- Multidisciplinary support

Nutrition intervention is a formidable ally in each stage of CKD. Contact with an RD who is competent in MNT for both diabetes and CKD and involved in the care and management of these patients as part of a multidisciplinary health care team can greatly enhance the opportunity to delay progression of the disease. The complicated nature of nutritional guidelines for renal disease and diabetes necessitates a multidisciplinary educational effort.

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