Medical Nutrition Therapy for the Predialysis CKD Patient

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Chronic Kidney Disease (CKD) affects 1 in 9 U.S. adults, or 20 million people living in the U.S. (1). It is predicted that the number of people needing renal replacement therapy (RRT) will increase from 406,000 in 2000 to 651,000 in 2010 (2). CKD is obviously a growing and costly public health concern. Total Medicare expenditures for CKD reached $18.6 billion in 2004, of which $16.3 billion was spent just providing dialysis (3).

Major causes of CKD include diabetes (DM), which accounts for approximately 40% of cases, hypertension (HTN), which leads to 27% of cases, and glomerulonephritis, which accounts for approximately 13% of cases. The remaining cases are from various other causes, including inherited diseases (such as polycystic kidney disease) and immune dysfunction (3). Approximately 20-30% of diabetics (either type 1 or 2) develop nephropathy, as evidenced by microalbuminuria. Of this group, about 20% of type 2 diabetics will proceed to stage 5 CKD, compared with 50-75% of type 1 diabetics (4). However, there is a much greater prevalence of type 2 diabetes in the population. So, ultimately, these patients constitute a large part of the diabetic population starting dialysis.

The medical community is being urged to screen early for kidney disease. Risk factors for CKD include HTN, DM, family history, and older age. Screening includes checking blood pressure (BP), checking for urinary albumin excretion and looking at serum creatinine. Serum creatinine can be used to estimate glomerular filtration rate (GFR), using the Modification of Diet in Renal Disease (MDRD) equation which can be found at http://www.kidney.org/professionals/KDOQI/gfr_calculator.cfm. The estimated GFR can then help determine whether there is kidney impairment and, if so, to what degree the kidney disease has progressed.

The National Kidney Foundation Kidney Disease Outcomes Quality Initiative (K/DOQI) has classified kidney failure into stages:

- Stage 1 normal GFR $\geq$ 90 ml/min/1.73m^2
- Stage 2 mild low GFR 60-89 ml/min/1.73m^2
- Stage 3 moderate low GFR 59-30 ml/min/1.73m^2
- Stage 4 severe low GFR 15-29 ml/min/1.73m^2
- Stage 5 kidney failure GFR<15 ml/min/1.73m^2

These stages have been set up to allow more uniform diagnosis and care of the patient with CKD. There are a number of K/DOQI guidelines for interventions aimed at slowing the progression of CKD (5). Interventions that have been proven to be effective include:

- tight glycemic control in diabetics
- strict blood pressure control
- use of angiotensin-converting enzyme (ACE) inhibitors or angiotensin-2-receptor blockers

Two of the interventions that have been studied, but with inconclusive results include:

- dietary protein restriction
- lipid-lowering therapy

Medical Nutrition Therapy (MNT) can play an important role in helping slow the decline of renal function and preserve the nutritional status of the patient with CKD. In recognition of this, Medicare now reimburses for MNT provided to patients with CKD whose estimated GFR is 13-50 ml/min. A total of three hours of MNT during the first calendar year, and an additional two hours each subsequent year can be reimbursed (6). Dietary interventions can help improve control of blood pressure, serum lipids, and blood glucose levels. Weight loss can be a beneficial part of dietary approaches, but should proceed slowly in the CKD patient, to minimize breakdown of muscle tissue and use of dietary protein for energy.

Activity should be encouraged, both for weight control and to maintain functional status and well-being. This is often challenging for patients who may have co-morbid conditions limiting exercise tolerance and who may be anemic and too fatigued to pursue higher levels of activity.

Protein Restriction

Restricting protein in the diet of a person with CKD may help slow the progress of renal failure. It is thought that high protein intake leads to kidney damage through increased glomerular perfusion and increased intraglomerular capillary pressures (4,7).

Some physicians are reluctant to have their patients follow low protein diets. There are probably several reasons for this. Inadequate calorie intake that could occur with low protein intakes can lead to protein-energy malnutrition (PEM). Patients initiating renal replacement therapy with PEM have poorer outcomes (8). Physicians may also be concerned that the diet is too difficult to follow and don't want to add an extra burden to their patient.

But the primary reason may be because there is still some uncertainty over the benefit of protein restriction in slowing the progression of renal disease. The initial results of the Modification of Diet in Renal Disease (MDRD) study, which was done to demonstrate that low protein diets could slow progression of renal failure, made it look like there was no effect. But secondary analysis showed there probably was a benefit. An initial

reduction in GFR, which was probably just a result of the reduced protein intake, made it look like renal function had decreased; it obscured a later reduction in the rate of decline of GFR in the low protein diet group (9). The secondary analyses of the MDRD Study suggested that a lower protein intake retards the progression of advanced renal disease. The study recommended a dietary protein intake of 0.6 g/kg/d in patients with GFR less than 25 ml/min/1.73m^2 (10).

Although direct evidence to support the low protein diet may be lacking, findings from observational epidemiological studies support an association between dietary protein intake and renal disease progression in certain population subsets. Knight, *et al* in the Nurse's Health Study found a relationship between GFR change and protein consumption. In the 489 women with renal insufficiency, each 10g/d increase in protein consumption was linked with an adjusted decrease in GFR of 1.69 ml/min/1.73m^2 (CI, -2.93 to -0.45 ml/min/1.73m^2) (11).

In the 3rd NHANES study, Wrone *et al* found, among a subset of people with co-morbid HTN and diabetes (DM), that those with the highest protein intake had higher odds of having microalbuminuria. They suggested this may raise a concern for the safety of high protein diets (often used for weight loss) in people with both HTN and DM (12).

Protein restriction is recommended by the K/DOQI guidelines, and in late renal failure, a lower protein intake will reduce nitrogenous waste products (13).

K/DOQI guidelines recommend the use of standard body weight (SBW) based on NHANES II data for calculating patients' protein and calorie needs (14). Tables for SBW are available in the ADA Clinical Guide to Nutrition Care in Kidney Disease and in the Pocket Guide to Nutrition Assessment of the Patient with Chronic Kidney Disease available through the Council on Renal Nutrition of the National Kidney Foundation.

To help maintain adequate nutritional status, at least 50% of the protein should be from high biological sources, and adequate calories should be provided to prevent breakdown of dietary protein for energy (13). Traditionally, this has meant using animal sources to provide the HBV protein. Vegetarian diets were discouraged. But it may not be necessary to use only animal sources of protein. As long as calorie intake is sufficient, protein requirements can be met, even with vegetable proteins.

In fact, research looking at the type of protein in the diet suggests that vegetable protein may provide some benefits to people with impaired renal function. Data from the INTERMAP study indicates that vegetable proteins are associated with lower blood pressure (15). Knight, *et al* found that in women with mild renal insufficiency, an increased risk of progression of renal disease was associated with nondairy animal protein but not with intake of vegetable protein (11). Finally, soy protein appears to be less harmful to the kidneys than animal protein. This may be because soy contains less of the sulfur-containing amino acids. Sulfur-containing amino acids are primarily metabolized by kidneys and have vasodilatory effects that increase renal blood flow and increase glomerular capillary pressure (16).

Concern with using vegetarian diets in renal failure has often centered on the high phosphorus and potassium content of such foods such as tofu, soymilk, legumes and nuts. However, these foods could still be included in the diet. The bioavailability of the phosphorus in plant foods is lower than that in animal meats, and phosphate binders can be taken to help decrease phosphorus absorption. Also, many patients with earlier stage CKD do not yet need potassium restrictions. In the future, perhaps dietary recommendations for early stages of CKD will concentrate more on protein sources than on their quantity.

Calorie Intake

Adequate calorie intake is essential in preventing PEM. Calorie sources for those who are limiting protein can sometimes be limited. Until dietary potassium intake needs to be restricted, fruits and vegetables can add some calories with little protein. Beyond that, fats and sugars can be included in the diet to reach calorie goals. Juices, pop, non-chocolate candies, syrup, honey and table sugar can provide calories without adding excess protein, phosphorus, sodium and potassium. Patients should be encouraged to replace saturated fats with unsaturated fats if they have elevated lipid levels.

Teaching patients to include fats, oils and sugars for calories can be a very difficult part of diet education. People hear messages telling them that healthy eating should emphasize whole grains, generous intakes of vegetables and fruits, and limited consumption of sweets and fats. People who have managed diabetes for many years may have been educated before the days of carbohydrate counting. They may avoid sugar and sweets entirely, and can be very resistant to including them in their diets. It can be helpful to explain how diet priorities change in the face of declining kidney function. Also, reframing the diet changes in a positive light—as a way the patient can work around the kidney's limitations and maintain their health—may be beneficial.

Role of Phosphorus Restriction in the Diet

CKD patients are at high risk for developing secondary hyperparathyroidism and bone and mineral metabolism disorder (BMMD). This disorder can begin as early as Stage 2 or Stage 3 CKD (17). The kidneys are responsible for the activation of vitamin D, to form calcitriol. With the decline in functioning renal mass, less calcitriol is formed and, as a result, intestinal calcium absorption is reduced. Low levels of calcium trigger parathyroid hormone (PTH) secretion, which then stimulates bone release of minerals, in an effort to restore serum calcium levels. Normally, calcitriol provides feedback to the parathyroid (PT) gland, to turn down PTH synthesis and secretion. When calcitriol levels are low, this feedback mechanism is reduced.

As renal function declines, the kidneys also retain phosphorus. Blood phosphorus levels rise and provide another stimulus to PTH release. The result is ever-increasing levels of PTH and the development of secondary hyperparathyroidism. The resulting BMMD is a

hallmark of renal failure. High levels of calcium and phosphorus in the blood can result in precipitation of calcium phosphate in soft tissues, including blood vessels. This worsens risk for cardiovascular disease.

Patients may have symptoms of itching from high serum phosphorus levels—or they may have no symptoms at all. The body compensates and keeps serum levels of calcium and phosphorus normal for a long time, but a rise in PTH levels can be an early sign of this metabolic disorder.

Bone and mineral metabolism disorders can be treated in three ways:

- Vitamin D analogs may be prescribed to promote better calcium absorption and reduce the over-stimulation of the PT gland. Some nephrologists also measure serum 25 (OH) D levels and prescribe ergocalciferol supplements to correct deficiencies in early stages of CKD (13).
- If serum phosphorus (P) is elevated, dietary phosphorus restriction may be implemented. It may be appropriate to limit dietary P intake, even when serum P levels are still normal, if an elevated PTH also occurs. Serum P levels are not typically elevated before stage 4 CKD because high PTH levels help maintain a normal serum P level by increasing renal P excretion (17).
- Phosphate binding medications can be given to bind dietary phosphorus. Many of these contain calcium and may also be used to raise low serum calcium levels. Calcium carbonate is a commonly prescribed phosphate binder, but patients are often confused as to its purpose. They may think it is for treating stomach upset, or for prevention of osteoporosis. As a result, they may not take it on a regular basis. If its intended use is as a phosphate binder, then patients need to be educated to take it with meals, and not to see it as optional. If it is prescribed to raise calcium levels, the patient may be advised to take it between meals for better calcium absorption.

If serum phosphorus levels become low, phosphate binding medications should be held. Phosphorus levels can also be low in the absence of phosphate-binding medication—often because of malnutrition. In this case, the diet should not be restricted in phosphorus.

Early and effective control of phosphorus is essential in the effort to prevent or inhibit PT cell hyperplasia and progressive secondary hyperparathyroidism (18). In addition to its importance in the control of BMMD, early P restriction may also play a role in slowing the progression of renal disease (19).

Dietary phosphorus levels should be set at 800-1000 mg/day or about 8-12 mg/kg body weight. The restriction of protein makes this fairly easy, but patients may also need to be taught to limit whole grains, nuts, colas and dairy products.

Calcium

Dietary calcium intake may need attention as well. Calcium intake, including dietary calcium and that from calcium-based phosphorus binders is recommended not to exceed 2,000 mg/day (20-21). A low protein diet is quite modest in calcium content because dairy products are restricted, but the dietitian may need to be alert to a patient's consumption of calcium-fortified foods which will increase total calcium intake. Calcium levels occasionally rise too high, from bone release, from too much calcium absorption from calcium-containing P-binders, or because the patient's dose of vitamin D analog is too high.

Sodium and Fluid

Dietary sodium is usually restricted in CKD. Not only is hypertension a risk factor for developing CKD, but once nephropathy is present, sodium handling by the kidneys is altered. Sodium retention plays a major role in the hypertension that can develop as a result of the CKD—largely because of expansion of the extra-cellular fluid volume. Sodium intake should be individualized to the patient's needs, and will usually fall between 2 and 4 grams/day.

Patients can easily experience tissue weight losses that are obscured by fluid retention. They should be encouraged to take note of edema and also to weigh themselves regularly to track weight changes. Adhering to a sodium-restricted diet can help minimize fluid retention. However, restriction of fluid intake is usually not necessary before beginning dialysis. Patients should be encouraged to drink according to thirst, and should neither restrict nor "push" fluids (21).

Potassium

The potassium level of the diet needs to be individualized. Medications may affect serum levels of potassium. Commonly prescribed medications include diuretics, which may increase excretion of potassium, as well as ACE- inhibitors and angiotensin receptor blockers, which can cause potassium retention. Thus, serum levels must be monitored and the diet adjusted accordingly.

Vitamins

Intake of vitamins may be low on a protein-restricted diet. Patients should be encouraged to take a multiple vitamin. Renal vitamins are formulated to provide water-soluble vitamins only. Fat-soluble vitamins should be avoided as renal failure progresses, especially vitamin A, which is usually elevated in advanced renal failure. High intake of vitamin C should also be avoided as it can cause accumulation of ascorbic acid metabolites, such as oxalate, creating a potential for stone formation (22).

Conclusion

The dietitian caring for the CKD patient needs to be able to assess the patient's individual requirements and tailor the diet accordingly, taking into consideration the stage of CKD and co-morbidities. Follow-up care is vital, to monitor nutritional status and changes in

kidney function and lab values, which may necessitate adjustments in the diet. By providing individualized MNT, the dietitian can play an important role in improving patient outcomes.

This article has been approved for 2 CPE units and the CPE insert can be accessed in the Members Only Section of the RPG website from the CPE Inserts link.

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