Update on Nutrition Management and Chronic Kidney Disease

Indian Health Service
Division of Diabetes Treatment and Prevention
5300 Homestead Road NE
Albuquerque, New Mexico 87110
http://www.diabetes.ihs.gov/

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Introduction and Overview

The topics to be covered today include a brief review of kidney functions, a review of the identification and monitoring of chronic kidney disease, and showing you some new tools that you can use from the National Kidney Disease Education Program. I will also be talking about a tool designed for dietitians called the *Assessment, Management and Treatment Tool*, and briefly review the recommendations for dialysis diets.

We all know that the kidneys have various functions that include regulating the composition and the volume of blood, removing wastes from the blood and putting them into the urine. These wastes include certain elements or nutrients such as sodium or nitrogen, potassium, hydrogen, phosphorus, fluid and others. They also remove things like water-soluble vitamins. The kidneys are a source for hormones, the ones that I am going to focus on include calcitriol or active vitamin D, which we need for strong bones; erythropoietin, which is used to help us make more red blood cells, and renin that helps control blood pressure. The kidneys are also involved in metabolism, they break down insulin and glucagon, for example, and they do make some new sugar or gluconeogenesis, when we need some sugar.

Just a brief review of the anatomy of the nephron, you can see the glomerulus or the filter and the tubule where reabsorption and secretion occur. For example, the reabsorption of albumin occurs in the tubule. Some albumin does cross the glomerulus and gets into the tubule, however, most of it is reabsorbed by the time the urine formation is complete. And everything goes finally into the collecting duct, which eventually goes to the bladder.

Identification and Monitoring

Now when we identify and monitor chronic kidney disease, we use two different tests, we look at blood work and we look at what's in the urine. So the kidney function is identified and monitored using the estimated glomerular filtration rate (eGFR) and kidney damage is identified and monitored using the urine albumin-to-creatinine ratio (UACR). This is a graphic that you can use with your patients to discuss GFR. You can see that between 60 and 120 that is considered to be a normal glomerular filtration rate, and that 15 to 60 is considered kidney disease, and less than 15 is kidney failure.

Now if you think of the graphic of the nephron that I had shown previously, consider the GFR the sum of all of the working nephrons. As the nephrons are damaged or are destroyed by diabetes or by high blood pressure, there are fewer of them to filter, to clean the blood. There are fewer of them to activate vitamin D or to make erythropoietin. So fewer nephrons mean a lower GFR, and our goal is to help patients keep their GFR stable if we can.

The estimated glomerular filtration rate will give us an idea how well the kidneys are filtering and we want to follow the trends, stable levels may mean that the therapy is working and that a rapid decline may mean rapid progression. In order to get the estimated glomerular filtration rate, we need to do some blood work, and in particular we need a

serum creatinine level. We also need the age, the race, and the gender of the patient in order to put those parameters into a formula to get the estimated glomerular filtration rate.

We use the serum creatinine, and in the past, creatinine levels have been used to assess kidney function in general. Just briefly, creatinine is a product of muscle creatinine catabolism. Everyday our muscles make a certain amount of creatinine and everyday the kidneys try to excrete most of it. As the creatinine level goes up, that does show that the kidneys are not clearing like they did in the past. However, we have better information now instead of just using the serum creatinine. It is also interesting to note that the levels of serum creatinine transiently increase after we eat meat. Animal muscle has creatinine in it as well, and we will absorb that when we eat animal foods with protein.

The creatinine is freely filtered by the glomerulus and the tubules actually secrete some creatinine into the tubules and that secretion increases when the GFR decreases, and the total urinary excretion will decline as the kidney function declines. The serum creatinine levels are also affected by muscle mass, a large man, his normal creatinine level could be a little bit higher, a little tiny woman she won't have as much muscles so she will not be making as much creatinine on a daily basis.

In addition, as we get older, our serum creatinine levels tend to go up. We lose some of those nephrons as we age whether we have diabetes or not. We are not exactly sure why that happens, but there is a tendency as we get older for the serum creatinine level to go up slightly. And then it depends on gender as well, men have more muscles and they can have higher serum creatinine levels as well; and race makes a difference.

The normal level that we are using for this presentation is between 0.6 and 1.2. The equation that we use to estimate glomerular filtration rate is based on the Modification of Diet in Renal Disease Study (MDRD). The equation uses creatinine, age, race, and gender.

If you use any of the online calculators they'll ask you which type of creatinine assay is used at your lab. Within IHS, the GFR is automatically part of the lab results that you see based on it being already programmed into our RPMS system; however, if you are not in IHS and you don't have that, you will find that the calculators do ask for the creatinine assay that is used. This MDRD equation is not reliable if the creatinine level is rapidly changing. For example if someone is in the Intensive Care Unit. And it's not particularly accurate for people with extremes in muscle mass, in body size, or with altered diet patterns.

The two eGFR formulas you can see are shown here and nobody wants to do this by hand. So you can see that there is a constant, and then the serum creatinine is put in, the age, the gender, and then African-Americans, their GFRs are higher with this correction, and again there are calculators available.

As you can see by this table, if we look at the normal serum creatinine level of 0.6 to 1.2. If we have a 53-year-old man whose creatinine is 2.4, his eGFR based on the MDRD study alone is 30. If they use the isotope dilution mass spectrometry (IDMS) result its 28, so it's a

little bit more accurate if you are using the IDMS assay. Look at the difference between a 65-year-old African-American male with a GFR of 24 versus a 65-year-old African-American female. You can see here based on the gender that the same creatinine level will result in a different eGFR.

This is the top part of the handout [*How Well are Your Kidneys Working?]* that you can use to explain the GFR to patients. You can see that you can put their result and the date, and you can indicate whether or not their GFR is 60 or higher, below 60, or less than 15. And it has some brief information about what GFR stands for.

Moving on to urine albumin or albuminuria, this is assessing kidney damage. From this graphic you can see that blood inside a healthy kidney on the left, blood is on one side of the barrier of the filter and urine is on the other side, and albumin as indicated by the triangles is supposed to stay in the blood. In a damaged kidney, however, that albumin crosses that filter and leaks into the urine. I was talking previously about how albumin is reabsorbed by the tubules, well if there is more albumin going into the urine based on some damage at the glomerulus, the tubules are unable perhaps to reabsorb all of that albumin. Anyway, inside a damaged kidney, the albumin crosses that filter.

If we are going to be assessing kidney damage, we are going to be using the urine albumin to creatinine ratio. As I discussed previously, it's not normal for large levels of albumin to be found in the urine. We use the UACR to assess kidney damage and to monitor whether or not our therapy is working. High levels of UACR are associated with more rapid progression of the kidney disease. A normal UACR is considered to be less than 30 milligrams/gram currently. This may change in the future but at this time we define a urine albumin, positive urine albumin, greater than 30. The UACR is measured in milligrams per gram. Again we don't usually find a lot of albumin in the urine. This particular test can help us identify early kidney disease. There are some folks whose kidney disease is identified by this urine albumin. The good news is we can use a spot urine, no more 24-hour urine collections are required. And if we follow the trends, if the UACR goes down, we can believe that perhaps our therapy is working. And when I say albuminuria, it is equal to or the same term as urine albumin.

Now when I showed you this graphic originally I just had the inside of a normal kidney or health kidney and the inside of a damaged kidney. You can see that this is the rest of the section of the handout where you can write down the patient's result, the date that the UACR was done, what their level is and you can click off whether or not their result below 30 is normal or above 30 may mean kidney disease. As you can see from this handout, *Explaining Your Kidney Test Results* combines both the GFR speedometer that was discussed previously and the urine albumin, UACR results. So if you use these together you can talk to the patients about their kidney function. If their GFR is 60 or higher that is considered normal. If it is less than 60 it may mean kidney disease for the GFR and an eGFR of 15 or less may mean kidney failure. As far as the urine albumin results, if it is above 30 that may mean kidney disease and if the level is high and goes down then you can assure the patient that some of their efforts have been perhaps successful.

This is the back of the handout, it just has some brief information about what the kidneys do, how the kidneys get checked, why, and what happens if people have kidney disease. And it gives a brief bit of information about what to do, no matter what the results are. It says to keep your blood pressure below 130/80, keep your blood glucose and blood cholesterol in your target range, eat foods that are healthy for your heart and cut back on salt, be physically active, stop smoking and take the medicines the way your provider tells you to.

To summarize when we identify and monitor chronic kidney disease, you can see that CKD may be present if the UACR is greater than 30 milligrams/gram, even if the GFR is higher than 60. We consider the eGFR between 15 and 60 to be chronic kidney disease and eGFR less than 15 is considered kidney failure or end stage renal disease.

Patient Education Tools

Moving on to the tools that you can use with your patients - I am going to review eating right for kidney health, how to read a food label, tips for people with chronic kidney disease, briefly give you information about the sodium, protein, phosphorus, and potassium handouts that were developed to be used by dietitians. The kidney test results, the assessment management and treatment tool, which again was designed for registered dietitians.

There is a lot of information about the different nutrients, and the dietitians are best trained to teach people the specifics about chronic kidney disease and nutritional management. However, we have something that any provider can use and that's the *Eating Right for Kidney Health,* and we'll go right into that.

The first steps to the *Eating Right for Kidney Health*, step 1 is to choose and prepare foods with less salt and sodium; step 2, would be to eat the right amount and type of protein; step 3, choose foods that are healthy for your heart.

Step 1: I believe that most of us are talking to the patients about eating less salt and sodium and these tips are probably things that you already discuss with them. That fresh foods have less salt than canned foods or processed foods. That sodium is actually a part of salt; sodium chloride is table-salt. We recommend using spices and herbs and sodium-free seasonings in place of salt. We can have them check the nutrition facts labels on food packages for the sodium content. We can try lower sodium versions of frozen dinners and other convenience foods. And we can rinse the canned vegetables, beans, meats, and fish with water to rinse out a little bit of the sodium, not a whole lot, but it still helps a little bit. And we can look for labels that say sodium-free, salt-free, very low sodium, for example.

When we talk about step 2 and we are talking about protein: protein is the source of nitrogenous waste in the blood. And if we eat less protein, we will have less nitrogenous waste. If we have fewer nephrons, it would probably be better to eat smaller amounts of protein so that we don't tax those remaining nephrons. Anyway, you can see that eating smaller portions of protein foods are recommended and that the protein foods are found in animal foods and plant foods.

We also want people to choose foods that are healthy for their heart, all of those tips. Instead of frying we want them to stew or roast or bake or broil or stir fry, or grill. We'd like them to use nonstick cooking spray or else a small amount of olive oil instead of butter or lard, if they are frying. And of course we ask them to trim the fat from the meat by the leanest meats they can afford, use low-fat dairy products. I can tell you more than what's on here, and I am pretty sure that most of you are aware of those particular items to help keep your heart healthy.

The next steps that people may need to do after reducing the sodium, the protein, and eating heart healthy, would be to choose foods with less phosphorus or/and choose foods that have the right amount of potassium. And these will depend on the person's serum levels of phosphorus and potassium. If you want to use the *How to Read a Food Label Tips for People with Chronic Kidney Disease*, you can see that it tells them to look for sodium, phosphorus, or potassium, and that they should limit saturated and trans fats as well.

When we look at the sodium part of that hand out, it says "look for sodium on the nutrition facts". And you can see that this Nutrition Facts Labels, the product, the serving size at the top is one cup, and you will always find the serving size listed at the top of the nutrition facts label. And it's very important to make sure that your patients are realizing that if they eat this whole container, there are two servings, they are actually having twice as much of everything that's listed on this label. If you scroll down, you can see that the sodium, one serving has 660 milligrams of sodium and that that is 28% of the daily value. For these nutrition facts labels, anything that is 5 or lower is considered low-sodium, anything that is 20% or more is high-sodium. So this particular product whether we look at 660 milligrams, we know that's high, patient would know that's probably high as well, but if they are not comfortable using the milligram part of the label they can go over to the percent daily value and know that if it's higher than 20% that this is a high sodium product.

We also want them to look at the ingredient list. We want them to look for the letters "phos" on the ingredient list. There are many phosphorus additives that have multiple syllables and multiple words and are pretty scary when you read the food label. And so if we can just identify those with "phos", we can helps them identify foods that have added phosphorus.

We can also show them where to look if we are worried about their potassium - that they can start looking on the ingredient list for potassium chloride in particular. What we found is that lower sodium items are now using potassium chloride in place of sodium chloride. So it's going to be very important for us when we are talking to patients about using less salt and perhaps even lower sodium products, that if their potassium is high, they need to make sure that the salt has not been replaced with potassium chloride.

Assess, Manage and Treat

Moving on to the assessment, management, and treatment piece. This is again has been developed for dietitians and is at the National Kidney Disease Education Program website. It is separated into three parts: assessment, it has eGFR and UACR, which you're already

familiar with, and then it goes into slowing the progression and preventing, monitoring, and treating the complications.

To slow progression were going to help the patients control their blood pressure, hopefully help them reduce albuminuria and manage their diabetes. You can see by these graphs that diabetes and hypertension are the leading causes of end-stage renal disease in this country. So both the prevalence in 2007, those people who were on dialysis, many of them have diabetes and hypertension. And that the new cases of end-stage renal disease in 2007 were again mostly attributed to diabetes and hypertension. That's why dietitians are going to be focusing on managing high blood pressure, helping them control their diabetes. This is what one of the pages, page 3, looks like on that particular assessment, management, and treatment guide that has been developed. And you can see that it's a table form. Control blood pressure, it has some brief information. The whole guide is in the same format.

To slow progression, if we help people control their blood pressure, we'd like their target blood pressure to be 130/80 or less, and that of course is individualized. If the doctor wants it a little bit higher or a little bit lower, I would just agree because everything is individualized, whether we are talking about diabetes or blood pressure. There may be some individual variation as what the target should be, but in general 130/80 or less. And to do that we need to limit sodium to 1500 milligrams per day.

We want them to decrease their dietary protein intake, if they are eating a lot. We want them to get it down to about the RDA, which is 0.8 grams/kilogram for people who do not have diabetes. And they recommend 0.8 to 1 gram/kilogram for people with diabetes. For example, if somebody, a 70 kilogram reference male, he needs 0.8 grams of protein, that's 56 grams of protein in a day. One ounce of meat has 7 grams of protein. If somebody eats a 10 ounce steak, they had 70 grams of protein at one time. That's a lot of protein, that's a lot of nitrogenous waste, so smaller protein intake, less meat would probably be a good basic recommendation. And of course we all want them to manage diabetes.

We do not recommend salt substitutes. When we are talking about limiting sodium many people's inclination when we tell them to use less salt is to go purchase a salt substitute. However we need to be aware that the salt substitutes are high in potassium. So we have to give them a caveat when we tell them to use less salt, we may need to mention, "Oh, by the way, a salt substitute is probably not a good idea for you".

Weight reduction may also help control blood pressure. Most of our patients will need multiple medications to control the blood pressure, and if people are on the Angiotensin Converting Enzyme inhibitors or the ACEs, or Angiotensin Receptor Blockers, the ARBs, we need to watch their potassium because they are at risk for hyperkalemia. This graph shows that most people in this country eat more sodium than we need. If the RDA is 2300 milligrams, you can see that at all ages for both genders that most of us in this country eat more sodium than we need. And the recommendation for chronic kidney disease is 1500 milligrams per day.

This is what the handout looks like from the National Kidney Disease Education Program in regards to sodium. This is what the back of the sodium handout looks like, has very similar tips to the ones that we talked about with the eating right - the steps, has the nutrition facts label so you can re-emphasize the need for them to start reading those. And looking at that at the percent daily value, less than 5 is low, that percent daily value over 20 is high.

When we are talking about reducing albuminuria, the evidence is not as strong that lowering dietary protein will reduce albuminuria. It may lower urine albumin particularly if someone has large quantities of albumin in their urine, for those folks it may work a little bit better. But keep in mind when I talked about protein and nitrogenous waste if we are eating less protein it's still going to be benefiting the patient and their kidneys. Most of us eat way more protein than we need. In this country it's on average 1.3 to 1.4 grams per kilogram, that big 10 ounce steak that I talked about previously. The RDA again is 0.8 grams per kilogram bodyweight, and for non-diabetes 0.8, for people with diabetes 0.8 to 1 grams per kilogram bodyweight. And the dietitian will be looking at the specific calculations as far as the total quantity of protein, that's not necessary for non-dietitians to do. I am just trying to give you an idea of why we are saying that eating a little bit less protein is probably a good idea.

You can see from this graph, again people in this country from "What We Eat in America", the NHANES 2007-2008 data, it shows that women and men across all ages eat more protein higher than the RDA. On average women ages over 20, 66 grams of protein per day and men 98, almost 98. And if that reference man only needs 56 grams of protein a day that's an awful lot of extra nitrogenous waste, a lot of metabolic acid, a lot of calories perhaps that they don't need.

Other risk factors for albuminuria beyond hypertension and diabetes include obesity and smoking, and I know that everybody in Indian country is working on the obesity issue. We may reduce albuminuria if we help people lose weight. We are not really sure if hyperlipidemia, a high salt diet, or high protein diet really are risks in relation to albuminuria. We do recommend lowering the protein to help reduce albuminuria, because it may.

The other thing to keep in mind is, sometimes, believe it or not, the dietitian is actually going to have to talk to people about eating more protein. I have shown you slides that show that we eat way more protein than we need; however, in chronic disease, there is a spontaneous decrease in protein intake. People will tell you that meat doesn't taste good anymore. They probably won't come right out and tell you, you may have to ask them. If you are wondering if they've approached that point where they are not eating enough protein – "How does meat taste?" – " Oh! You know what, I found that it just doesn't taste good like it used to, I just don't eat so much. When I have stew, I eat just a little bit, I get mostly the juice." So there is a taste aversion for meat, and it's very common as the eGFR declines. And again that's where the dietitian will be able to be helpful, because they will be able to determine how they can help them eat a little bit more protein to maintain their nutritional status.

This is what the protein handout looks like. Protein metabolism does produce metabolic acid and nitrogenous waste. Those are just things that the nephrons have to excrete, so if we add less in those nephrons we'll have less to excrete. And a serving size of protein at this point is about the size of a deck of playing cards or smaller, if someone can get a little bit less that would not be a bad idea. But again think of that 10 ounce steak, that's like three decks of cards, that's a lot of protein at one time. And we can only make so much protein. The other thing to keep in mind is that we eat protein, we make protein, we can only make so much protein in a day, and what is left over has to be excreted or turned into fat.

We also want people to manage their diabetes. We'd like their A1c to be 7 or less. However, if someone is elderly, if they are having severe hypoglycemia, or if they have multiple comorbid conditions, the control can be less stringent. The Diabetes Complications and Control Trial and the United Kingdom Prospective Diabetes Study showed that diabetes control may help prevent albuminuria. So for those folks who are newly diagnosed, if we can get their A1cs less than 7, there is that metabolic memory that may actually prevent or delay the presence of albuminuria. We need to keep in mind that some diabetes medications are metabolized by the kidneys, insulin for example. I know that I have seen patients whose insulin requirements have decreased to the point where the provider takes them off their insulin and patients tell me "I don't have diabetes anymore, the doctor took me off my insulin". Well, the doctor took them off their insulin because they were afraid that they were going to have low blood sugars, as a result of the insulin continuing to be in a system instead of being excreted by the kidneys. So a spontaneous improvement in diabetes control may indicate the progression of chronic kidney disease.

We want them to treat their hypoglycemia appropriately. We need to know that any kind of juice can treat hypoglycemia. We may actually need to recommend low potassium juice for those folks who are having higher serum potassium levels. And if we want to not even worry about the potassium in the juice, the three to four glucose tabs, always a good thing to carry, certainly a little easier to keep in the truck than low potassium juice, keep it in the pocket or the purse. And I guess 10 jelly beans if they don't put them in a hot car they probably be alright as well. When we're talking to people who have hemodialysis, who are on hemodialysis, juice not is only potassium potentially but it's also fluid. You can see from this graphic that cranberry juice cocktail, which is basically some cranberry juice with sugar, is very low in potassium. So for people whose serum potassiums are elevated having cranberry juice cocktail in their refrigerator might be a better idea than orange juice if they are having hypoglycemic reactions and are tending towards hyperkalemia.

Complications- Part 1

Moving on to the preventing, monitoring, and treating complications, I am going to look at *Your Kidney Test Results* [handout]. We are going to briefly talk about malnutrition, metabolic acidosis, hyperkalemia, the mineral and bone disorders of chronic kidney disease, anemia, and cardiovascular disease. This is the top part of *Your Kidney Test Results*; this is where you can give them their eGFR number and their UACR. I use this and sometimes if somebody's GFR is 34 at one time, and the next time it's 36, and then sometimes maybe it's down to 29, I might put them serially so that they could see that it's

stable. Same thing with the UACR, if somebody's UACR is 212 or 60 or whatever the number is, if it's about the same, the next time we check it, then we can show them that all their efforts, taking the medicine, following the diet, all of those things that we've asked them to do may actually be helping them.

The *Kidney Test Results* handout is quite complicated and it has a lot of language and terminology that people may not be familiar with. When I use this, I do not necessarily go over every single lab results. I would start with one or two and get them familiar with the terminology. I might fill out all of the results, but I would only focus on one. For example, if somebody's serum potassium was higher than 5, because the normal is 3.5 to 5.0, if somebody's potassium was 5.1, I would say that that was a little bit higher than the normal range and then I would talk to them about the foods. If their potassium was fine but I wanted them to know a new word, I might talk about phosphorus and say that I will be talking about phosphorus in ongoing visits. So just to know it's like learning a new language. Don't be afraid to learn the words of this new language because once someone's on dialysis, if they go on to dialysis these are the same labs, these are the same words, these are the same nutrients that they are going to have to be aware of at that time.

The back part of the *Your Kidney Test Results* has the A1c, here it says less than 7, again, if somebody is having hypoglycemia, if they have multiple comorbid conditions and the doctor says the A1c less than 7 is really not the goal, cross it off, put it down, put down what the provider has determined as the goal. There is the cholesterol. You can see, you can write the HDL, the LDL, the triglycerides, and then the hemoglobin. And again the hemoglobin may be low because of the erythropoietin that we need to make red blood cells, they don't have enough of it.

Malnutrition, we're going to be looking at the serum albumin. If people are having urine albumin that means that their serum levels are probably low, and perhaps even very low if they have a lot of albuminuria. I talked previously about there is a spontaneous decrease in intake in protein, the overall appetite decreases as well. And again they have that aversion to high-protein foods, particularly animal foods. I have seen people who will eat eggs, eggs still taste okay to them. And yes, I sort of am concerned about the cholesterol in the egg yolk, but I am not is concerned about that as I am about maybe the sausage or the bacon or the spam that they used to have with the eggs. And I have seen people's serum albumins go up if that person eats one or two egg whites. The egg white has egg albumin in it, and I tell patients that that's all of the ingredients that you need to make your human albumin. So the egg whites is a very good protein to recommend if they are not eating other meats, high quality protein, does not have a lot of phosphorus in it, it's very good, and if people will eat it, it seems to be well-tolerated.

They will also need adequate calories and protein. As far as how many calories they need, that's under debate, some people will do fine with about 1800 calories. The recommendation that you find in guidelines out there, say 30 to 35 calories per kilogram that's an awful lot of calories. Many people can maintain their nutritional status with fewer calories than that, not miniscule or not enough calories, but we don't have to necessarily

be pushing extra calories. We have to watch their weights and their albumins, all sorts of things. Send them to the dietitian.

We also want to monitor their serum albumins, the target for the serum albumin is greater than 4. There is evidence that people who start dialysis with an albumin less than 4 have higher rates of morbidity and mortality. So that's why the serum target is greater than 4. If someone is very albuminuric (nephrotic range) they have a lot of protein in their urine. I have never been able to get their serum albumin up to 4. If somebody's serum albumin is 1.2 because they are losing so much in their urine, no matter how many egg whites they eat, I don't believe we'll get it to 4. The serum albumin level is affected by albuminuria, as I just explained, it also is affected by inflammation, infection, metabolic acidosis and uremia, as well as edema. Edema is more of a complication or a side-effect of the fact that their albumin is so low.

Moving on to metabolic acidosis, in relation to bicarbonate level. The metabolic acidosis is too much acid in the blood, that's what I tell patients. If their serum CO_2 level is less than 22, and I am using that kidney test report card, if it says 20, the serum CO_2 is 20, I will tell them that this number is to low, this is telling me that they have too much acid in the blood. It seems weird that the number is low and there is too much acid, but they are opposites. They are supposed to be balanced, but anyway, if the serum CO_2 is less than 22, it may indicate metabolic acidosis. And dietary protein is a source of metabolic acidosis, in particular animal proteins, animal flesh. Lowering dietary protein may improve serum bicarbonate levels. I have seen that if people are eating those large 10 ounce steaks and they can get down to even 5 ounce steaks, I have seen their serum CO_2s go up. And sodium bicarbonate has been prescribed by providers, by physicians to help correct the serum level, the bicarb replaces the bicarb. However, when we are giving it as sodium, the sodium salt, we have also added to the sodium load. So if I see somebody is on sodium bicarb I really focus on and now I got to tell you, you really got to be stingy with that salt, because this is adding sodium.

Moving on to hyperkalemia. We may see hyperkalemia at higher eGFRs than we would expect when people have diabetes. I don't usually see the potassium start creeping up until the eGFR is quite low. However, in diabetes it may be a higher eGFR. And if people are on an ACE inhibitor or an ARB, they are at risk for hyperkalemia, those medicines increase serum potassium. We are going to restrict the dietary potassium when the serum potassium is greater than 5, and the normal range is 3.5 to 5. So if it's greater than the normal range, we need to start talking to them about that. We don't want them to use those salt substitutes, and we want them to read the ingredient list, particularly for potassium additives, such as potassium chloride. If they look at a light salt ingredient list and they see potassium chloride, they are going to see, oh, this is potassium chloride, and hopefully they won't use it.

There are other guidelines relating to potassium, the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (KDOQI), it recommends 2400 milligrams per day of potassium for people with chronic kidney disease. However, this particular recommendation is not evidence-based. And this is a little confusing if we are following the guidelines. That's not a bad thing to do as long as the guidelines are evidence-based. One

of the slides I am going to show you that most of us don't get enough potassium, so if we are restricting sodium and we're asking them to eat less meat and we're trying to get them to eat less lard or whatever, we don't need to be limiting this potassium until we have to limit it. It's just another complication, it's just more work and it's just more stress on the patient and their family. As you can see here the level that we're supposed to be having for potassium is about 4700 milligrams per day and both women and men in this country, adult women and adult men, do not eat anywhere near the recommended 4700 milligrams per day. So this is another reason why we're not restricting the potassium until they need to have the potassium restricted. On average, women who are 20 years and older, they are having about 2300 milligrams per day; and men, it's about 3000 milligrams per day. We don't have to restrict it, they are already restricting it themselves.

This is what the handout for potassium looks like. It has the same format as the sodium and the protein that we looked at before, what is the mineral, why is it important. A thing to note for you that you may not be aware of is, that they will be told if their potassium level is high - besides limiting high potassium fruits and vegetables that they may also need to eat refined grains, white bread, use white flour. And I know that's really hard to have that come out of our mouths because we are so used to saying eat whole grains, they are more nutritious, they are better for you and they are. However, they are a source of potassium and phosphorus. So for people who have chronic kidney disease, we may need to be telling them to eat refined grains. Sometimes that's really good news, sometimes people are really happy, "Oh! I can eat white bread!" The back of this handout shows the fruits and vegetables that are lower in potassium, and the line here is 200 milligrams or less, and that the fruits and the vegetables that are higher in potassium have more than 200 milligrams in a serving.

Now we need to keep in mind that if somebody has a slice of tomato on a sandwich, tomato is a high potassium food. That's not what is going to be the problem. If they are eating tomato sauce that's going to be a bigger issue. So small amounts of high potassium foods are fine. We also need to keep in mind that large amounts of low potassium foods can turn into a high potassium food. So, they need to be aware of which foods have potassium, to look at the label for the ingredients. If they are eating canned and processed foods, potassium is an issue for them. What I tell patients is, if the potassium level gets too high in the blood, it can make the heart stop beating. Those cardiac arrhythmias, it's true and so heart health, healthy fats and we certainly don't want the heart overexcited with a high serum potassium level. We need to have them control that as well.

Complications – Part 2

The bone disorders with chronic kidney disease, chronic kidney disease actually causes bone disorders, and it's basically because the kidneys are failing to maintain the serum calcium, and phosphorus levels. The calcium and phosphorus will look fine in the blood work until the eGFR is low, and of course it's individual just like everything else. The problem with this though is that the bones may decalcify and the extra-skeletal tissue, the soft tissues, may calcify so the bones get soft and the blood vessels get hard like bone. That's not exactly what we want for the patients.

There are different types of renal bone diseases. The high-turnover bone disease is the one that is the secondary hyperparathyroidism. It's associated with an elevated calcium, phosphorus, intact PTH level and alkaline phosphatase level. The low-bone turnover disease is osteomalacia or adynamic bone disease. Those [are] two different kinds and the levels of those parameters, the calcium, the phosphorus, the iPTH and the alk phos will vary depending. And then the mixed will have features of both low and high bone turnover disease. This is part of why we cannot just recommend one type of a certain level of phosphorus or a certain level of calcium because there are so many different kinds that we just have to be aware that this is going on, and unless we check we are not even going to know this is happening because the serum levels of calcium and the serum levels of phosphorus will look just about fine. Sometimes the calcium is on the low end of normal and the phosphorus is sort of creeping towards the high end but unless you check the PTH, you are not going to know whether or not this renal bone disease is happening.

As far as the bone disorders, how the kidneys are involved is that they activate vitamin D to 1-25-dihydroxy vitamin D. That vitamin D, we need that for calcium absorption. There is a side-effect from this active vitamin D in an effect is that it increases phosphorus absorption, so we can't just be giving people active vitamin D without watching their phosphorus level. Now vitamin D is actually measured as the 25-hydroxy D or the calcidiol level, and sufficiency at this time is to defined as 30 or higher. This is a hot topic, vitamin D, as you all know. But at this point, 30 or higher is considered a sufficient level of vitamin D. And we may need to supplement people with chronic kidney disease and if you do, we need to monitor for the hypercalcemia, because you will see increased calcium absorption and you will need to monitor for hyperphosphatemia, because it does increase phosphorus absorption as well.

Now the parathyroid gland is intimately involved in this whole scenario. There are actually calcium-sensing receptors in this parathyroid gland and the parathyroid, its job is to maintain serum calcium levels. The normal serum level of intact PTH, that's the particular one that we want to assay, the normal serum level is less than 65. And this level, this PTH, iPTH will vary by the kidney function and by the type of bone disease. The PTH secretion is stimulated by hypocalcemia. If those calcium sensing receptors don't sense any calcium, the parathyroid sends out PTH, which then goes and tells the body to make more active vitamin D. So it's a pretty complicated system but you need to check the iPTH levels. PTH is also stimulated by low levels of vitamin D and by hyperphosphatemia.

And this is all with normal people. If people's hypocalcemia is a temporary thing. However, in chronic kidney disease the body becomes resistant to vitamin D and this PTH level gets higher and higher and higher, and can cause problems. The higher ones can cause problems. PTH does stimulate the formation of the active vitamin D, and remember that increases calcium absorption, increases phosphorus absorption. PTH works at the kidney to increase re-absorption of calcium in the tubules to help us maintain our serum calcium level.

The PTH is also helping to increase the excretion of phosphorus by the kidneys. That's why these levels look like they are within the normal range and they are within the normal range, but it's because of this parathyroid hormone that the levels are normal. We've got

to check the PTH. And the problem is that the bones get resorbed and they get soft. The good news is that the serum calcium probably will look within the normal range, but check the PTH.

Serum calcium levels are normally between 8.5 and 10.2. Now, the labs, their normal ranges may vary slightly, but on the kidney test results, this is the serum level that is listed. If your lab uses a little different one it's okay to cross that out and put what your lab uses. If somebody does have albuminuria, meaning they have hypoalbuminemia, they have low serum albumin, we are going to have to correct, use the corrected calcium formula and you can see that here. Serum calcium in mg/dL plus 0.8 X4 minus what that person's serum albumin level is, that will give the corrected calcium.

The normal range for serum phosphorus is 2.7 to 4.6. This is the range that is listed on *Your Kidney Test Results*. If your lab is a little bit different, it's okay to cross it out and put whatever it is that you use. You have already heard that the absorption of dietary phosphorus increases with active vitamin D, that the levels may be normal until the CKD is advanced. There is no one level eGFR that I can tell you that oops, you've got to start limiting the phosphorus.

We have already told people to eat less protein. We have already cut their phosphorus somewhat if they've done that. So that's the good news. As far as the absolute amount, we don't really know what it is for chronic kidney disease. The RDA for phosphorus is 700 milligrams per day and that's for healthy people whose kidneys work. And for people who have chronic kidney disease, they may need a phosphorus binder to bind that phosphorus in the gut. So they need to take that medication with their meals to get the best effect. And people don't always like to take these. One, they have to take them with every meal and they have to remember and it's more medicine. However, this is very important. If people are prescribed them and they are not taking them, and I use that *Your Kidney Test Results*, I tell them that the phosphorus binders help protect the kidneys because this phosphorus doesn't get into the blood and it doesn't go to the kidneys and the kidneys don't have to excrete it. And I've had some success with telling people that it does benefit their kidneys.

And again, foods that are high in protein are a source of dietary phosphorus. The amount that we absorb actually varies on whether it's an animal protein or a plant protein. The phytates in plants decrease the phosphorus absorption. So when we talk about whole foods, we probably absorb somewhere between 40% to 70% of the dietary phosphorus, and different texts will have different percentages. However, the ones that we really need to be concerned about, because we want them to eat food, are those ones that, are added as a food additive, that inorganic phosphorus is thought to be absorbed at about 90% and that's way more efficiently than 50% to 70%. That's why when they look at that ingredient list, it's that "phos" we want them to find. For example, colas have phosphoric acid in them, that's acidulant, it's in there. If you show them a cola that has phosphoric acid in it and you show them a lemon-lime soda that doesn't have any. One that's a really good practice tool, but two, maybe they won't be so scared to look at something the next time as far as the ingredient list.

We eat more phosphorus than we need. We eat more protein. Hey, it goes hand-in-hand. The RDA is 700 milligrams. If it is actually listed on the nutrition facts label, because it will be sometimes found on the nutrition facts the same place that we looked at the sodium with the percent daily values, it doesn't list what the percent daily value is compared to. It will just have that percentage, but I need you to know that if it is listed, if it says 40%, it's 400 milligrams of phosphorus. Because the food label is based on, the percent daily value, is based on 1000 milligrams. It's a little bit confusing. Look for "phos" on the ingredient list instead, it might be easier.

This is what the handout looks like. You can see that it shows a bone because the phosphorus is the one with the mineral bone disorder. Again, the refined grains have less phosphorus. When someone goes to dialysis, they will be told to not eat oatmeal. I know that's hard for us to hear, but there is phosphorus in oatmeal and potassium as well, a little bit. And so just be aware that when they go to dialysis, they are told even stricter things. I have been saying that eating less protein helps lower phosphorus, that's absolutely true and if they need to cut their phosphorus more, they need to look for the ingredient lists and look for foods they do not have "phos" somewhere within those ingredients.

In summary, for this mineral and bone disorders, we want to maintain serum levels. If someone has hypoalbuminemia, we will use the corrected calcium formula to correct for that, to get the serum calcium level. As far as phosphorus is concerned, they may need a phosphorus restriction, they probably will. As far as what that exact level is, that has yet to be determined in chronic kidney disease. But if we are having them eat less protein, we have already restricted their phosphorus. If they need a further restriction, ingredient list "phos" and they may need a phosphate binder.

For iPTH, it's measured as intact PTH. Vitamin D is measured as 25-hydroxy D. And if you are using an active vitamin D supplement, we do need to monitor for hypercalcemia and hyperphosphatemia. If you are using an active vitamin D supplement, you will probably see the PTH level go down as well. So the vitamin D and the PTH they have an inverse relationship because they are maintaining the calcium levels in the blood.

Moving on to anemia, people who have chronic kidney disease may have inadequate synthesis of erythropoietin, the hormone that we need to make red blood cells. We don't really know what the target hemoglobin level is for chronic kidney disease patients. We do know that for the normal population that hemoglobin level is between 12 to 17 and that varies by gender. If someone was going to treat a lack of erythropoietin, a potential lack of erythropoietin with erythropoiesis stimulating agents, an injectable medication. They should be checking the iron status first. If somebody doesn't have enough iron, we are going to have to supplement them with oral or intravenous iron, because we need both ingredients. We need the erythropoietin and the iron in order to make good hemoglobin.

Briefly on the cardiovascular disease. Patients with CKD are at very high risk for cardiovascular disease. It's the leading cause of mortality in chronic kidney disease as well as in everybody else. However in chronic kidney disease, that mineral bone disorder that I was talking about before, that hardening of the blood vessels into bone-like vessels, that's really bad. And that may be part of a big problem for cardiovascular disease and chronic

kidney disease. We are still going with the same cholesterol goals less than 200 for total, less than a 100 for LDL, greater than 40 for HDL, and triglycerides less than 150. And the heart-healthy stuff, we are going to limit the saturated and trans fats.

Dialysis Diets and Summary

Ah! Finally, what about dialysis? So I've got into the what do they need to eat for dialysis section. It's individualized just like everybody else. We just need to keep in mind that hemodialysis and/or peritoneal dialysis, renal replacement therapy, those are done different frequencies. Hemodialysis is three times a week. So that particular diet is strict, because between the time they leave dialysis to the time they come back, all of these things that I have been talking about buildup in their blood. And then that dialyzer, which may have a three-hour, may be a four-hour treatment time, that artificial kidney does not have the capability of taking out massive quantities of all of these things. It can only take out so much time based on the length of treatment. So if people do not put in as much, then that dialyzer doesn't have to take out as much, and they feel better. It's not that we're trying to make the dialyzer's job easier; we want the patient to feel better.

And then peritoneal dialysis, that is done everyday, and since its done everyday, the diet is not quite as strict. In regards to protein, we have been telling them "eat less meat, eat less meat - oh, maybe eat a little meat because you are not feeling so good." When they get to dialysis, they will be told, eat more meat, they need more meat. Hemodialysis, that the dialyzer actually removes some amino acids. Peritoneal dialysis, they lose amino acids every single day in their exchanges. So their protein requirements are higher. We want them to eat high quality, high biologic value protein. We want them to eat meat.

Now the calories per kilogram, depends on age, if somebody is younger than 60, they may need 30 to 35 calories per kilogram. If they are older than 60, they may need about 30 calories per kilogram. For people who do peritoneal dialysis, we will need to keep in mind that the peritoneal dialysis solutions, the dextrose solutions, add calories, and so that needs to be considered as well. For people who are on hemo, they will need a sodium restriction 2000 milligrams per day. People on peritoneal dialysis, sometimes, they can have a little bit of wiggle room with that. But if they are needing higher concentrations of the dextrose solutions, if they are using a lot of 4.25s, because they are eating too much salt and they are trying to pull off more fluid, we need to talk to them about sodium as well.

Potassium will be restricted on hemodialysis patients, between 2 to 3 grams. Again with peritoneal dialysis, they may get to have a little bit more because they clean their blood every single day.

Phosphorus this 800 to a 1000, I am not as sure as it's evidence-based, this is based on the National Kidney Foundation (KDOQI) guidelines. Remember the RDA 700 milligrams, and they are eating more protein. We are giving them more proteins than the RDA, so this is a little bit higher than the RDA, 800 to 1000. And I think that's where they came up with that because of the protein content. And they will have to take phosphorus binders with every single meal, and patients don't like to do that, but it's really beneficial. This is still going to prevent that hardening of the blood vessels.

And then calcium, they will be talked to about limiting the calcium and most of the calcium they may be getting is from calcium-based phosphate binders. It's not that we want them to have 2000 milligrams of dietary calcium, we just need to limit their total intake of calcium, dietary and that from binders to less than 2 grams total per day. And people on hemo will more likely, most likely need a fluid restriction and people with peritoneal dialysis, it's not as common; however, if someone is indiscrete with their sodium, their salt intake, they may swell or gain more weight during the night and they have to pull off more fluid. They may need a bit of a fluid restriction, but that's not very common.

Finally, to summarize, we want to monitor, the eGFR and the UACR. That's going to help us identify chronic kidney disease. It's going to help us see if our therapy is working. The first steps, in regards to the diet is to limit the sodium to 1500 milligrams a day. We want to help them control their blood pressure by reducing the sodium.

We want them to reduce their protein intake if it's excessive that may lower the albuminuria, but it certainly lowers the metabolic acid. It lowers the nitrogenous waste, may lower their bodyweight. If they are eating a lot of protein, eating less may not be a bad idea.

We want them to control their diabetes. They may need that low potassium juice. If we are using the juice to treat a hypoglycemic reaction. And then choose heart healthy fats. We are all saying, don't cook with lard, don't use a lot of bacon, this is all true with chronic kidney disease as well.

If we need to start talking to them about the next steps as far as the diet is concerned. We want them to check the ingredient list for "phos", all of those additives. We want them to have less of them, and for potassium, they may need to check the ingredient list for potassium. They can use that list of foods that are high potassium and low potassium at home to choose their fruits and vegetables.

Well, I certainly thank you for your attention. I hope that the information that has been provided has given you something to use with your patients. If you are overwhelmed and overloaded with information, keep in mind that when we are talking to patients about this, who are scared, that it's really overwhelming and overloading. But I do appreciate your attention. Thank you very much.