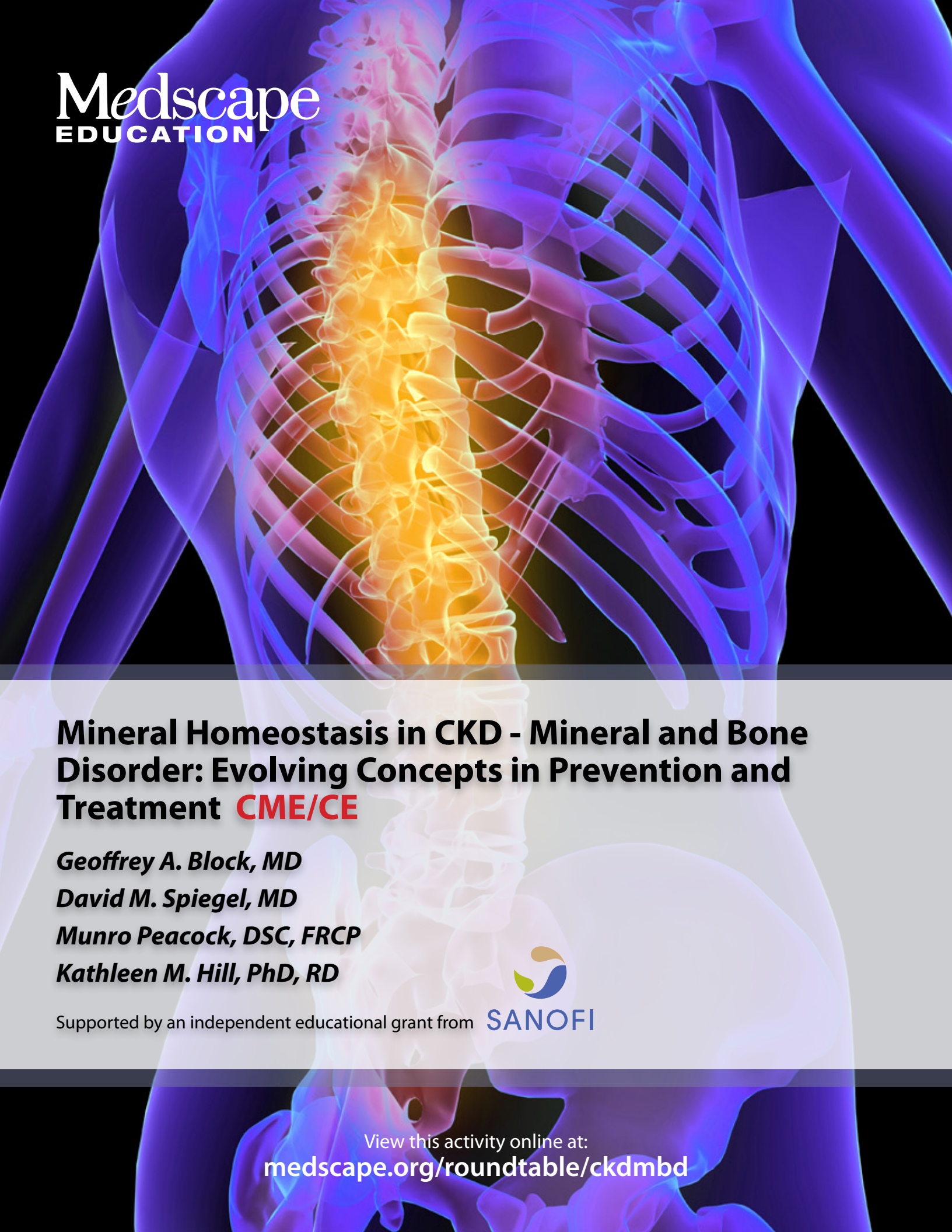

Medscape EDUCATION

Mineral Homeostasis in CKD - Mineral and Bone Disorder: Evolving Concepts in Prevention and Treatment CME/CE

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Munro Peacock, DSC, FRCP

Kathleen M. Hill, PhD, RD

Supported by an independent educational grant from SANOFI

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Target Audience

This activity is intended for nephrologists, nephrology nurses, endocrinologists, cardiologists, family medicine and internal medicine providers, and allied healthcare professionals who treat patients with chronic kidney disease/mineral and bone disorders (CKD-MBD).

Goal

The goal of this activity is to provide healthcare providers with expert perspectives on the relationship between kidney function and bone metabolism, including new data and strategies to treat CKD-MBD.

Learning Objectives

Upon completion of this activity, participants will be able to:

1. Recognize the risks represented by changes in mineral balance and associated morbidity and mortality among patients with CKD

2. Devise strategies to tailor medical therapy with phosphate binders, vitamin D compounds, and/or calcimimetics to prevent or slow the progression of CKD and cardiovascular disease

3. Analyze emerging data on calcium absorption and metabolism in patients with CKD and evaluate new management strategies for patients with CKD-MBD

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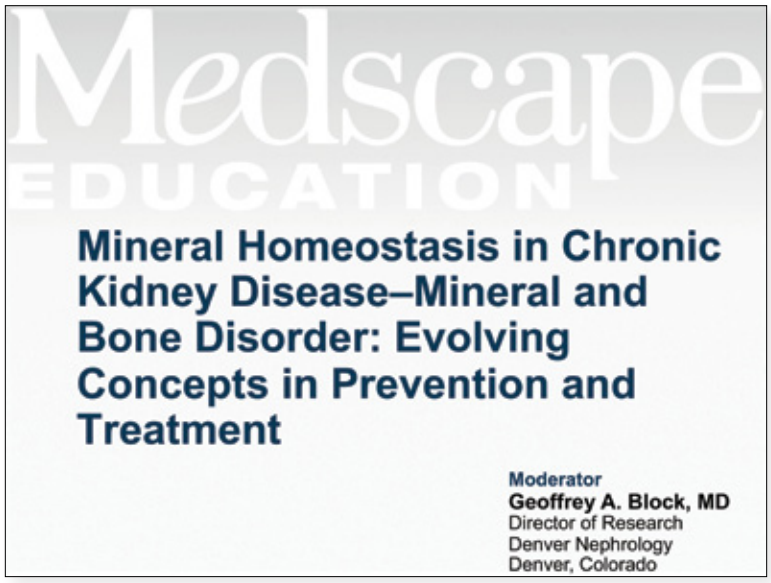
Introduction



Geoffrey A. Block, MD: Hi, and welcome to today's program. I am Dr. Geoffrey Block from Denver Nephrology, and I am joined today by my expert colleagues.

Dr. Block: First, we have Dr. David Spiegel. Dr. Spiegel is a Professor of Medicine at the University of Colorado in Denver, Colorado. Welcome, David.

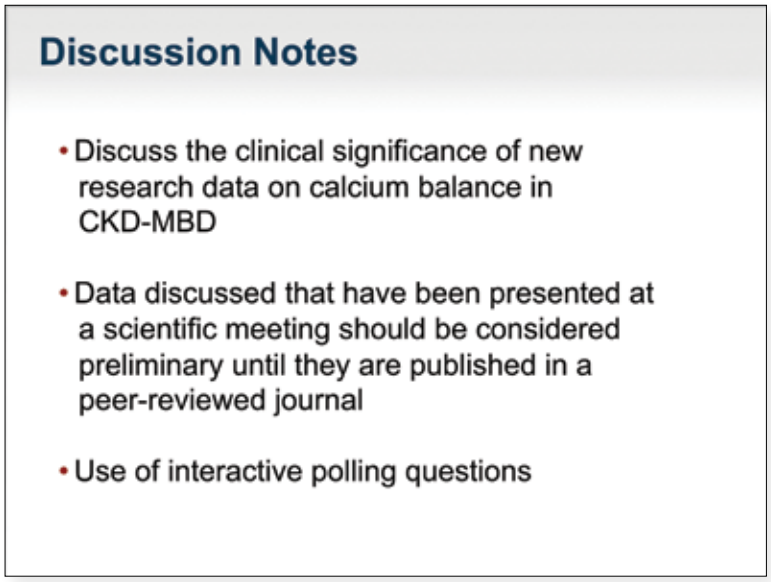
David M. Spiegel, MD: Thank you.

Dr. Block: Next, we have Dr. Munro Peacock. Dr. Peacock is a Professor of Medicine at Indiana University Medical School in Indianapolis, Indiana. It is a pleasure to have you here today, Munro.

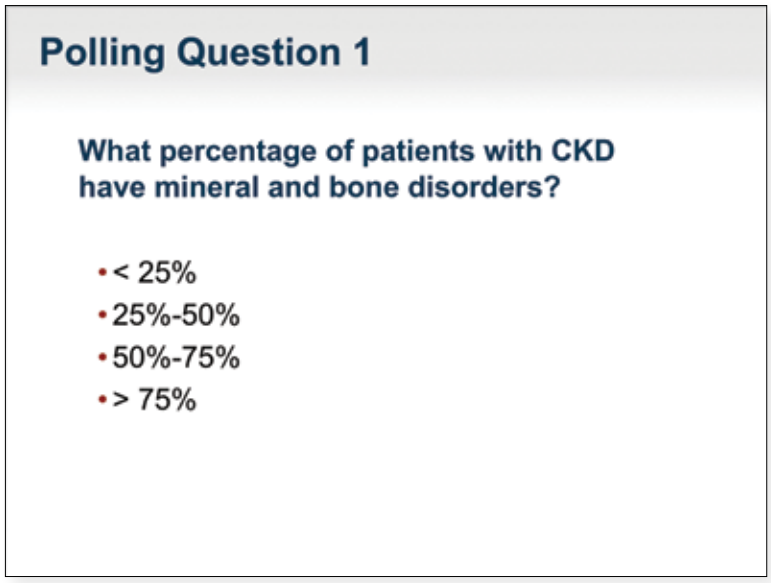
Munro Peacock, DSC, FRCP: Thanks.

Dr. Block: Last but not least, I am pleased to have Dr. Kathleen Hill, also from Indiana University School of Medicine. Welcome, Katie, to today's discussion.

Kathleen M. Hill, PhD, RD: Thank you.



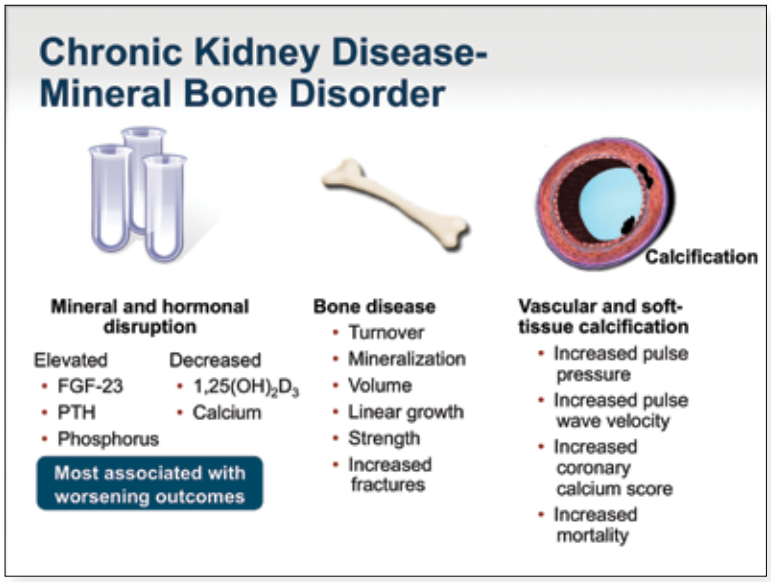
Dr. Block: We are here in Philadelphia, Pennsylvania, at the 2011 American Society of Nephrology Kidney Week. Our goal is to discuss the clinical significance of new research data presented here at the meeting on calcium balance in chronic kidney disease-mineral and bone disorder (CKD-MBD). Of course, data discussed here that have been presented as an abstract at a clinical meeting should be considered preliminary until published in a peer-reviewed journal. I would also like to note that throughout this activity, I will ask interactive questions to gauge your knowledge of this area. When you click on your answer, you will be able to see how your peers have answered.



Dr. Block: How you would answer this question?

What percentage of patients with CKD have mineral and bone disorders?

- ◯ < 25%
- ◯ 25%-50%
- ◯ 50%-75%
- ◯ > 75%

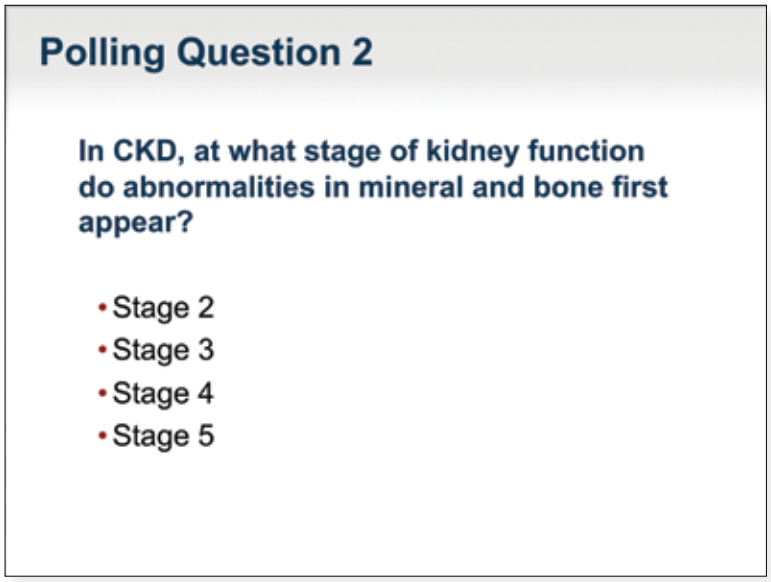


Dr. Block: David, to start us off, perhaps you could guide us. How you would begin to answer this question?

Dr. Speigel: It is a tough question to answer. First of all, CKD is a growing epidemic in this country, driven by obesity, hypertension, smoking, and lipid disorders. Determining what percentage of patients have the bone and mineral disorder of CKD depends a little bit on how you define the condition. Kidney Disease: Improving Global Outcomes (KDIGO) has defined CKD-MBD as a complex interaction of both laboratory abnormalities, bone disease, and vascular disease.[1]

We know now that, early on, there are hormonal changes that occur long before we see mineral changes in patients with CKD. Very early on, we have parathyroid hormone (PTH) elevations in CKD, and now there are also data that FGF-23 [fibroblast growth factor-23] levels rise early in CKD. We know that 1,25-dihydroxyvitamin D levels also fall early in CKD. Those things happen before we see changes in calcium and phosphorus, so the answer to the question of what percent of patients have bone and mineral disorders depends on how you define MBD. Certainly, if you define it as an elevated phosphorus [level], then that occurs late in CKD, and only about 20% of patients will have elevated phosphorus levels, even as late as stage 4. If you define it as elevated PTH levels, then that percentage is higher because it occurs very early.

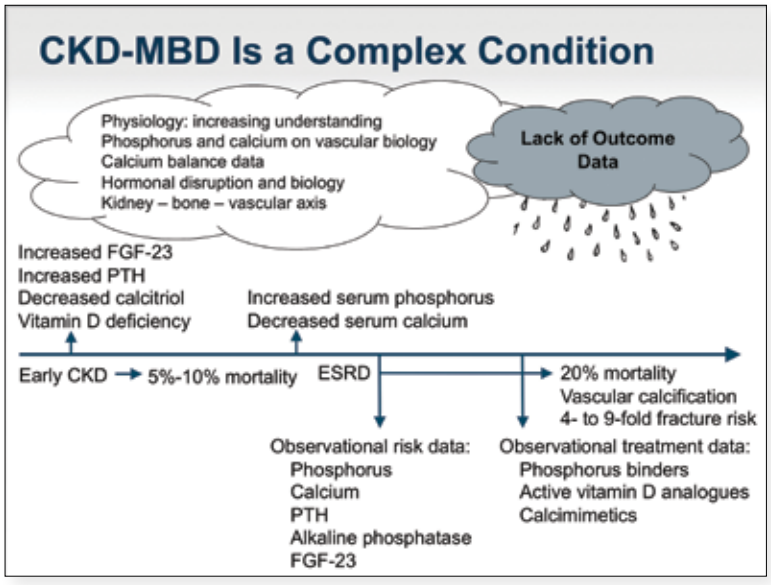
CKD-MBD also involves abnormalities of bone, which probably also occur very early in CKD. KDIGO has given us parameters for evaluating bone disease in terms of turnover, mineralization, volume, and -- in children at least -- linear growth of bone. We know that CKD is accompanied by decreased bone strength, which is the hardest parameter to measure, but the end result is we know that our patients have fracture at a very high rate. Vascular calcification is also a common phenomenon in patients with CKD. It probably progresses as patients progress through stages of kidney disease, and by the time people are on dialysis, it is very common to find both intimal and medial vascular calcification.



Dr. Block: Now I would like to ask the second polling question.

In CKD, at what stage of kidney function do abnormalities in mineral and bone first appear?

- ○ Stage 2
- ○ Stage 3
- ○ Stage 4
- ○ Stage 5



Dr. Speigel: As soon as you can document that there is a decrease in glomerular filtration rate (GFR), I think you can show hormonal changes in a large percentage of patients, especially if you look carefully at FGF-23.

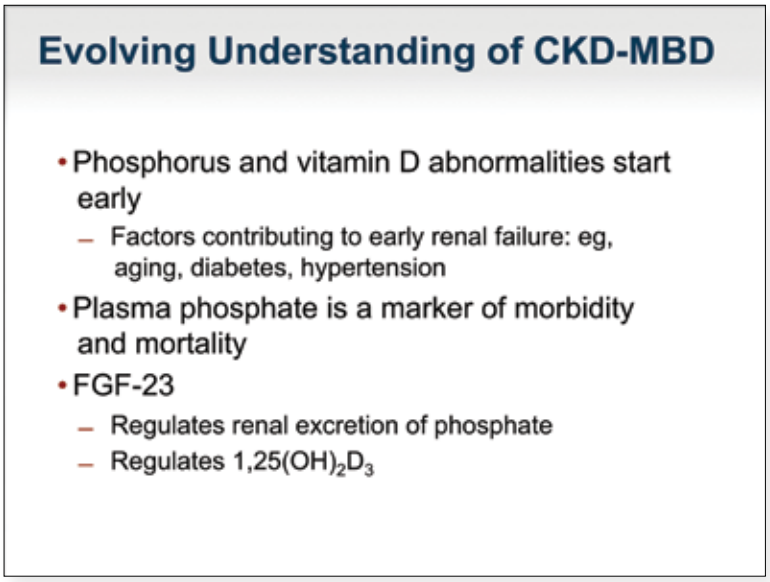
In terms of the process of what happens in patients with CKD, we know that hormonal abnormalities occur early on, and we can predict what will happen to these patients once they have a diagnosis of CKD. The disease is associated with very high mortality, and that mortality risk increases as CKD progresses. By the time patients are on dialysis, in this country at least, the mortality rate is more than 20%. The problem with treatment of patients with CKD is that we have a lot of what I will call "observational risk data," which show that patients with elevated serum phosphorus, elevated calcium, elevated PTH, and now elevated FGF-23 [levels] all have an increased mortality.

Then we have another set of data, which I call "observational treatment data," showing that patients who get placed on phosphate binders early may have improved survival. Patients who get treated with active vitamin D analogues may have improved survival, and patients who get treated with calcimimetics may also have an improved survival, but all these data are observational. I think we have some very positive information -- a "bright cloud," if you will -- that shows we understand more and more about the kidney-bone-vascular axis. But we also have a "dark cloud" hanging over our field, in that we have not done the large outcome studies to guide us in how to treat these patients at different stages of CKD.

Dr. Block: It is remarkable that we do not have any outcome studies, whether it be in CKD stages 2, 3, 4, or 5, regarding the treatment of MBD to tangibly affect patient outcomes. One of the key things that you mentioned with regard to how we view CKD-MBD now is the shift in focus from composite laboratory bone calcification to the real meaningful thing, which is, "What is happening to your patients? Are they having fractures? Are they living longer? Do they feel better? Are they going in the hospital?" Those are the things that we need to be studying that we are just not studying yet.

It appears that very early in CKD, probably long before the patient ever gets referred to a nephrologist, we can begin to see these abnormalities. As you just pointed out, data are showing that regulatory hormones may be the first indicator of abnormalities in CKD-MBD. You mentioned a few of those regulatory markers like FGF and 1,25 vitamin D. Dr. Peacock, I would like to hear your thoughts on how our understanding of the early physiology of CKD has evolved dramatically over the last few years.

Dr. Peacock: The central issue is that the kidney is the main excretory organ for calcium and phosphate, so an adult in balance is absorbing, say, 200 mg of calcium and 800 mg of phosphate. Most of that has to come out in urine. As soon as the GFR drops, the body still has to continue to excrete that amount, unless intake or absorption decrease, so calcium and phosphate in the plasma increase. That sets up an alarm in the endocrine system, which wants to keep calcium and phosphate serum concentrations normal because of the very vital actions of calcium and phosphate in tissues. And so the endocrine system is alerted. We have known for many years that when you decrease the GFR below, say, 60 mL/min/1.73 m^2, then PTH secretion is increased and that leads to hyperparathyroid (HPT) bone disease. We also know that the hormonal form of vitamin D, 1,25-dihydroxyvitamin D3 made in the kidney, also decreases, and that eventually leads to osteomalacia. The rise in serum calcium and phosphate that occurs later certainly leads to ectopic calcification in soft tissues, particularly in blood vessels. So, it is these 3 actions that occur.

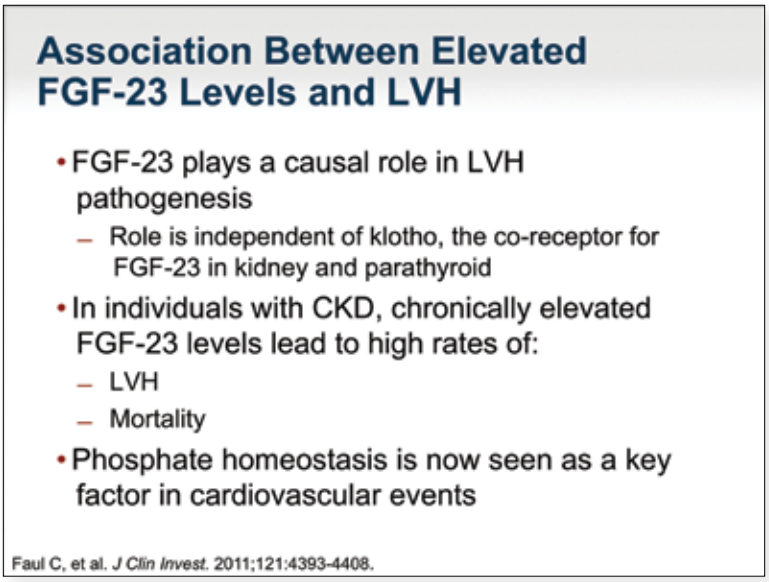


But if we look at a patient who has early renal failure, that, I think, is where the action is. In the last decade it has become obvious, first of all, that the normal population is moving into renal failure with aging and with a number of other conditions, such as hypertension and diabetes. There are many patients whom we call normal but who are in early renal failure. We have come to realize that plasma phosphate is a marker of morbidity and mortality in this population and, of course, in the population who has established or well-recognized renal failure.

The other thing that has really changed the field is that we have discovered the hormone that regulates phosphate. It was unknown 10 years ago. Now we know that fibroblast growth factor, FGF-23, acts on the kidney to do 2 things. First, it allows the kidney to excrete more phosphate and brings the phosphate back down, and second -- very important -- it regulates 1,25-dihydroxyvitamin D3 production, which regulates phosphate absorption. All of this has moved the field into looking at the earliest effects of renal failure. This is of interest not only to nephrologists but also to people in medicine and the endocrinologists and dietitians and all the other groups who are interested in the healthy population.

Dr. Block: And cardiology as well. Before, when we talked about cardiorenal syndromes, we focused mainly on how cardiac pump function is altered by kidney changes. Now we are learning that, when the kidney changes early, these hormones affect the heart and may play a role in why the heart ultimately fails.

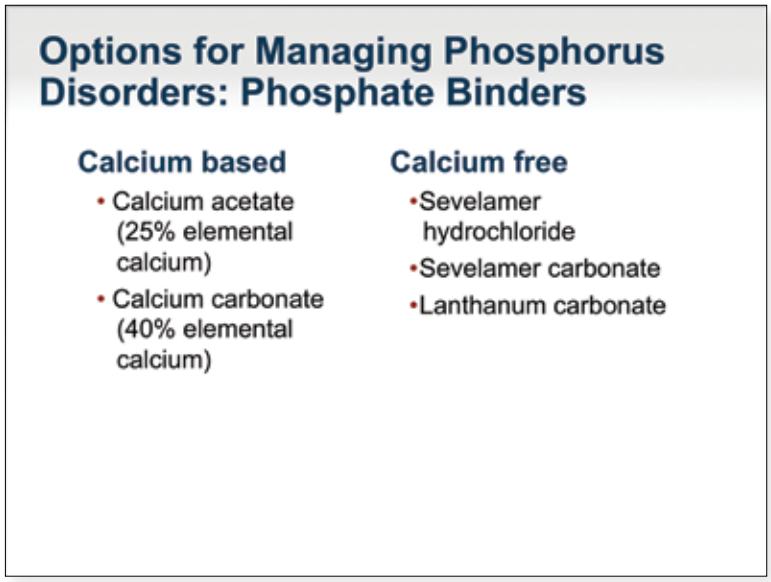
I am sure all of us have read with great interest the article by Christian Faul and colleagues, with Myles Wolf as the senior author, that was just published in *Journal of Clinical Investigation*. The article is a really solid piece of work that has brought together the concept of cardiac-renal homeostasis. It centers on phosphorus, which is interesting. Katie, maybe you can help talk about that a little bit.



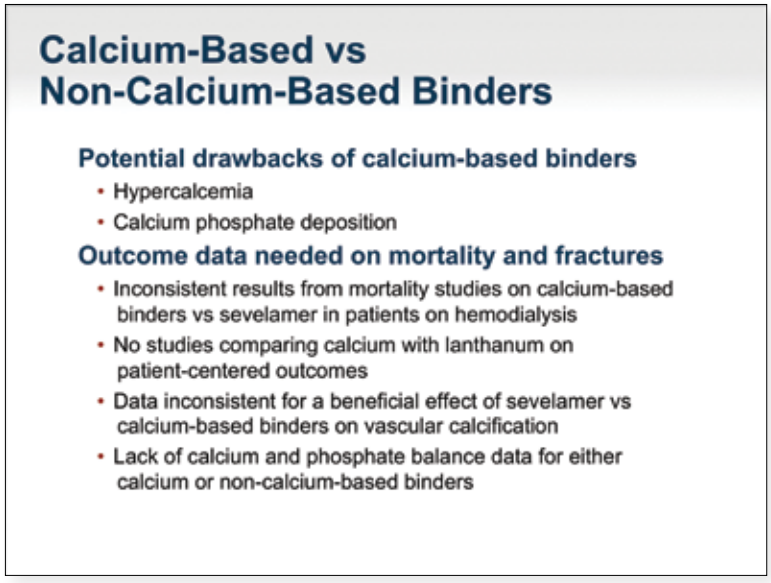
Dr. Hill: Yes. This study by Faul and colleagues showed that, in patients with CKD, elevated FGF-23 is independently associated with left ventricular hypertrophy (LVH). Through a series of very nice experiments in both cell and tissue, they showed that FGF-23 plays a causal role in the pathogenesis of LVH and that this role is not dependent on the coreceptor klotho, which is present and necessary for FGF-23 action in the parathyroid and the kidney. This finding shows that chronically elevated FGF-23 levels in these patients are important for the high rates of LVH and the high rates of mortality that we see in individuals with CKD.

Dr. Block: David, you mentioned that mortality is 20% per year in the end-stage renal disease (ESRD) population, but I find it amazing that with GFRs of 45 mL/min/1.73 m2, the cardiovascular hospitalization rate, the cardiovascular event rate, is 5 or 10 times higher. We are talking about people with normal CHEM-7s [blood chemistry values], normal hemoglobin values -- what ostensibly looks like normal biochemistry. But as you point out, Katie, the FGF article changes everything. It puts phosphate homeostasis potentially at the center of these cardiovascular events. Yet, nephrologists in general are quite uncertain about how to we manage phosphorus over the course of evolving CKD. That is the hot topic.

Now that we have this wonderful piece of work showing that FGF-23 is related to LV mass and is likely to be related to events, how do we lower it? How do we treat people with disorders of phosphorus, and what do we have available to us? Right now the only thing we have available are phosphate binders. We have interventional trial data on those agents, but they have never been looked at in terms of hard outcomes. Katie, maybe you can share your thoughts about our choices of phosphate binders and their advantages and disadvantages.



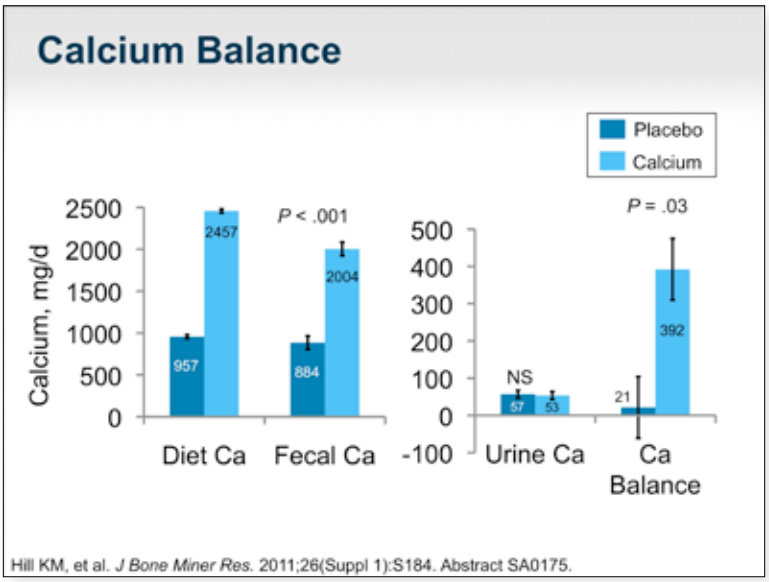
Dr. Hill: The 2 main categories of phosphate binders are calcium-based and non-calcium-based. The commonly used calcium-based ones are calcium acetate, which is 25% elemental calcium, and calcium carbonate, which is 40% elemental calcium.



With calcium-based binders, there is always the possibility of hypercalcemia or perhaps progressing calcium phosphate deposition if that is present. The non-calcium-based binders are sevelamer, in the forms of sevelamer hydrochloride and sevelamer carbonate, and lanthanum carbonate. These bind phosphate as anion exchangers and do not necessarily have the effect of hypercalcemia in patients.

However, there are limited outcome data to suggest use of one phosphate binder over another. Studies comparing calcium-based and non-calcium-based binders have investigated mortality, vascular calcification, and bone outcomes. While some of these studies have shown a benefit of using the non-calcium-based binders such as sevelamer over calcium carbonate, others have shown no difference. There is still uncertainty about what the data are showing us, so we need more studies with hard outcome data on mortality and fractures to be able to determine which phosphate binders are best to use.

Dr. Block: You bring up a great point. David and I have done some of that work, and I agree with you -- some of the research points in one direction and some points in the other direction, and so there is uncertainty. One of the things that you brought up with calcium vs noncalcium agents is whether serum calcium values should be the marker by which we evaluate their safety. Are these drugs safe because they do, or do not, increase serum calcium? I think all of you have done some work with regard to how much calcium actually gets into us. What is the calcium balance? As you said, Munro, the physiology we try to maintain is a neutral balance as you reach a steady state -- the "in" equals the "out." But when we provide this elemental calcium load in the form of calcium binders, we run into some potential problems. One of the exciting things at this year's meeting are the abstracts that both of you have submitted with regard to calcium balance. We have had very little calcium balance data or phosphorus balance data in the past 20 years. Katie, maybe you can share with us a little bit about your work with Dr. Peacock on this and how you approach this balance issue.



Dr. Hill: What I will show you with our data is that you can have very high positive calcium balance but serum calcium remains completely normal -- you have not affected it. At the ASN [American Society of Nephrology] meeting this year, we are reporting our results from a study in patients with stage 3 and 4 CKD, where we measured calcium balance and phosphate balance while the patients were on a controlled calcium and phosphate diet. We previously reported our calcium balance data in these patients at the American Society of Bone and Mineral Research in September 2011. What we found is that, as expected, when patients are given 1500 mg per day of elemental calcium in the form of a calcium carbonate phosphate binder, fecal calcium increases from 884 mg per day to just over 2000 mg per day. Urinary calcium, however, is unaffected. Patients are absorbing a lot more net calcium, but they are not excreting any more in their urine. This is a problem that results in a positive calcium balance. We can see that, on placebo, when the patients were on a basal diet of around 1000 mg of calcium per day, they essentially were in neutral calcium balance, but given the 1500 mg of calcium from the phosphate binder, they went up to around 400 mg positive calcium balance. This was a significant difference, being able to produce a pretty substantial positive calcium balance by giving this phosphate binder. We did not see any differences in serum calcium, so we were not producing hypercalcemia in these patients.

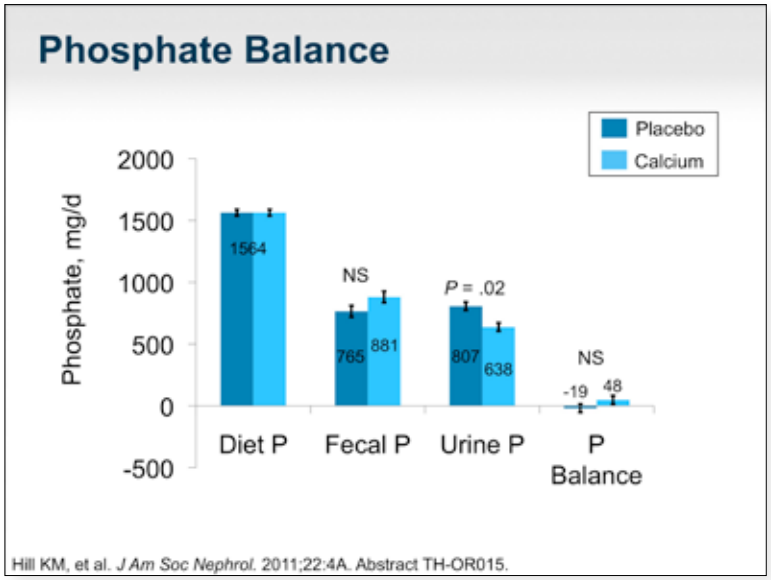
Dr. Block: That is fundamentally important for how we treat these patients, particularly if we are going to start treating them early. Given the FGF data, the temptation is to start using phosphate binders very early in the course of CKD-MBD. I think we have to show a little restraint, because we do not have the clinical studies to demonstrate whether or not using clinical doses of a binder to produce nearly 400 mg per day of positive calcium balance will turn out to be beneficial.

Dr. Peacock: This is of concern to the population with osteoporosis and the elderly. Many of these patients are in early renal failure, and one of the standard therapies is calcium supplementation. We hope the calcium is going into the bone, but of course there is no way of knowing that it is not going into the soft tissues.

Dr. Block: Some recent meta-analyses suggest that giving calcium supplementation may not be good for cardiovascular risk in that population. In your data, Katie, even with 1000 mg of calcium, your patients were essentially neutral or slightly positive. Your finding that serum calcium does not change makes the point that we cannot rely on that. It may also be true that serum phosphorus does not reflect phosphate load or balance quite so well.

Dr. Speigel: This is fundamentally important. We think of this when we think of potassium balance and sodium balance in CKD. We know patients with CKD have a limited ability to handle loads of potassium and of sodium, and we adjust the dietary intake to meet what the kidney can put out. What we are clearly finding now is that the same is true with calcium and probably with phosphorus. We need to think more about adjusting intake to match what the kidney is able to put out.

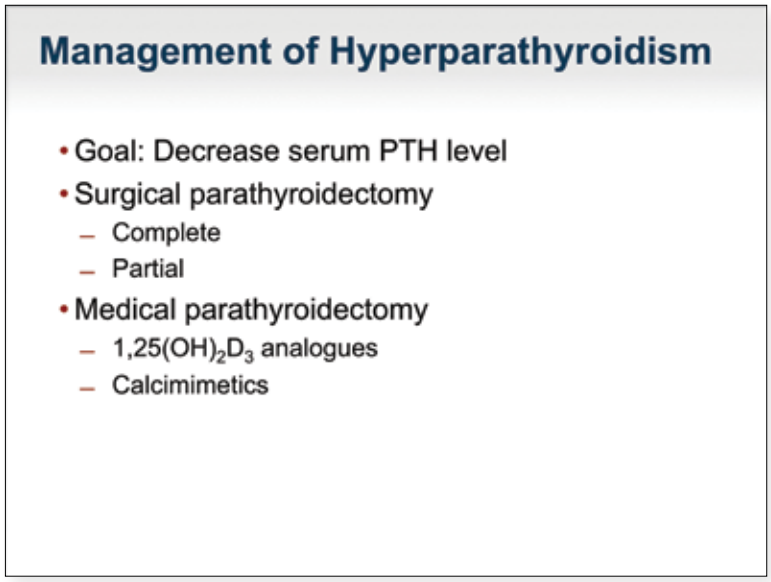
Dr. Block: That is absolutely true.



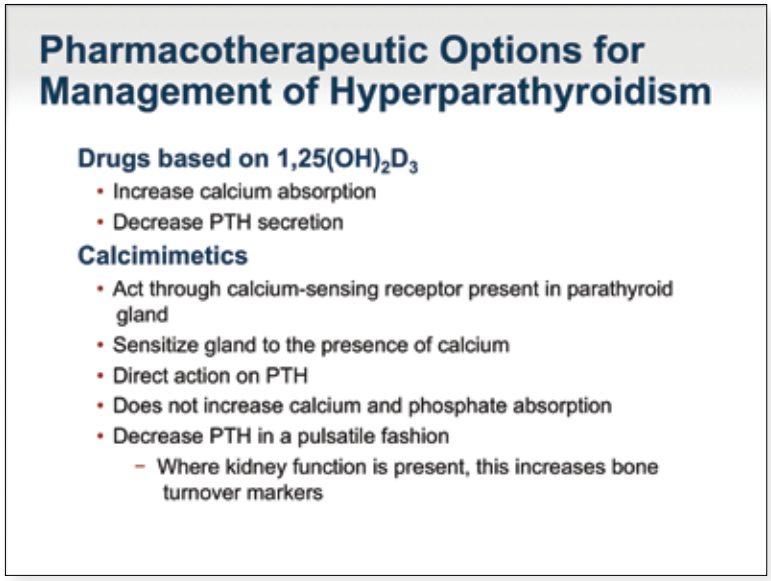
Dr. Hill: We also have corresponding data for the phosphate balance. This is really interesting too, because you are giving a level of calcium that is quite high -- 1500 mg per day -- which, as you mentioned, is what is used clinically. The effect on phosphate balance is very minimal, so we also gave a controlled diet of 1500 mg of phosphate, and there was no difference between either placebo or calcium. Fecal phosphate was unaffected. Urine phosphate was decreased with the calcium supplement, which was what you would hope to see, but only by about 170 mg per day, which was a pretty modest effect. Phosphate balance was not different. It was essentially neutral in both of the conditions of the treatment. So, there was a huge effect on calcium balance but a pretty modest effect on phosphate throughput and binding phosphate.

Dr. Block: This work makes us question our standard thinking and our standard approach to what we are doing. People have the perception that this is a benign event. We have been using phosphate binders forever, and we will just give our patients phosphate binders earlier. But what your data point out is that there are some concerns that we need to be aware of in that regard.

You cannot talk about the issue of calcium balance, CKD-MBD, and calcium vs noncalcium without getting to the basic issue of vitamin D and PTH and the management of hyperparathyroidism. As both of you described earlier, FGF seems to be one of the proximate reasons why 1,25-dihydroxyvitamin D3 goes down as you lose kidney function. When you reach ESRD, of course, we treat hyperparathyroidism with pretty large doses of vitamin D and/or use of a calcimimetic. Dr. Peacock, you are involved in some studies presented here that are interesting with regard to comparing how those 2 drugs work.



Dr. Peacock: In the past, the management has been to do a surgical parathyroidectomy, or to do a partial procedure so that you leave some of the parathyroid tissue in, and bring down the parathyroid blood level. That is very difficult to do, and so we are very fortunate, I think, having 2 classes of drugs that allow us to attempt, if you will, a medical parathyroidectomy.



The first class of drugs is based on 1,25-dihydroxyvitamin D. In addition to increasing calcium absorption, these drugs act to decrease the secretion of PTH directly. A number of these analogues have been developed. The goal in using these is to bring down the serum PTH and not to increase calcium absorption from the gut or calcium resorption and phosphate resorption from bone. These agents are very effective.

The second group are the calcimimetics, and they act through a different mechanism. They act on the calcium-sensing receptor, which is present in a number of tissues, including the parathyroid gland. The allosteric calcimimetics sensitize the gland to the presence of calcium, and so they decrease PTH. There are 2 different mechanisms involved. One acts on PTH directly and also increases calcium and phosphate absorption from gut, whereas the other one decreases PTH but does so in a pulsatile fashion. Where there is kidney function present, this has an effect on increasing bone turnover markers. So, they have a slightly different action, as one might think. Further work is needed developing these 2 types of drug. Ideally we will have a drug that only acts on the parathyroid receptor in terms of the vitamin D, and the same for the calcimimetic.

Treatment Strategies for SHPT

	IV Stratum		Oral Stratum	
	Paricalcitol	Cinacalcet	Paricalcitol	Cinacalcet
iPTH (pg/mL)	N = 60	N = 60	N = 70	N = 70
BL	527.6 ± 18.8	523.8 ± 18.9	500.6 ± 19.9	509.5 ± 16.6
Mean Δ	-224.2* ± 36.4	-78.4 ± 36.4	-216.3 ± 24.5	-150.2 ± 24.5
AP (IU/L)	N = 50	N = 51	N = 53	N = 64
BL	109.2 ± 7.1	124.0 ± 6.0	95.6 ± 4.7	104.5 ± 5.7
Mean Δ	-17.5 ± 6.6	+28.9 ± 6.5	-14.4* ± 5.1	+4.3 ± 4.6
BSAP (U/L)	N = 50	N = 50	N = 54	N = 61
BL	35.9 ± 2.3	41.9 ± 3.1	39.2 ± 3.1	47.6 ± 2.5
Mean Δ	=8.5* ± 3.6	+20.4 ± 3.6	-12.0* ± 2.6	+0.8 ± 2.5
Calcium (mg/dL)	N = 60	N = 61	N = 70	N = 70
BL	9.0 ± 0.1	9.1 ± 0.1	9.1 ± 0.1	9.1 ± 0.1
Mean Δ	+0.5* ± 0.1	-0.7 ± 0.1	+0.3* ± 0.1	+0.7 ± 0.1
Phosphorus (mg/dL)	N = 60	N = 60	N = 70	N = 70
BL	4.8 ± 0.1	4.9 ± 0.1	4.7 ± 0.1	4.4 ± 0.1
Mean Δ	+0.2 ± 0.2	-0.2 ± 0.2	+0.7* ± 0.2	+0.2 ± 0.2

*$P < .05$ between treatment groups; values are units ± SE.
AP = alkaline phosphatase; BL = baseline; BSAP = bone-specific alkaline phosphatase; iPTH = intact parathyroid hormone; SHPT = secondary hyperparathyroidism.
Martin KJ, et al. *J Am Soc Nephrol.* 2011;22:648A. Abstract SA-PO2297.

Dr. Block: A trial presented here this week, the IMPACT-SHPT trial, directly compares the protocols that use vitamin D-based therapies with cinacalcet-based therapies. Much to many people's surprise, these investigators found that PTH suppression was quite good with both therapies and was even a little better in the paricalcitol treatment arm. The bone markers that you mentioned did not really go in the direction that we had expected.

Treatment Strategies for SHPT (cont)

- Both calcium-based therapy and cinacalcet suppressed PTH[a]
  - Paricalcitol was slightly more effective[a]
- Use of a calcimimetic increases bone turnover
- Pulsatile effect on PTH
- Stimulate new bone growth [?]
- Further studies are needed, including combination therapy studies

a. Martin KJ, et al. *J Am Soc Nephrol.* 2011;22:648A. Abstract SA-PO2297.

Dr. Peacock: If you look at the work in primary hyperparathyroidism, giving the calcimimetic increases bone turnover. Again, I think it is the pulsatile effect on PTH, which is anabolic to the skeleton. I do not think the nephrologists should be so worried because the bone markers go up. That may be a good thing. You actually may be stimulating new bone formation, so I think further studies are needed along these lines to see exactly what we are doing to the bone.

Dr. Block: There is a trial that has been going on for roughly 3.5 or 4 years to look at hard outcomes related to cinacalcet-based therapies vs standard vitamin D-based therapies. Hopefully next year, if we have this same conversation, we will have some data to discuss if that trial finishes and we get a chance to look at it

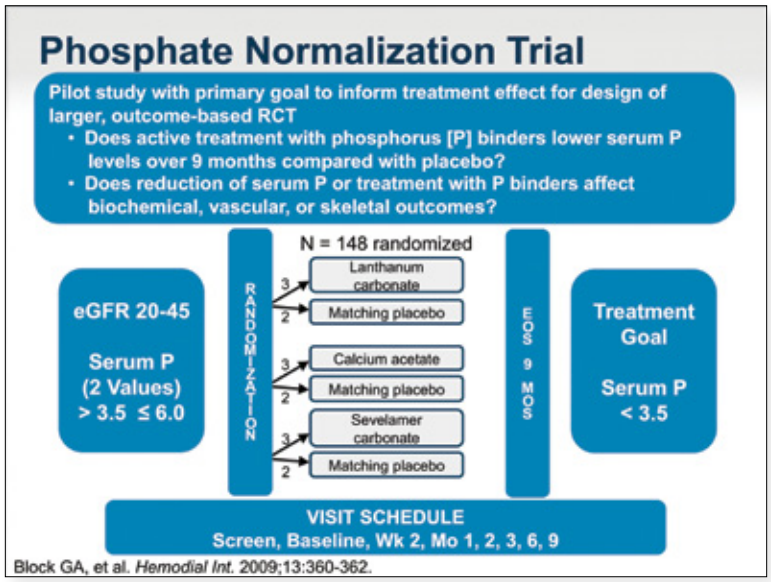
Dr. Peacock: Studies are needed where we combine these therapies. Again, this may be an approach that is very useful.

Dr. Block: David, you have done some studies similar to Katie's looking at calcium balance and have participated in some randomized trials of phosphate binder use. What is your thought on calcium-based phosphate binders, and the role of calcium balance in managing early CKD-MBD?

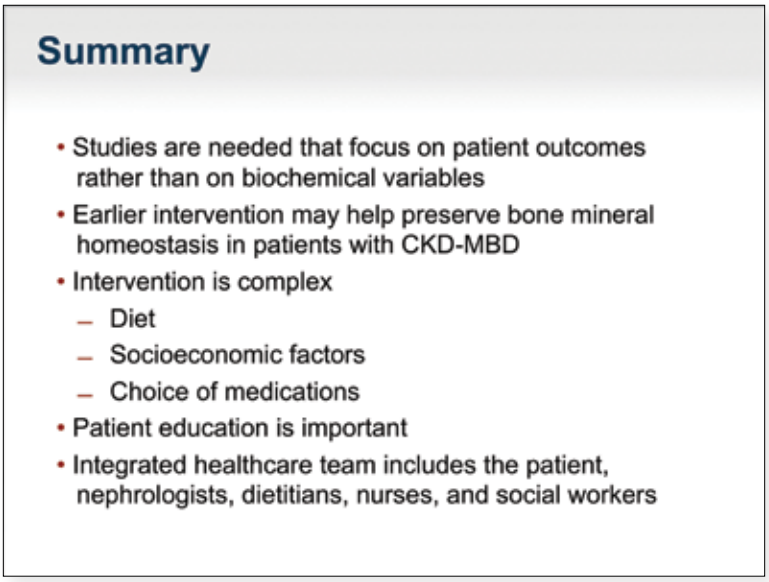
Dr. Speigel: We had an abstract at last year's ASN, which yielded data very similar to Katie's, in that patients with CKD on 2000 mg of calcium intake are in marked positive calcium balance. Certainly, the 2 studies seem to be finding the same things. That paper is currently under review.

The question is, is there a role for calcium-based phosphate binders in any stage of CKD? If patients with CKD follow our recommendations in terms of diet and restrict their milk and dairy intake, it is possible that their calcium intake can drop quite low. It is even possible, I think, that some people could be in negative calcium balance if they are on a very restricted diet. So, there may be a little bit of a role in those patients for some calcium supplementation or even for some calcium-based binders, but I think we have to be very cautious about that recommendation. We have to know what their dietary calcium intake is, and we probably should adjust their binders to bring them back to what we think is a neutral calcium balance, which may be in the order of 800 mg to 1200 mg total elemental calcium intake.

Dr. Block: You and I have worked together on a trial using these agents. Could you tell us about that trial design and what you think about how we are going to make these outcomes better in the future?



Dr. Speigel: The trial you are referring to is the Phosphate Normalization Trial, and it is a very nice study. Geoff, you were the one who spearheaded this study, and I think deserve congratulations for it. You pulled together an international group of nephrologists to help design the study and lead the trial, and then you pulled together industry to help sponsor the trial. The trial is a pilot study whose goal is to see if you can take patients with CKD who have normal to slightly elevated serum phosphorus levels, randomize them to the 3 predominant phosphate binders -- calcium acetate, sevelamer, and lanthanum with a matching placebo in each arm -- and then treat them for 9 months, to get their serum phosphorus to a target of less than 3.5 mg/dL. The beauty of the study also is that you have measured urinary phosphorus levels, fractional excretion of phosphorus, serum and urinary calcium, PTHs, 1,25-dihydroxyvitamin D -- all the hormones that we have been talking about. I think the study will give us a lot of information on the hormonal changes that occur when you place patients on phosphate binders, and hopefully it will be a tool or foundation to guide us for what will ultimately be a large randomized outcome study that will give us some hard information.



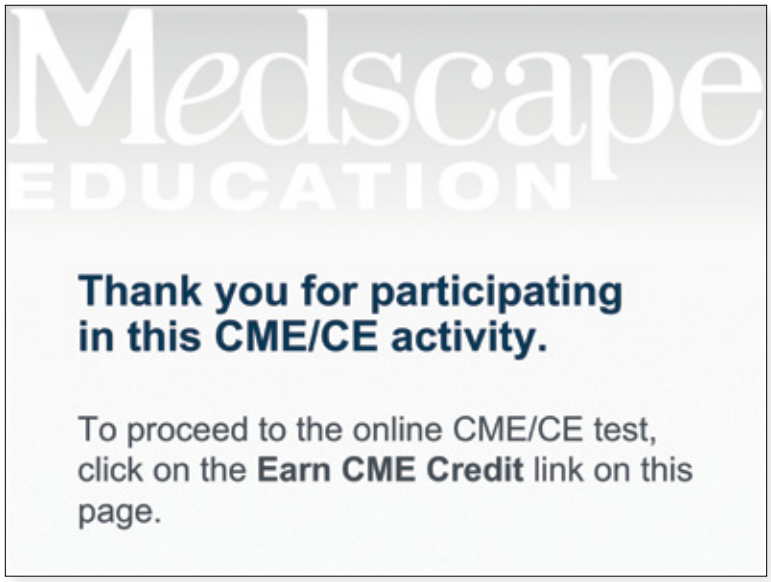
Dr. Block: I completely agree, and I want to end with that thought. I think that the data that you have presented are really clear. We need to focus on patient-centered outcomes as the endpoint of our clinical trials and not on biochemical parameters. Drugs that may be effective in lowering phosphorus or modifying calcium or raising vitamin D are not the endpoint, and we need to do placebo- controlled, randomized outcome trials of these interventions.

In closing, we all agree, I think, that we need to have earlier intervention, and it becomes clear that the intervention is complicated. It involves diet. It involves social behavior. It involves food choices. It involves what kind of food choices you can make based on your income and where you live, and it involves how you pick medicine based on cost. Katie, your thoughts about the integrated approach about managing CKD-MBD moving forward.

Dr. Hill: We need all of the healthcare professionals working together as a team -- the dietitians, the social workers, the nephrologists, the nurses, and even the patients, all focusing on the patient as the center of the healthcare team. Patient education is going to be very important. All of the members of the multidisciplinary team should work toward the patient-centered outcome and should educate patients to take responsibility for their own health and disease course.

Dr. Block: It is remarkable how often we blame patients for this problem. We blame them because their body is not behaving the way we want it to when we give them our medicines. I agree with you -- we need an integrated collaborative approach with the patient in the middle, because it is clearly important to educate patients about the nutritional aspect, about what is happening to their physiology. I think that the future will be an integrated approach early in the course of CKD, not waiting until they get to dialysis.

Dr. Hill: There is definitely room for patient education. A study published in 2010 in the journal *Nephrology Dialysis Transplantation* surveyed about 150 dialysis patients and found that about one half of them did not know what high-phosphate foods were. One half of them did not know what the consequences of high serum phosphate were, but, encouragingly, 75% to 80% of them wanted to know more about CKD-MBD. There is a want and a need for patient education.



Dr. Block: Our patients put their trust in us, and we need to honor that. Thank you, Katie, thank you, Munro, and thank you, David, for an excellent conversation. I hope you found this program of value in the clinical management of patients with CKD-MBD. Thank you for participating in this CME/CE [continuing medical education/continuing education] activity. To proceed to the online CME/CE test, click on the earn CME credit link on this page.

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