



# Chronic Kidney Disease- Mineral and Bone Disorder

## What is chronic kidney disease-mineral and bone disorder (CKD-MBD)?

CKD-MBD occurs when the kidneys fail to maintain the proper levels of calcium and phosphorus in the blood, leading to abnormal bone hormone levels. CKD-MBD is a common problem in people with kidney disease and affects almost all patients receiving dialysis.

CKD-MBD is most serious in children because their bones are still growing. The condition slows bone growth and causes deformities. One such deformity occurs when the legs bend inward toward each other or outward away from each other; this deformity is referred to as “renal rickets.” Another serious complication is short stature. Symptoms can be seen in growing children with renal disease even before they start dialysis.

The bone changes from CKD-MBD can begin many years before symptoms appear in adults with kidney disease. For this reason, the disease is known as a “silent crippler.” If CKD-MBD in adults is left untreated, the bones gradually become thin and weak, and a person with CKD-MBD may begin to feel bone and joint pain. CKD-MBD also increases the risk of bone fractures.

Doctors used to use the term renal osteodystrophy to describe the mineral and hormone disturbances caused by kidney disease. Now renal osteodystrophy is used only to describe the bone problems that result from CKD-MBD.

## Why are hormones and minerals important?

In healthy adults, bone tissue is continually being remodeled and rebuilt. The kidneys play an important role in maintaining healthy bone mass and structure because one of their jobs is to balance calcium and phosphorus levels in the blood and ensure the vitamin D a person receives from sunlight and food becomes activated.

Calcium is a mineral that builds and strengthens bones. Calcium is found in many foods, particularly milk and other dairy products. If calcium levels in the blood become too low, four small glands in the neck called the parathyroid glands release a hormone called parathyroid hormone (PTH). This hormone draws calcium from the bones to raise blood calcium levels. Too much PTH in the blood will remove too much calcium from the bones; over time, the constant removal of calcium weakens the bones.

Phosphorus, an element found in most foods, also helps regulate calcium levels in the bones. Healthy kidneys remove excess phosphorus from the blood. When the kidneys stop working normally, phosphorus levels in the blood can become too high, leading to lower levels of calcium in the blood and resulting in higher PTH levels and the loss of calcium from the bones. Even before blood levels of phosphorus become elevated, the kidneys are forced to work harder to clear phosphorus from the body.

Healthy kidneys produce calcitriol from vitamin D that is received from sunlight



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and food. Calcitriol helps the body absorb dietary calcium and phosphorus into the blood and bones. Calcitriol and PTH work together to keep calcium balance normal and bones healthy. If calcitriol levels drop too low, PTH levels increase and calcium is removed from the bones. In a person with kidney failure, the kidneys stop making calcitriol. The body then cannot absorb calcium from food, leading to increased PTH levels. The combination of decreased calcium absorption from food and PTH drawing calcium from bones makes the bones weak and brittle.

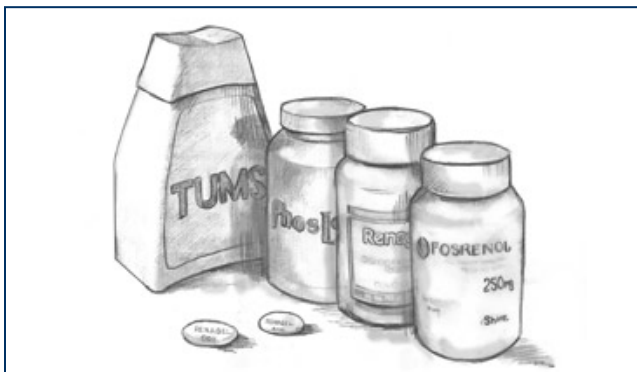
## How is CKD-MBD diagnosed?

To diagnose CKD-MBD, a doctor may take a blood sample to measure levels of calcium, phosphorus, PTH, and sometimes vitamin D. The doctor may perform a bone biopsy to see if the bone cells are building normal bone. A bone biopsy is done under local anesthesia and involves removing a small sample of bone from the hip and analyzing it with a microscope. Determining the cause of CKD-MBD helps the doctor decide on a course of treatment.

## How is CKD-MBD treated?

Controlling PTH levels prevents damage to bones. Usually, overactive parathyroid glands are controllable with a change in diet, dialysis treatment, or medication.

CKD-MBD can be treated with changes in diet. Reducing dietary intake of phosphorus is one of the most important steps in preventing bone disease. Almost all foods contain phosphorus, but it is especially high in milk, cheese, dried beans, peas, nuts, and peanut butter. Drinks such



These medications decrease the absorption of phosphorus into the blood.

as cocoa, dark sodas, and beer are also high in phosphorus. Often, medications called phosphate binders—such as calcium carbonate (Tums), calcium acetate (PhosLo), sevelamer hydrochloride (Renagel), or lanthanum carbonate (Fosrenol)—are prescribed with meals and snacks to bind phosphorus in the bowel. These medications decrease the absorption of phosphorus into the blood. A renal dietitian can help develop a dietary plan to control phosphorus levels in the blood.

Increasing dialysis dose by increasing a patient's flow rate or time in treatment can also help control phosphorus.

If the kidneys are not making adequate amounts of calcitriol, a person can take synthetic calcitriol as a pill (Rocaltrol) or in an injectable form (Calijex). Other types of vitamin D that may be prescribed are ergocalciferol (Calciferol, Drisdol), cholecalciferol (Delta D3), doxercalciferol (Hectoral), and paricalcitol (Zemplar). A doctor may prescribe a calcium supplement in addition to calcitriol. The drug cinacalcet hydrochloride (Sensipar), approved by the U.S. Food and Drug Administration in 2004, lowers PTH levels by imitating calcium's effects on the parathyroid gland. If PTH levels cannot be controlled, the parathyroid glands may need to be removed surgically.

A good treatment program, including proper attention to diet, dialysis, and medications, can improve the body's ability to repair bones damaged by CKD-MBD. Overall bone health can also be improved by exercising and not smoking. People on dialysis should consult a health care professional before beginning any exercise program.

## Points to Remember

- Chronic kidney disease-mineral and bone disorder (CKD-MBD) occurs when the kidneys fail to maintain the proper levels of calcium and phosphorus in the blood.
- CKD-MBD is a common problem in people with kidney disease and affects almost all patients receiving dialysis.
- If calcium levels in the blood become too low, or phosphorus levels too high, four small glands in the neck called the parathyroid glands release a hormone called parathyroid hormone (PTH). This hormone draws calcium and phosphorus from the bones to raise blood calcium levels.

- Healthy kidneys convert vitamin D into calcitriol to help the body absorb dietary calcium and phosphorus into the blood and bones. If calcitriol levels drop too low, PTH levels increase and the bones can become weak and brittle.
- Reducing dietary intake of phosphorus is one of the most important steps in preventing bone disease.
- Medications called phosphate binders are prescribed with meals and snacks to bind phosphorus in the bowel.
- Increasing dialysis dose by increasing a patient's flow rate or time in treatment can also help control phosphorus.
- If the kidneys are not making adequate amounts of calcitriol, a person can take synthetic calcitriol or other forms of vitamin D as a pill or in an injectable form.
- If PTH levels cannot be controlled, the parathyroid glands may need to be removed surgically.

## Hope through Research

The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), through its Division of Kidney, Urologic, and Hematologic Diseases, supports several programs and studies devoted to improving treatment for patients with progressive kidney disease and end-stage kidney failure, which is sometimes called end-stage renal disease or ESRD, including patients on hemodialysis:

- **The End-Stage Renal Disease Program.** This program promotes research to reduce medical problems from bone, blood, nervous system, metabolic, gastrointestinal, cardiovascular, and endocrine abnormalities in end-stage kidney failure and to improve the effectiveness of dialysis and transplantation. The research focuses on reuse of hemodialysis membranes and using alternative dialyzer sterilization methods; devising more efficient, biocompatible membranes; refining high-flux hemodialysis; and developing criteria for dialysis adequacy. The program also seeks to increase kidney graft and patient survival and maximize quality of life.
- **The Frequent Hemodialysis Network.** This multicenter clinical trial will test whether receiving hemodialysis more than the standard three times a week provides better outcomes.

- **The U.S. Renal Data System (USRDS).** This national data system collects, analyzes, and distributes information about the use of dialysis and transplantation to treat kidney failure in the United States. The USRDS is funded directly by the NIDDK in conjunction with the Centers for Medicare & Medicaid Services. The USRDS publishes an *Annual Data Report*, which characterizes the total population of people being treated for kidney failure; reports on incidence, prevalence, mortality rates, and trends over time; and develops data on the effects of various treatment modalities. The report also helps identify barriers to the delivery of quality health care and opportunities for more focused studies of renal research issues.
- **The Hemodialysis Vascular Access Clinical Trials Consortium.** This program is conducting a series of multicenter, randomized, placebo-controlled clinical trials of drug therapies to reduce the failure and complication rate of arteriovenous grafts and fistulas in hemodialysis. Recently developed anti-thrombotic agents and drugs to inhibit cytokines are being evaluated in these large clinical trials.

Participants in clinical trials can play a more active role in their own health care, gain access to new research treatments before they are widely available, and help others by contributing to medical research. For information about current studies, visit [www.ClinicalTrials.gov](http://www.ClinicalTrials.gov).

## For More Information

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## Acknowledgments

Publications produced by the Clearinghouse are carefully reviewed by both NIDDK scientists and outside experts. This publication was reviewed by Mary Leonard, M.D., University of Pennsylvania Health System, Philadelphia, and Sharon Moe, M.D., Indiana University School of Medicine, Indianapolis.

## About the Kidney Failure Series

The NIDDK Kidney Failure Series includes booklets and fact sheets that can help you learn more about treatment methods for kidney failure, complications of dialysis, financial help for the treatment of kidney failure, and eating right on hemodialysis. For free single printed copies of this series, please contact the National Kidney and Urologic Diseases Information Clearinghouse.

You may also find additional information about this topic by

- searching the NIDDK Reference Collection at [www.catalog.niddk.nih.gov/resources](http://www.catalog.niddk.nih.gov/resources)
- visiting MedlinePlus at [www.medlineplus.gov](http://www.medlineplus.gov)

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U.S. DEPARTMENT OF HEALTH  
AND HUMAN SERVICES  
National Institutes of Health

NIH Publication No. 09-4630  
February 2009

