



Anemia in Chronic Kidney Disease

What is anemia?

Anemia is a condition in which the body has fewer red blood cells than normal. Red blood cells carry oxygen to tissues and organs throughout the body and enable them to use energy from food. With anemia, red blood cells carry less oxygen to tissues and organs—particularly the heart and brain—and those tissues and organs may not function as well as they should.

How is anemia related to chronic kidney disease?

Anemia commonly occurs in people with chronic kidney disease (CKD)—the permanent, partial loss of kidney function. Anemia might begin to develop in the early stages of CKD, when someone has 20 to 50 percent of normal kidney function. Anemia tends to worsen as CKD progresses. Most people who have total loss of kidney function, or kidney failure, have anemia.¹ A person has kidney failure when he or she needs a kidney transplant or

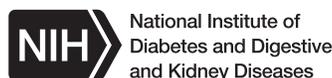
dialysis in order to live. The two forms of dialysis include hemodialysis and peritoneal dialysis. Hemodialysis uses a machine to circulate a person's blood through a filter outside the body. Peritoneal dialysis uses the lining of the abdomen to filter blood inside the body.

What are the kidneys and what do they do?

The kidneys are two bean-shaped organs, each about the size of a fist. They are located just below the rib cage, one on each side of the spine. Every day, the kidneys filter about 120 to 150 quarts of blood to produce about 1 to 2 quarts of urine.

Healthy kidneys produce a hormone called erythropoietin (EPO). A hormone is a chemical produced by the body and released into the blood to help trigger or regulate particular body functions. EPO prompts the bone marrow to make red blood cells, which then carry oxygen throughout the body.

¹Brugnara C, Eckardt KU. Hematologic aspects of kidney disease. In: Taal MW, ed. *Brenner and Rector's The Kidney*. 9th ed. Philadelphia: Saunders; 2011: 2081–2120.



What causes anemia in chronic kidney disease?

When kidneys are diseased or damaged, they do not make enough EPO. As a result, the bone marrow makes fewer red blood cells, causing anemia. When blood has fewer red blood cells, it deprives the body of the oxygen it needs.

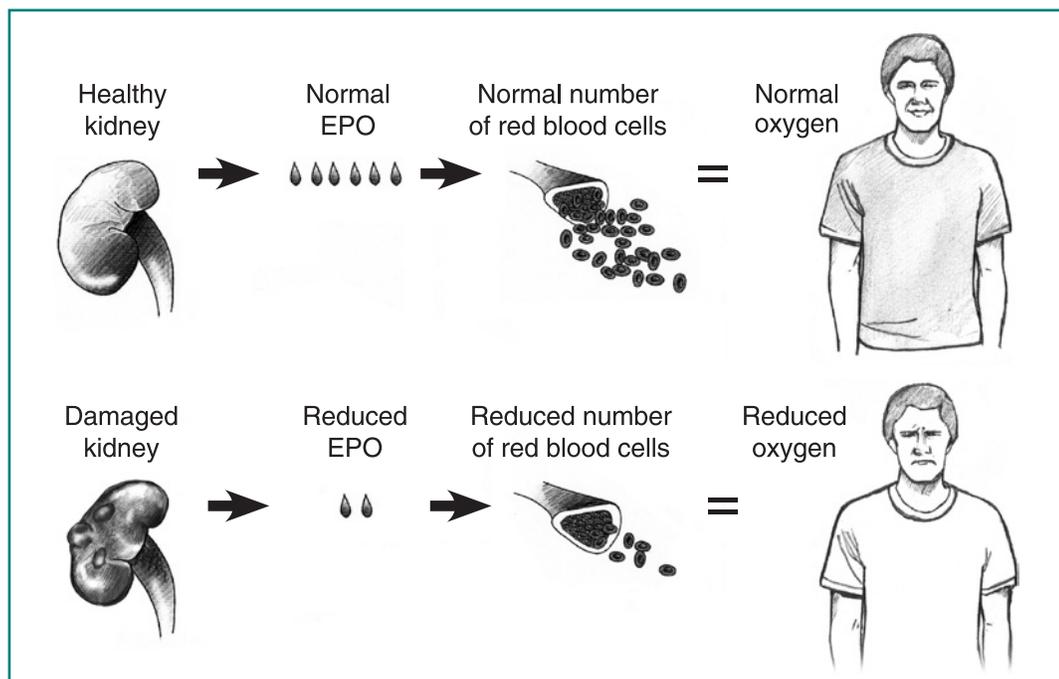
Other common causes of anemia in people with kidney disease include blood loss from hemodialysis and low levels of the following nutrients found in food:

- iron
- vitamin B12
- folic acid

These nutrients are necessary for red blood cells to make hemoglobin, the main oxygen-carrying protein in the red blood cells.

If treatments for kidney-related anemia do not help, the health care provider will look for other causes of anemia, including

- other problems with bone marrow
- inflammatory problems—such as arthritis, lupus, or inflammatory bowel disease—in which the body’s immune system attacks the body’s own cells and organs
- chronic infections such as diabetic ulcers
- malnutrition



Healthy kidneys produce a hormone called EPO. EPO prompts the bone marrow to make red blood cells, which then carry oxygen throughout the body. When kidneys are diseased or damaged, they do not make enough EPO. As a result, the bone marrow makes fewer red blood cells, causing anemia.

What are the signs and symptoms of anemia in someone with chronic kidney disease?

The signs and symptoms of anemia in someone with CKD may include

- weakness
- fatigue, or feeling tired
- headaches
- problems with concentration
- paleness
- dizziness
- difficulty breathing or shortness of breath
- chest pain

Anyone having difficulty breathing or with shortness of breath should seek immediate medical care. Anyone who has chest pain should call 911.

What are the complications of anemia in someone with chronic kidney disease?

Heart problems are a complication of anemia and may include

- an irregular heartbeat or an unusually fast heartbeat, especially when exercising.
- the harmful enlargement of muscles in the heart.
- heart failure, which does not mean the heart suddenly stops working. Instead, heart failure is a long-lasting condition in which the heart can't pump enough blood to meet the body's needs.

How is anemia in chronic kidney disease diagnosed?

A health care provider diagnoses anemia based on

- a medical history
- a physical exam
- blood tests

Medical History

Taking a medical history is one of the first things a health care provider may do to diagnose anemia. He or she will usually ask about the patient's symptoms.

Physical Exam

A physical exam may help diagnose anemia. During a physical exam, a health care provider usually examines a patient's body, including checking for changes in skin color.

Blood Tests

To diagnose anemia, a health care provider may order a complete blood count, which measures the type and number of blood cells in the body. A blood test involves drawing a patient's blood at a health care provider's office or a commercial facility. A health care provider will carefully monitor the amount of hemoglobin in the patient's blood, one of the measurements in a complete blood count.

The Kidney Disease: Improving Global Outcomes Anemia Work Group recommends that health care providers diagnose anemia in males older than age 15 when their hemoglobin falls below 13 grams per deciliter (g/dL) and in females older than 15 when it falls below 12 g/dL.² If someone has lost at least half of normal kidney function and has low hemoglobin, the cause of anemia may be decreased EPO production.

²Kidney Disease: Improving Global Outcomes (KDIGO) Anemia Work Group. KDIGO clinical practice guideline for anemia in chronic kidney disease. *Kidney International Supplements*. 2012;2(4):279–335.

Two other blood tests help measure iron levels:

- The ferritin level helps assess the amount of iron stored in the body. A ferritin score below 200 nanograms (ng) per liter may mean a person has iron deficiency that requires treatment.²
- The transferrin saturation score indicates how much iron is available to make red blood cells. A transferrin saturation score below 30 percent can also mean low iron levels that require treatment.²

In addition to blood tests, the health care provider may order other tests, such as tests for blood loss in stool, to look for other causes of anemia.

How is anemia in chronic kidney disease treated?

Depending on the cause, a health care provider treats anemia with one or more of the following treatments:

Iron

The first step in treating anemia is raising low iron levels. Iron pills may help improve iron and hemoglobin levels. However, for patients on hemodialysis, many studies show pills do not work as well as iron given intravenously.²

Erythropoietin

If blood tests indicate kidney disease as the most likely cause of anemia, treatment can include injections of a genetically engineered form of EPO. A health care provider, often a nurse, injects the patient with EPO subcutaneously, or under the skin, as needed. Some patients learn how to inject the EPO themselves. Patients on hemodialysis may receive EPO intravenously during hemodialysis.

Studies have shown the use of EPO increases the chance of cardiovascular events, such as heart attack and stroke, in people with CKD. The health care provider will carefully review the medical history of the patient and determine if EPO is the

best treatment for the patient's anemia. Experts recommend using the lowest dose of EPO that will reduce the need for red blood cell transfusions. Additionally, health care providers should consider the use of EPO only when a patient's hemoglobin level is below 10 g/dL. Health care providers should not use EPO to maintain a patient's hemoglobin level above 11.5 g/dL.² Patients who receive EPO should have regular blood tests to monitor their hemoglobin so the health care provider can adjust the EPO dose when the level is too high or too low.² Health care providers should discuss the benefits and risks of EPO with their patients.

Many people with kidney disease need iron supplements and EPO to raise their red blood cell count to a level that will reduce the need for red blood cell transfusions. In some people, iron supplements and EPO will improve the symptoms of anemia.

Red Blood Cell Transfusions

If a patient's hemoglobin falls too low, a health care provider may prescribe a red blood cell transfusion. Transfusing red blood cells into the patient's vein raises the percentage of the patient's blood that consists of red blood cells, increasing the amount of oxygen available to the body.

Vitamin B12 and Folic Acid Supplements

A health care provider may suggest vitamin B12 and folic acid supplements for some people with CKD and anemia. Using vitamin supplements can treat low levels of vitamin B12 or folic acid and help treat anemia. To help ensure coordinated and safe care, people should discuss their use of complementary and alternative medical practices, including their use of dietary supplements, with their health care provider.

Read more about vitamin B12 and folic acid on the MedlinePlus website at www.nlm.nih.gov/medlineplus. Read more about complementary and alternative medicine at www.nccam.nih.gov.

Eating, Diet, and Nutrition

A health care provider may advise people with kidney disease who have anemia caused by iron, vitamin B12, or folic acid deficiencies to include sources of these nutrients in their diets. Some of these foods are high in sodium or phosphorus, which people with CKD should limit in their diet. Before making any dietary changes, people with CKD should talk with

their health care provider or with a dietitian who specializes in helping people with kidney disease. A dietitian can help a person plan healthy meals.

Read more about nutrition for people with CKD on the National Kidney Disease Education Program website at www.nkdep.nih.gov.

The following chart illustrates some good dietary sources of iron, vitamin B12, and folic acid.

Food	Serving Size	Iron	Vitamin B12	Folic Acid
Recommended Daily Value		18 mg	6 mcg	400 mcg
100 percent fortified breakfast cereal	¾ cup (1 oz)	18 mg	6 mcg	394 mcg
beans, baked	1 cup (8 oz)	8 mg	0 mcg	37 mcg
beef, ground	3 oz	2 mg	2 mcg	8 mcg
beef liver	3 oz	5 mg	67 mcg	211 mcg
clams, fried	4 oz	3 mg	1 mcg	66 mcg
spinach, boiled	1 cup (3 oz)	2 mg	0 mcg	115 mcg
spinach, fresh	1 cup (1 oz)	1 mg	0 mcg	58 mcg
trout	3 oz	0 mg	5 mcg	16 mcg
tuna, canned	3 oz	1 mg	1 mcg	2 mcg

Points to Remember

- Anemia is a condition in which the body has fewer red blood cells than normal. Red blood cells carry oxygen to tissues and organs throughout the body and enable them to use energy from food.
- Anemia commonly occurs in people with chronic kidney disease (CKD)—the permanent, partial loss of kidney function. Most people who have total loss of kidney function, or kidney failure, have anemia.
- When kidneys are diseased or damaged, they do not make enough erythropoietin (EPO). As a result, the bone marrow makes fewer red blood cells, causing anemia.
- Other common causes of anemia in people with kidney disease include blood loss from hemodialysis and low levels of the following nutrients found in food:
 - iron
 - vitamin B12
 - folic acid
- The first step in treating anemia is raising low iron levels.
- If blood tests indicate kidney disease as the most likely cause of anemia, treatment can include injections of a genetically engineered form of EPO.
- Many people with kidney disease need iron supplements and EPO to raise their red blood cell count to a level that will reduce the need for red blood cell transfusions.

- A health care provider may suggest vitamin B12 and folic acid supplements for some people with CKD and anemia.
- A health care provider may advise people with kidney disease who have anemia caused by iron, vitamin B12, or folic acid deficiencies to include sources of these nutrients in their diets.

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 people with CKD and kidney failure. One group of NIDDK-supported researchers is collecting data on doses of EPO and intravenous (IV) iron given to people on hemodialysis. The goal of the study is to guide dosing of both agents so a desired therapeutic outcome is achieved for each patient with the smallest dose possible. The Prospective Observational Study of Erythropoietin-Iron Interaction in Anemia of Renal Disease is funded under National Institutes of Health (NIH) clinical trial number NCT01719146.

Clinical trials are research studies involving people. Clinical trials look at safe and effective new ways to prevent, detect, or treat disease. Researchers also use clinical trials to look at other aspects of care, such as improving the quality of life for people with chronic illnesses. To learn more about clinical trials, why they matter, and how to participate, visit the NIH Clinical Research Trials and You website at www.nih.gov/health/clinicaltrials. For information about current studies, visit www.ClinicalTrials.gov.

For More Information

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About the Kidney Failure Series

The NIDDK Kidney Failure Series includes booklets and fact sheets that can help the reader learn more about treatment methods for kidney failure, complications of dialysis, financial help for the treatment of kidney failure, and eating right on hemodialysis. Free single printed copies of this series can be obtained by contacting the National Kidney and Urologic Diseases Information Clearinghouse.

National Kidney Disease Education Program

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The National Kidney Disease Education Program (NKDEP) is an initiative of the National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health, U.S. Department of Health and Human Services. The NKDEP aims to raise awareness of the seriousness of kidney disease, the importance of testing those at high risk, and the availability of treatment to prevent or slow kidney disease.

National Kidney and Urologic Diseases Information Clearinghouse

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The National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC) is a service of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). The NIDDK is part of the National Institutes of Health of the U.S. Department of Health and Human Services. Established in 1987, the Clearinghouse provides information about diseases of the kidneys and urologic system to people with kidney and urologic disorders and to their families, health care professionals, and the public. The NKUDIC answers inquiries, develops and distributes publications, and works closely with professional and patient organizations and Government agencies to coordinate resources about kidney and urologic diseases.

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This publication is available at www.kidney.niddk.nih.gov.

You may also find additional information about this topic by visiting MedlinePlus at www.medlineplus.gov.

This publication may contain information about medications and, when taken as prescribed, the conditions they treat. When prepared, this publication included the most current information available. For updates or for questions about any medications, contact the U.S. Food and Drug Administration toll-free at 1-888-INFO-FDA (1-888-463-6332) or visit www.fda.gov. Consult your health care provider for more information.



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