

Overview of Kidney Disease in Children

How does kidney disease affect children?

Kidney disease can affect children in various ways, ranging from treatable disorders without long-term consequences to life-threatening conditions. Acute kidney disease develops suddenly, lasts a short time, and can be serious with long-lasting consequences or may go away completely once the underlying cause has been treated. Chronic kidney disease (CKD) does not go away with treatment and tends to get worse over time. CKD eventually leads to kidney failure, described as end-stage kidney disease or ESRD when treated with a kidney transplant or blood-filtering treatments called dialysis.

Children with CKD or kidney failure face many challenges, which can include

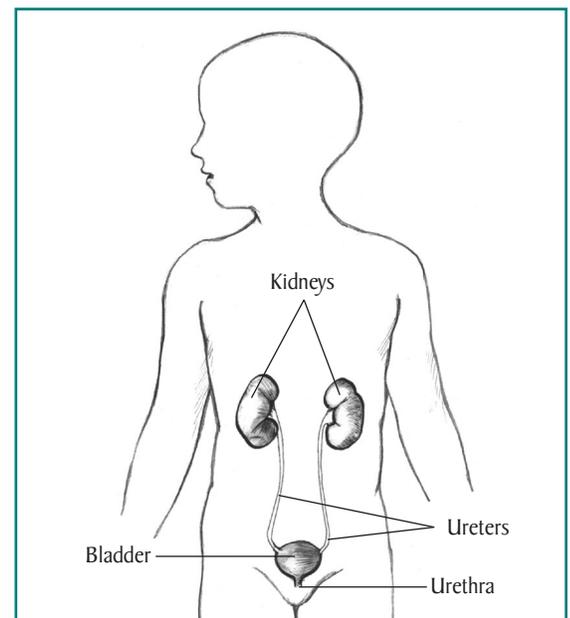
- a negative self-image
- relationship problems
- behavior problems
- learning problems
- trouble concentrating
- delayed language skills development
- delayed motor skills development

Children with CKD may grow at a slower rate than their peers, and urinary incontinence—the loss of bladder control, which results in the accidental loss of urine—is common.

Read more in *Facing the Challenges of Chronic Kidney Disease in Children* at www.kidney.niddk.nih.gov.

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 two kidneys filter about 120 to 150 quarts of blood to produce about 1 to 2 quarts of urine, composed of wastes and extra fluid. Children produce less urine than adults and the amount produced depends on their age. The kidneys work around the clock; a person does not control what they do. Ureters are the thin tubes of muscle—one on each side of the bladder—that carry urine from each of the kidneys to the bladder. The bladder stores urine until the person finds an appropriate time and place to urinate.

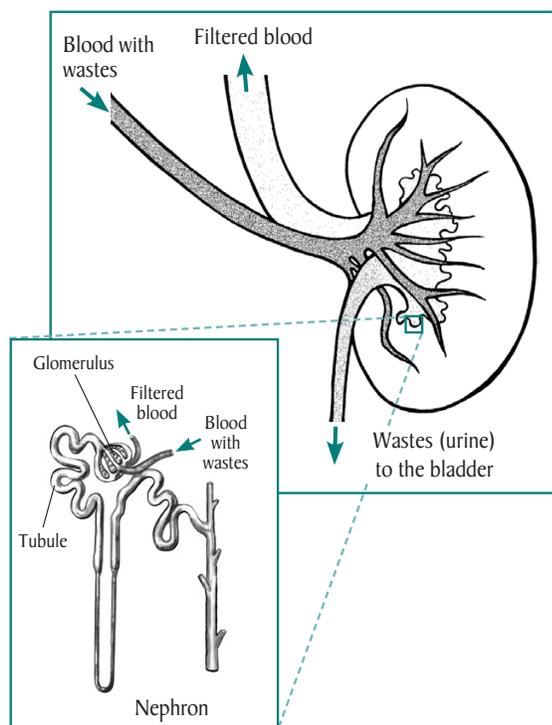


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The kidney is not one large filter. Each kidney is made up of about a million filtering units called nephrons. Each nephron filters a small amount of blood. The nephron includes a filter, called a glomerulus, and a tubule. The nephrons work through a two-step process. The glomerulus lets fluid and waste products pass through it; however, it prevents blood cells and large molecules, mostly proteins, from passing. The filtered fluid then passes through the tubule, which changes the fluid by sending needed minerals back to the bloodstream and removing wastes. The final product becomes urine.

The kidneys also control the level of minerals such as sodium, phosphorus, and potassium in the body, and produce an important hormone to prevent anemia. Anemia is a condition in which the number of red blood cells is less than normal, resulting in less oxygen carried to the body's cells.



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What are the causes of kidney disease in children?

Kidney disease in children can be caused by

- birth defects
- hereditary diseases
- infection
- nephrotic syndrome
- systemic diseases
- trauma
- urine blockage or reflux

From birth to age 4, birth defects and hereditary diseases are the leading causes of kidney failure. Between ages 5 and 14, kidney failure is most commonly caused by hereditary diseases, nephrotic syndrome, and systemic diseases. Between ages 15 and 19, diseases that affect the glomeruli are the leading cause of kidney failure, and hereditary diseases become less common.¹

Birth Defects

A birth defect is a problem that happens while a baby is developing in the mother's womb. Birth defects that affect the kidneys include renal agenesis, renal dysplasia, and ectopic kidney, to name a few. These defects are abnormalities of size, structure, or position of the kidneys:

- renal agenesis—children born with only one kidney
- renal dysplasia—children born with both kidneys, yet one does not function
- ectopic kidney—children born with a kidney that is located below, above, or on the opposite side of its usual position

In general, children with these conditions lead full, healthy lives. However, some children with renal agenesis or renal dysplasia are at increased risk for developing kidney disease.

¹National Institute of Diabetes and Digestive and Kidney Diseases. *United States Renal Data System 2010 Annual Data Report: Volume 2: Atlas of End-Stage Renal Disease in the United States*. Washington, D.C.: U.S. Government Printing Office; 2010. NIH publication 09-3176. Report.

Hereditary Diseases

Hereditary kidney diseases are illnesses passed from parent to child through the genes. One example is polycystic kidney disease (PKD), characterized by many grapelike clusters of fluid-filled cysts—abnormal sacs—that make both kidneys larger over time. These cysts take over and destroy working kidney tissue. Another hereditary disease is Alport syndrome, which is caused by a mutation in a gene for a type of protein called collagen that makes up the glomeruli. The condition leads to scarring of the kidneys. Alport syndrome generally develops in early childhood and is more serious in boys than in girls. The condition can lead to hearing and vision problems in addition to kidney disease.

Infection

Hemolytic uremic syndrome and acute post-streptococcal glomerulonephritis are kidney diseases that can develop in a child after an infection.

- **Hemolytic uremic syndrome** is a rare disease that is often caused by the *Escherichia coli* (*E. coli*) bacterium found in contaminated foods, such as meat, dairy products, and juice. Hemolytic uremic syndrome develops when *E. coli* bacteria lodged in the digestive tract make toxins that enter the bloodstream. The toxins start to destroy red blood cells and damage the lining of the blood vessels, including the glomeruli. Most children who get an *E. coli* infection have vomiting, stomach cramps, and bloody diarrhea for 2 to 3 days. Children who develop hemolytic uremic syndrome become pale, tired, and irritable. Hemolytic uremic syndrome can lead to kidney failure in some children.
- **Post-streptococcal glomerulonephritis** can occur after an episode of strep throat or a skin infection. The *Streptococcus* bacterium does not attack the kidneys directly; instead, the infection may stimulate the immune system to overproduce antibodies. Antibodies are proteins made by the immune system. The immune system protects people from infection by identifying and destroying bacteria, viruses, and other potentially harmful foreign substances.

When the extra antibodies circulate in the blood and finally deposit in the glomeruli, the kidneys can be damaged. Most cases of post-streptococcal glomerulonephritis develop 1 to 3 weeks after an untreated infection, though it may be as long as 6 weeks. Post-streptococcal glomerulonephritis lasts only a brief time and the kidneys usually recover. In a few cases, kidney damage may be permanent.

Nephrotic Syndrome

Nephrotic syndrome is a collection of symptoms that indicate kidney damage. Nephrotic syndrome includes all of the following conditions:

- **albuminuria**—when a person’s urine contains an elevated level of albumin, a protein typically found in the blood
- **hyperlipidemia**—higher-than-normal fat and cholesterol levels in the blood
- **edema**—swelling, usually in the legs, feet, or ankles and less often in the hands or face
- **hypoalbuminemia**—low levels of albumin in the blood

Nephrotic syndrome in children can be caused by the following conditions:

- **Minimal change disease** is a condition characterized by damage to the glomeruli that can be seen only with an electron microscope, which shows tiny details better than any other type of microscope. The cause of minimal change disease is unknown; some health care providers think it may occur after allergic reactions, vaccinations, and viral infections.
- **Focal segmental glomerulosclerosis** is scarring in scattered regions of the kidney, typically limited to a small number of glomeruli.
- **Membranoproliferative glomerulonephritis** is a group of autoimmune diseases that cause antibodies to build up on a membrane in the kidney. Autoimmune diseases cause the body’s immune system to attack the body’s own cells and organs.

Systemic Diseases

Systemic diseases, such as systemic lupus erythematosus (SLE or lupus) and diabetes, involve many organs or the whole body, including the kidneys:

- Lupus nephritis is kidney inflammation caused by SLE, which is an autoimmune disease.
- Diabetes leads to elevated levels of blood glucose, also called blood sugar, which scar the kidneys and increase the speed at which blood flows into the kidneys. Faster blood flow strains the glomeruli, decreasing their ability to filter blood, and raises blood pressure. Kidney disease caused by diabetes is called diabetic kidney disease. While diabetes is the number one cause of kidney failure in adults, it is an uncommon cause during childhood.

Read more about systemic kidney diseases in these publications at www.kidney.niddk.nih.gov:

- *Lupus Nephritis*
- *Diabetic Kidney Disease*

Trauma

Traumas such as burns, dehydration, bleeding, injury, or surgery can cause very low blood pressure, which decreases blood flow to the kidneys. Low blood flow can result in acute kidney failure.

Urine Blockage or Reflux

When a blockage develops between the kidneys and the urethra, urine can back up into the kidneys and cause damage. Reflux—urine flowing from the bladder up to the kidney—happens when the valve between the bladder and the ureter does not close all the way.

How is kidney disease in children diagnosed?

A health care provider diagnoses kidney disease in children by completing a physical exam, asking for a medical history, and reviewing signs and symptoms. To confirm diagnosis, the health care provider may order one or more of the following tests:

Urine Tests

Dipstick test for albumin. The presence of albumin in urine is a sign that the kidneys may be damaged. Albumin in urine can be detected with a dipstick test performed on a urine sample. The urine sample is collected in a special container in a health care provider's office or a commercial facility and can be tested in the same location or sent to a lab for analysis. With a dipstick test, a nurse or technician places a strip of chemically treated paper, called a dipstick, into the person's urine sample. Patches on the dipstick change color when albumin is present in urine.

Urine albumin-to-creatinine ratio. A more precise measurement, such as a urine albumin-to-creatinine ratio, may be necessary to confirm kidney disease. Unlike a dipstick test for albumin, a urine albumin-to-creatinine ratio—the ratio between the amount of albumin and the amount of creatinine in urine—is not affected by variation in urine concentration.

Blood test. Blood drawn in a health care provider's office and sent to a lab for analysis can be tested to estimate how much blood the kidneys filter each minute, called the estimated glomerular filtration rate or eGFR.

Imaging studies. Imaging studies provide pictures of the kidneys. The pictures help the health care provider see the size and shape of the kidneys and identify any abnormalities.

Kidney biopsy. Kidney biopsy is a procedure that involves taking a small piece of kidney tissue for examination with a microscope. Biopsy results show the cause of the kidney disease and extent of damage to the kidneys.

How is kidney disease in children treated?

Treatment for kidney disease in children depends on the cause of the illness. A child may be referred to a pediatric nephrologist—a doctor who specializes in treating kidney diseases and kidney failure in children—for treatment.

Children with a kidney disease that is causing high blood pressure may need to take medications to lower their blood pressure. Improving blood pressure can significantly slow the progression of kidney disease. The health care provider may prescribe

- angiotensin-converting enzyme (ACE) inhibitors, which help relax blood vessels and make it easier for the heart to pump blood
- angiotensin receptor blockers (ARBs), which help relax blood vessels and make it easier for the heart to pump blood
- diuretics, medications that increase urine output

Many children require two or more medications to control their blood pressure; other types of blood pressure medications may also be needed.

As kidney function declines, children may need treatment for anemia and growth failure. Anemia is treated with a hormone called erythropoietin, which stimulates the bone marrow to produce red blood cells. Children with growth failure may need to make dietary changes and take food supplements or growth hormone injections.

Children with kidney disease that leads to kidney failure must receive treatment to replace the work the kidneys do. The two types of treatment are dialysis and transplantation. Read more in *Treatment Methods for Kidney Failure in Children* at www.kidney.niddk.nih.gov.

Birth Defects

Children with renal agenesis or renal dysplasia should be monitored for signs of kidney damage. Treatment is not needed unless damage to the kidney occurs. Read more in *Solitary Kidney* at www.kidney.niddk.nih.gov.

Ectopic kidney does not need to be treated unless it causes a blockage in the urinary tract or damage to the kidney. When a blockage is present, surgery may be needed to correct the position of the kidney for better drainage of urine. If extensive kidney damage has occurred, surgery may be needed to remove the kidney. Read more in *Ectopic Kidney* at www.kidney.niddk.nih.gov.

Hereditary Diseases

Children with PKD tend to have frequent urinary tract infections, which are treated with bacteria-fighting medications called antibiotics. PKD cannot be cured, so children with the condition receive treatment to slow the progression of kidney disease and treat the complications of PKD. Read more in *Polycystic Kidney Disease* at www.kidney.niddk.nih.gov.

Alport syndrome also has no cure. Children with the condition receive treatment to slow disease progression and treat complications until the kidneys fail. Read more in *Glomerular Diseases Overview* at www.kidney.niddk.nih.gov.

Infection

Treatment for hemolytic uremic syndrome includes maintaining normal salt and fluid levels in the body to ease symptoms and prevent further problems. A child may need a transfusion of red blood cells delivered through an intravenous (IV) tube. Some children may need dialysis for a short time to take over the work the kidneys usually do. Most children recover completely with no long-term consequences. Read more in *Hemolytic Uremic Syndrome in Children* at www.kidney.niddk.nih.gov.

Children with post-streptococcal glomerulonephritis may be treated with antibiotics to destroy any bacteria that remain in the body and with medications to control swelling and high blood pressure. They may also need dialysis for a short period of time. Read more about post-streptococcal glomerulonephritis in *Glomerular Diseases Overview* at www.kidney.niddk.nih.gov.

Nephrotic Syndrome

Nephrotic syndrome due to minimal change disease can often be successfully treated with corticosteroids. Corticosteroids decrease swelling and reduce the activity of the immune system. The dosage of the medication is decreased over time. Relapses are common; however, they usually respond to treatment. Corticosteroids are less effective in treating nephrotic syndrome due to focal segmental glomerulosclerosis or membranoproliferative glomerulonephritis. Children with these conditions may be given other immunosuppressive medications in addition to corticosteroids. Immunosuppressive medications prevent the body from making antibodies. Read more in *Childhood Nephrotic Syndrome* at www.kidney.niddk.nih.gov.

Systemic Diseases

Lupus nephritis is treated with corticosteroids and other immunosuppressive medications. A child with lupus nephritis may also be treated with blood pressure-lowering medications. In many cases, treatment is effective in completely or partially controlling lupus nephritis. Read more in *Lupus Nephritis* at www.kidney.niddk.nih.gov.

Diabetic kidney disease usually takes many years to develop. Children with diabetes can prevent or slow the progression of diabetic kidney disease by taking medications to control high blood pressure and maintaining normal blood glucose levels. Read more in *Diabetic Kidney Disease* at www.kidney.niddk.nih.gov.

Trauma

The types of trauma described above can be medically treated, though dialysis may be needed for a short time until blood flow and blood pressure return to normal.

Urine Blockage and Reflux

Treatment for urine blockage depends on the cause and severity of the blockage. In some cases, the blockage goes away without treatment. For children who continue to have urine blockage, surgery may be needed to remove the obstruction and restore urine flow. After surgery, a small tube, called a stent, may be placed in the ureter or urethra to keep it open temporarily while healing occurs. Read more in *Urine Blockage in Newborns* at www.kidney.niddk.nih.gov.

Treatment for reflux may include prompt treatment of urinary tract infections and long-term use of antibiotics to prevent infections until reflux goes away on its own. Surgery has also been used in certain cases. Read more in *Vesicoureteral Reflux* at www.kidney.niddk.nih.gov.

Eating, Diet, and Nutrition

For children with CKD, learning about nutrition is vital because their diet can affect how well their kidneys work. Parents or guardians should always consult with their child's health care team before making any dietary changes. Staying healthy with CKD requires paying close attention to the following elements of a diet:

■ **Protein.** Children with CKD should eat enough protein for growth while limiting high protein intake. Too much protein can put an extra burden on the kidneys and cause kidney function to decline faster. Protein needs increase when a child is on dialysis because the dialysis process removes protein from the child's blood. The health care team recommends the amount of protein needed for the child. Foods with protein include

- eggs
- milk
- cheese
- chicken
- fish
- red meats
- beans
- yogurt
- cottage cheese

■ **Sodium.** The amount of sodium children need depends on the stage of their kidney disease, their age, and sometimes other factors. The health care team may recommend limiting or adding sodium and salt to the diet. Foods high in sodium include

- canned foods
- some frozen foods
- most processed foods
- some snack foods, such as chips and crackers

■ **Potassium.** Potassium levels need to stay in the normal range for children with CKD, because too little or too much potassium can cause heart and muscle problems. Children may need to stay away from some fruits and vegetables or reduce the number of servings and portion sizes to make sure they do not take in too much potassium. The health care team recommends the amount of potassium a child needs. Low-potassium fruits and vegetables include

- apples
- cranberries
- strawberries
- blueberries
- raspberries
- pineapple
- cabbage
- boiled cauliflower
- mustard greens
- uncooked broccoli

High-potassium fruits and vegetables include

- oranges
- melons
- apricots
- bananas
- potatoes
- tomatoes
- sweet potatoes
- cooked spinach
- cooked broccoli

■ **Phosphorus.** Children with CKD need to control the level of phosphorus in their blood because too much phosphorus pulls calcium from the bones, making them weaker and more likely to break. Too much phosphorus also can cause itchy skin and red eyes. As CKD progresses, a child may need to take a phosphate binder with meals to lower the concentration of phosphorus in the blood. Phosphorus is found in high-protein foods. Foods with low levels of phosphorus include

- liquid nondairy creamer
- green beans
- popcorn
- unprocessed meats from a butcher
- lemon-lime soda
- root beer
- powdered iced tea and lemonade mixes
- rice and corn cereals
- egg white
- sorbet

■ **Fluids.** Early in CKD, a child’s damaged kidneys may produce either too much or too little urine, which can lead to swelling or dehydration. As CKD progresses, children may need to limit fluid intake. The health care provider will tell the child and parents or guardians the goal for fluid intake.

Read more in *Nutrition for Chronic Kidney Disease in Children* and *Kidney Failure: Eat Right to Feel Right on Hemodialysis* at www.kidney.niddk.nih.gov.

Points to Remember

- Kidney disease can affect children in various ways, ranging from treatable disorders without long-term consequences to life-threatening conditions. Acute kidney disease develops suddenly, lasts a short time, and can be serious with long-lasting consequences, or may go away completely once the underlying cause has been treated.
- Chronic kidney disease (CKD) does not go away with treatment and tends to get worse over time.
- Kidney disease in children can be caused by
 - birth defects
 - hereditary diseases
 - infection
 - nephrotic syndrome
 - systemic diseases
 - trauma
 - urine blockage or reflux
- A health care provider diagnoses kidney disease in children by completing a physical exam, asking for a medical history, and reviewing signs and symptoms. To confirm diagnosis, the health care provider may order one or more of the following tests:
 - urine tests
 - blood test
 - imaging studies
 - kidney biopsy
- Treatment for kidney disease in children depends on the cause of the illness.

- Children with a kidney disease that is causing high blood pressure may need to take medications to lower their blood pressure. Improving blood pressure can significantly slow the progression of kidney disease. As kidney function declines, children may need treatment for anemia and growth failure.
- Children with kidney disease that leads to kidney failure must receive treatment to replace the work the kidneys do. The two types of treatment are dialysis and transplantation.
- For children with CKD, learning about nutrition is vital because their diet can affect how well their kidneys work. Parents or guardians should always consult with their child's health care team before making any dietary changes.

Hope through Research

The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) conducts and supports research to help people with urologic diseases, including children. The NIDDK, in collaboration with the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development and the National Heart, Lung, and Blood Institute, funded the formation of a cooperative agreement between two Clinical Coordinating Centers and a Data Coordinating Center to conduct a prospective epidemiological study of children with CKD. The primary goals of the Chronic Kidney Disease in Children Prospective Cohort Study (CKiD) are to

- determine the risk factors for decline in kidney function
- define how a progressive decline in kidney function affects neurocognitive function and behavior
- determine risk factors for cardiovascular disease
- assess growth failure and its associated morbidity

More information about the CKiD, funded under National Institutes of Health (NIH) clinical trial number NCT00327860, can be found at www.statepi.jhsph.edu/ckid.

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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Life Options

c/o Medical Education Institute, Inc.
414 D'Onofrio Drive, Suite 200
Madison, WI 53719
Phone: 1-800-468-7777 or 608-833-8033
Fax: 608-833-8366
Internet: www.lifeoptions.org
www.kidneyschool.org

National Kidney Foundation

30 East 33rd Street
New York, NY 10016
Phone: 1-800-622-9010 or 212-889-2210
Fax: 212-689-9261
Internet: www.kidney.org

United Network for Organ Sharing

P.O. Box 2484
Richmond, VA 23218
Phone: 1-888-894-6361 or 804-782-4800
Fax: 804-782-4817
Internet: www.unos.org

Resources

American Society of Transplantation

Facts about Kidney Transplantation: Pediatric Patient Education Brochure
www.myast.org/sites/default/files/images/2_FACT%20ABOUT%20KIDNEYTRANSPLANTATION%20%20FINAL.pdf

National Kidney Foundation

Children with Chronic Kidney Disease: Tips for Parents
www.kidney.org/atoz/content/childckdtips.cfm

Family Focus newsletter

www.kidney.org/patients/pfc/backissues.cfm

Employers' Guide

www.kidney.org/atoz/content/employersguide.cfm

Nemours KidsHealth Website

When Your Child Has a Chronic Kidney Disease
www.kidshealth.org/parent/medical/kidney/chronic_kidney_disease.html

What's the Deal with Dialysis?

www.kidshealth.org/kid/feel_better/things/dialysis.html

Nephkids

Cyber-support group
www.cybernephrology.ualberta.ca/nephkids

United Network for Organ Sharing

Organ Transplants: What Every Kid Needs to Know
www.unos.org/docs/WEKNTK.pdf

U.S. Department of Health and Human Services, Centers for Medicare & Medicaid Services

Medicare Coverage of Kidney Dialysis & Kidney Transplant Services
www.medicare.gov/Publications/Pubs/pdf/10128.pdf

U.S. Social Security Administration

Benefits for Children with Disabilities
www.socialsecurity.gov/pubs/EN-05-10026.pdf

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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.

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.

National Kidney and Urologic Diseases Information Clearinghouse

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