The bean-shaped kidneys, which are roughly the size of a human fist, lie on either side of the body in the middle of the back, just beneath the rib cage. Within each kidney, there are a million functioning units known as nephrons, which perform the vital functions of balancing concentrations of water, ions, salt, acids, potassium, and calcium in the body and removing contaminants from the blood stream. This balancing function also involves synthesizing, modifying, and secreting hormones and vitamins that influence other body functions. The kidney helps to regulate blood pressure and stimulates the formation of red blood cells. In a single day, around 200 quarts of fluid are filtered through the kidneys. Blood is received in the kidney from the renal artery, and filtered blood is returned to the body through the renal veins. Every day, around two quarts of waste fluids are channeled into the bladder where they are subsequently eliminated through the urethra as urine.

Great progress in understanding kidney functions and diseases has taken place since the end of World War II. Increased research funding has been essential to this progress, and has precipitated advances in renal anatomy and physiology, biochemistry, pharmacology, bioenergetics, molecular, cell, and development biology, genetics and genomics. Physicians are now able to draw on new knowledge and technologies to deal with kidney diseases and injuries that would have proved fatal in the past. One of the most significant successes has been in the field of kidney transplants. The human genome project continues to provide researchers with great insight into the role of inheritance in the development of kidney diseases. Johns Hopkins University maintains an extensive online database of genetic aspects of kidney disease.

When any aspect of essential kidney functions fails to operate properly, kidney diseases develop. The six warning signs of kidney disease are: burning or difficult urination, increased frequency of urination, bloody urine, puffiness around the eyes, swelling of the hands and feet, pain in the small of the back, and high blood pressure. Important factors in preventing kidney disease are controlling hypertension, maintaining a healthy weight, reducing salt intake, eating foods containing calcium and potassium, being physically active, and avoiding excess alcohol intake.

The four major causes of kidney failure are diabetes, hypertension, glomerulonephritis, and polycystic disease. It is estimated that 20 million Americans suffer from kidney or urinary tract-related diseases. African-Americans are at higher risk than others for all incidences of kidney disease except polycystic disease. They are 20 times likelier than other Americans to develop kidney disease that results from hypertension. African-Americans also tend to develop kidney diseases at earlier ages than white Americans. The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) is currently involved in a research initiative to develop a greater understanding of kidney disease in African-Americans.

While some disorders such as kidney stones may affect only one kidney, most kidney diseases are bilateral. Kidney diseases range from minor infections to progressive kidney failure. Approximately 100,000 Americans with kidney disease require dialysis or a kidney transplant. During dialysis, artificial
kidneys take over the role of filtering the blood and returning cleansed blood to the body. While the process keeps kidney patients alive, it is not without side effects. Dialysis patients are prone to blood clots and infections. Patients new to dialysis may develop headaches, nausea, muscle cramps, anorexia, dizziness, and seizures. A 1998 study revealed that 86 percent of African-Americans with kidney failure were on dialysis as opposed to 69 percent of Whites. A number of studies have shown that African-Americans tend to remain on dialysis, in part because they tend to have fewer complications and are likely to live longer than white dialysis patients. Advances in kidney transplants have been instrumental in removing hundreds of thousands of patients from dependence on dialysis and restoring quality of life despite the continued need for immunosuppressive drugs.

**DIAGNOSIS**

Medical professionals are able to test for proper kidney function during routine office visits through urinalysis, the most frequently performed of all laboratory tests. Urinalysis provides physicians with information about unexplained renal insufficiency, urinary tract irregularities, high blood pressure, and potential renal dysfunction. Infections of the lower urinary tract are generally identified through urinalysis. Since most of these infections respond well to antibiotics, no further treatment is needed unless infections recur. Urinalysis may also be instrumental in diagnosing other diseases such as diabetes and high blood pressure. Glomerular Filtration Rate (GFR) is another widely used method of determining renal function, and abnormal GFR results may indicate the need for additional testing. Blood tests are important in determining kidney health because elevated levels of blood urea nitrogen (BUN), creatinine (a product of muscle metabolism), calcium, or phosphorus may suggest potential renal failure. Imaging tests may be performed to identify or rule out the possibility of kidney tumors. Such masses may be either cystic or solid. If a mass is cystic, no further action is needed. When a mass is either solid or indeterminate, a biopsy may be performed to determine whether or not the growth is cancerous.

Kidney disease may be diagnosed in response to warning signs that seem unrelated to kidney functions. Unexplained weight loss, for example, may indicate uremia or a possible malignancy. Rapid weight gain may be a sign of volume expansion. A skin rash may be a byproduct of allergic renal disease, connective tissue disease, vasculitis, or atheroembolic disease. Hearing loss may be a symptom of hereditary nephritis. Chronic sinusitis or nasal ulcers may be indicative of Wegener’s granulomatosis, and oral ulcers may suggest connective tissue disease. Retinopathy may result from either malignant hypertension or connective disease. Abnormal kidney function may also be evidence of systolic dysfunction, cardiac dysfunction, pulmonary hypertension, or liver disease. Treatment for nephritis may include special diets, antibiotics, surgery, dialysis, or organ transplant.

**SPECIFIC DISEASES**

Kidney diseases generally fall into three categories: hereditary, congenital, and acquired. Hereditary kidney diseases may be transmitted by both males and females, but clinical symptoms may not develop until adolescence or early adulthood. Throughout the world, the most common hereditary kidney condition disease is polycystic kidney disease in which cysts develop in the kidney. This largely asymptomatic disease occurs in all races. The progression of the disease is highly variable, but it often leads to advanced kidney failure. In half of all cases, more aggressive treatments are unnecessary until after the age of 70. The delay is more common in patients with normal blood pressure. Other inherited kidney disorders include hereditary nephritis, primary hyperoxaluria, and cystinuria. Genetics does not play a factor in congenital kidney diseases, which are caused by malformations of the genitourinary tract that occur during fetal development. Obstructions caused by malformations may result in kidney
infections or chronic kidney failure.

Most kidney diseases are acquired and can occur at any age. Nephritis, an inflammation of the kidney, is an umbrella term for kidney diseases. The most common type of nephritis is glomerulonephritis, which may be caused by a variety of factors. It is often diagnosed through urinalysis. The condition is frequently associated with low albumen levels, elevated blood cholesterol, and severe fluid retention. The disorder can be primary, or it can be the result of other illnesses, including chronic kidney disease. Prolonged use of large amounts of pain compounds have been linked to nephritis, as have a number of toxins, pesticide exposure, and heroin use. Consumption patterns around the world may be responsible for diverse patterns of compound-related nephritis. The southeastern section of the United States, Belgium, Australia, Scotland, and Switzerland all have higher than normal incidences. In childhood, nephritis may manifest as swelling around the eyes, stomach, and legs, infrequent urination, weight gain, fatigue, pain in the arms or legs, irritability, loss of appetite, and paleness. Generally appearing between the ages of 1-1/2 to 5, the cause of this disorder is not known. Medications are generally successful in treating the disease, and children tend to outgrow it by the late teens or early adulthood.

It is estimated that one in ten individuals will develop kidney stones. They are more common in males than females and tend to occur between the ages of 20 and 40. Evidence of kidney stones has been traced back thousands of years. The tendency for stone formation may be inherited. Stones may also be a result of infection, malformations of the kidney, pregnancy, or metabolic disorders. They may also occur in isolation. In textbook cases, kidney stones lead to frequent urination, burning and difficult urination, and excruciating pain in the small of the back. Pain may also be present in the sides and abdomen, and the patient may experience nausea and vomiting. Fever and chills indicate the presence of infections. Pain medication may be used until stones have passed or until further treatment takes place. Immediate surgery is indicated when stones block the kidney. In the past, surgery to remove kidney stones was a major operation. The introduction of extracorporeal shock wave lithotripsy (ESWL), the nephroscope, and the ureteroscope permit physicians to shatter or remove stones without surgery. In around a third of kidney stone analyses, lab tests are able to pinpoint the cause of the stone formation. Most stones are made up of a variety of chemicals, with the most common being calcium with oxalate or phosphate. Uric acid and cystine stones are less common. Post-op treatment may entail changes in diet and increased water consumption.

Kidney cancer may develop at any age. Wilms’ tumor, for instance, is a kind of children’s cancer in which cancer cells attack certain parts of the kidney. It is most common in individuals under the age of 15. Complete recovery is possible if the cancer has been caught early and if it has not spread to other parts of the body. When determining severity and treatment for all cancers of the kidney, physicians classify malignancies according to five stages. Surgeons are generally able to remove all of the cancer in Stage I, where cancer is concentrated in the kidney, and Stage II, where the malignancy has not spread beyond the kidney and surrounding areas. Cancer of the last three stages calls for more aggressive treatment because surgeons may not be able to remove cancers that have spread to other parts of the body (Stage III), the large organs (Stage IV), or to both kidneys (Stage V). Treatment for latter-state cancers includes chemotherapy and radiation in addition to surgery.

**PREGNANCY**

Pregnant women are particularly vulnerable to kidney abnormalities because of increased demands on the kidneys. Before 1980, women with pre-existing renal disease were discouraged from becoming
pregnancy. Highly related to kidney disease, hypertension affects 10 percent of all pregnant women. It is particularly prevalent in young women experiencing a first pregnancy and in older women who have undergone several pregnancies. Pregnancy-related high blood pressure may be indicative of preeclampsia (toxemia), a potentially fatal condition if left untreated; preeclampsia superimposed on chronic hypertension or renal disease; chronic essential hypertension, or gestational hypertension. The latter type generally disappears after giving birth. Pregnant women are no more susceptible to urinary tract infections than other women. If infections do occur, however, they may entail more serious consequences, especially in women who have either diabetes or sickle cell anemia or who come from lower socioeconomic backgrounds.

Only about half of all urinary tract infections that occur during pregnancy are symptomatic. The possibility of potential complications is the reason that physicians monitor the health of pregnant women carefully, particularly during the final month. In high-risk pregnancies and in patients with a prior history of kidney infections and diseases, closer monitoring is required. Left untreated, urinary tract infections may lead to pyelonephritis, a condition in which the kidneys are permanently scarred and damaged, or to the development of bacteremia, septic shock, and decreased renal function. The presence of bacteriuria in mothers is linked to an increased risk of mid-trimester spontaneous abortions (miscarriages). If infection occurs within two weeks of delivery, the risk of perinatal (within the first month of life) mortality doubles. Acute pyelonephritis during pregnancy has also been associated with higher than normal incidences of intrauterine growth retardation and mental retardation of the fetus. In some cases, urinary tract infections are not specifically related to pregnancy but may be indicative of kidney disease, acceleration of pre-existing renal disease, or systemic disorders.

**SEE ALSO:**
Abortion; Birth Defects; Cancer (General); Diabetes; Dialysis; Genetic Disorders; Glomerular Diseases; High Blood Pressure; Hormones; Liver Transplantation; National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK); Polycystic Kidney Disease; Pregnancy; Sickle Cell Anemia; Urinary Tract Infections.

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