


Kidney failure

Kidney failure, also known as **end-stage kidney disease**, is a medical condition in which the kidneys are functioning at less than 15% of normal.^[2] Kidney failure is classified as either acute kidney failure, which develops rapidly and may resolve; and chronic kidney failure, which develops slowly.^[6] Symptoms may include leg swelling, feeling tired, vomiting, loss of appetite, and confusion.^[2] Complications of acute and chronic failure include uremia, high blood potassium, and volume overload.^[3] Complications of chronic failure also include heart disease, high blood pressure, and anemia.^{[4][5]}

Causes of acute kidney failure include low blood pressure, blockage of the urinary tract, certain medications, muscle breakdown, and hemolytic uremic syndrome.^[6] Causes of chronic kidney failure include diabetes, high blood pressure, nephrotic syndrome, and polycystic kidney disease.^[6] Diagnosis of acute failure is often based on a combination of factors such as decrease urine production or increased serum creatinine.^[3] Diagnosis of chronic failure is based on a glomerular filtration rate (GFR) of less than 15 or the need for renal replacement therapy.^[1] It is also equivalent to stage 5 chronic kidney disease.^[1]

Treatment of acute failure depends on the underlying cause.^[7] Treatment of chronic failure may include hemodialysis, peritoneal dialysis, or a kidney transplant.^[2] Hemodialysis uses a machine to filter the blood outside the body.^[2] In peritoneal dialysis specific fluid is placed into the abdominal cavity and then drained, with this process being repeated multiple times per day.^[2] Kidney transplantation involves surgically placing a kidney from someone else and then taking immunosuppressant medication to prevent rejection.^[2] Other recommended measures from chronic disease include staying active and specific dietary changes.^[2]

In the United States acute failure affects about 3 per 1,000 people a year.^[8] Chronic failure affects about 1 in 1,000 people with 3 per 10,000 people newly

Kidney failure	
Other names	Renal failure, end-stage renal disease (ESRD), stage 5 chronic kidney disease ^[1]
	
A hemodialysis machine which is used to replace the function of the kidneys	
Specialty	Nephrology
Symptoms	Leg swelling, feeling tired, loss of appetite, confusion ^[2]
Complications	Acute: Uremia, high blood potassium, volume overload ^[3] Chronic: Heart disease, high blood pressure, anemia ^{[4][5]}
Types	Acute kidney failure, chronic kidney failure ^[6]
Causes	Acute: Low blood pressure, blockage of the urinary tract, certain medications, muscle breakdown, and hemolytic uremic syndrome. ^[6]

develop the condition each year.^{[1][9]} Acute failure is often reversible while chronic failure often is not.^[6] With appropriate treatment many with chronic disease can continue working.^[2]

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	Chronic: Diabetes, high blood pressure, nephrotic syndrome, polycystic kidney disease ^[6]
Diagnostic method	Acute: Decreased urine production, increased serum creatinine ^[3] Chronic: Glomerular filtration rate (GFR) < 15 ^[1]
Treatment	Acute: Depends on the cause ^[7] Chronic: Hemodialysis, peritoneal dialysis, kidney transplant ^[2]
Frequency	Acute: 3 per 1,000 per year ^[8] Chronic: 1 per 1,000 (US) ^[1]

Classification

Kidney failure can be divided into two categories: acute kidney failure or chronic kidney failure. The type of renal failure is differentiated by the trend in the serum creatinine; other factors that may help differentiate acute kidney failure from chronic kidney failure include anemia and the kidney size on sonography as chronic kidney disease generally leads to anemia and small kidney size.

Acute kidney failure

Acute kidney injury (AKI), previously called acute renal failure (ARF),^{[10][11]} is a rapidly progressive loss of renal function,^[12] generally characterized by oliguria (decreased urine production, quantified as less than 400 mL per day in adults,^[13] less than 0.5 mL/kg/h in children or less than 1 mL/kg/h in infants); and fluid and electrolyte imbalance. AKI can result from a variety of causes, generally classified as *prerenal*, *intrinsic*, and *postrenal*. Many people diagnosed with paraquat intoxication experience AKI, sometimes requiring hemodialysis. The underlying cause must be identified and treated to arrest the progress, and dialysis may be necessary to bridge the time gap required for treating these fundamental causes.

Chronic kidney failure

Chronic kidney disease (CKD) can also develop slowly and, initially, show few symptoms.^[14] CKD can be the long term consequence of irreversible acute disease or part of a disease progression.

Acute-on-chronic kidney failure

Acute kidney injuries can be present on top of chronic kidney disease, a condition called acute-on-chronic kidney failure (AoCRF). The acute part of AoCRF may be reversible, and the goal of treatment, as with AKI, is to return the person to baseline kidney function, typically measured by serum creatinine. Like AKI, AoCRF can be difficult to distinguish from chronic kidney disease if the person has not been monitored by a physician and no baseline (i.e., past) blood work is available for comparison.



Illustration of a kidney from a person with chronic renal failure.

Signs and symptoms

Symptoms can vary from person to person. Someone in early stage kidney disease may not feel sick or notice symptoms as they occur. When the kidneys fail to filter properly, waste accumulates in the blood and the body, a condition called azotemia. Very low levels of azotaemia may produce few, if any, symptoms. If the disease progresses, symptoms become noticeable (if the failure is of sufficient degree to cause symptoms). Kidney failure accompanied by noticeable symptoms is termed uraemia.^[15]

Symptoms of kidney failure include the following:^{[15][16][17][18]}

- High levels of urea in the blood, which can result in:
 - Vomiting or diarrhea (or both) may lead to dehydration
 - Nausea
 - Weight loss
 - Nocturnal urination (nocturia)
 - More frequent urination, or in greater amounts than usual, with pale urine
 - Less frequent urination, or in smaller amounts than usual, with dark coloured urine
 - Blood in the urine
 - Pressure, or difficulty urinating
 - Unusual amounts of urination, usually in large quantities
- A buildup of phosphates in the blood that diseased kidneys cannot filter out may cause:
 - Itching
 - Bone damage
 - Nonunion in broken bones
 - Muscle cramps (caused by low levels of calcium which can be associated with hyperphosphatemia)

- A buildup of potassium in the blood that diseased kidneys cannot filter out (called hyperkalemia) may cause:
 - Abnormal heart rhythms
 - Muscle paralysis^[19]
- Failure of kidneys to remove excess fluid may cause:
 - Swelling of the hands, legs, ankles, feet, or face
 - Shortness of breath due to extra fluid on the lungs (may also be caused by anemia)
- Polycystic kidney disease, which causes large, fluid-filled cysts on the kidneys and sometimes the liver, can cause:
 - Pain in the back or side
- Healthy kidneys produce the hormone erythropoietin that stimulates the bone marrow to make oxygen-carrying red blood cells. As the kidneys fail, they produce less erythropoietin, resulting in decreased production of red blood cells to replace the natural breakdown of old red blood cells. As a result, the blood carries less hemoglobin, a condition known as anemia. This can result in:
 - Feeling tired or weak
 - Memory problems
 - Difficulty concentrating
 - Dizziness
 - Low blood pressure
- Normally proteins are too large to pass through the kidneys. However they are able to pass through when the glomeruli are damaged. This does not cause symptoms until extensive kidney damage has occurred,^[20] after which symptoms include:
 - Foamy or bubbly urine
 - Swelling in the hands, feet, abdomen, and face
- Other symptoms include:
 - Appetite loss, which may include a bad taste in the mouth
 - Difficulty sleeping
 - Darkening of the skin
 - Excess protein in the blood
 - With high doses of penicillin, people with kidney failure may experience seizures^[21]

Causes

Acute kidney injury

Acute kidney injury (previously known as acute renal failure) – or AKI – usually occurs when the blood supply to the kidneys is suddenly interrupted or when the kidneys become overloaded with toxins. Causes of acute kidney injury include accidents, injuries, or complications from surgeries in which the kidneys are deprived of normal blood flow for extended periods of time. Heart-bypass surgery is an example of one such procedure.

Drug overdoses, accidental or from chemical overloads of drugs such as antibiotics or chemotherapy, may also cause the onset of acute kidney injury. Unlike chronic kidney disease, however, the kidneys can often recover from acute kidney injury, allowing the person with AKI to resume a normal life. People suffering from acute kidney injury require supportive treatment until their kidneys recover function, and they often remain at increased risk of developing future kidney failure.^[22]

Among the accidental causes of renal failure is the crush syndrome, when large amounts of toxins are suddenly released in the blood circulation after a long compressed limb is suddenly relieved from the pressure obstructing the blood flow through its tissues, causing ischemia. The resulting overload can lead to the clogging and the destruction of the kidneys. It is a reperfusion injury that appears after the release of the crushing pressure. The mechanism is believed to be the release into the bloodstream of muscle breakdown products – notably myoglobin, potassium, and phosphorus – that are the products of rhabdomyolysis (the breakdown of skeletal muscle damaged by ischemic conditions). The specific action on the kidneys is not fully understood, but may be due in part to nephrotoxic metabolites of myoglobin.

Chronic kidney failure

Chronic kidney failure has numerous causes. The most common causes of chronic failure are diabetes mellitus and long-term, uncontrolled hypertension.^[23] Polycystic kidney disease is another well-known cause of chronic failure. The majority of people afflicted with polycystic kidney disease have a family history of the disease. Other genetic illnesses cause kidney failure, as well.

Overuse of common drugs such as ibuprofen, and acetaminophen (paracetamol) can also cause chronic kidney failure.^[24]

Some infectious disease agents, such as hantavirus, can attack the kidneys, causing kidney failure.^[25]

Genetic predisposition

The APOL1 gene has been proposed as a major genetic risk locus for a spectrum of nondiabetic renal failure in individuals of African origin, these include HIV-associated nephropathy (HIVAN), primary nonmonogenic forms of focal segmental glomerulosclerosis, and hypertension affiliated chronic kidney disease not attributed to other etiologies.^[26] Two western African variants in APOL1 have been shown to be associated with end stage kidney disease in African Americans and Hispanic Americans.^{[27][28]}

Diagnostic approach

Measurement for CKD

Stages of kidney failure

Chronic kidney failure is measured in five stages, which are calculated using the person's GFR, or glomerular filtration rate. Stage 1 CKD is mildly diminished renal function, with few overt symptoms. Stages 2 and 3 need increasing levels of supportive care from their medical providers to slow and treat their renal dysfunction. People with stage 4 and 5 kidney failure usually require preparation towards active treatment in order to survive. Stage 5 CKD is considered a severe illness and requires some form of renal replacement therapy (dialysis) or kidney transplant whenever feasible.

Glomerular filtration rate

A normal GFR varies according to many factors, including sex, age, body size and ethnic background. Renal professionals consider the glomerular filtration rate (GFR) to be the best overall index of kidney function.^[29] The National Kidney Foundation offers an easy to use on-line GFR calculator^[30] for anyone who is interested in knowing their glomerular filtration rate. (A serum creatinine level, a simple blood test, is needed to use the calculator.)

Use of the term *uremia*

Before the advancement of modern medicine, renal failure was often referred to as uremic poisoning. Uremia was the term for the contamination of the blood with urea. It is the presence of an excessive amount of urea in blood. Starting around 1847, this included reduced urine output, which was thought to be caused by the urine mixing with the blood instead of being voided through the urethra. The term *uremia* is now used for the illness accompanying kidney failure.^[31]

Treatment

The treatment of acute kidney injury depends on the cause.^[7] The treatment of chronic kidney failure may include renal replacement therapy: hemodialysis, peritoneal dialysis, or kidney transplant^[2]

Diet

In non-diabetics and people with type 1 diabetes, a low protein diet is found to have a preventative effect on progression of chronic kidney disease. However, this effect does not apply to people with type 2 diabetes.^[32] A whole food, plant-based diet may help some people with kidney disease.^[33] A high protein diet from either animal or plant sources appears to have negative effects on kidney function at least in the short term.^[34]

Slowing progression

People who received earlier referrals to a nephrology specialist, meaning a longer time before they had to start dialysis, had a shorter initial hospitalization and reduced risk of death after the start of dialysis.^[35] Other methods of reducing disease progression include minimizing exposure to nephrotoxins such as NSAIDs and intravenous contrast.^[36]

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External links

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