DIALYSIS COMPACT

The function, diseases and treatments for the human kidney.

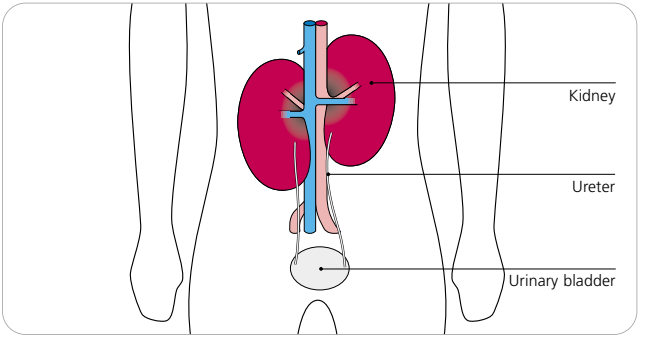
Fresenius Medical Care

Content

The kidney - a nearly irreplaceable organ!

The human kidneys are small, biological marvels with a fascinating design that fulfill a vital function. The failure or inability of the twin organs to function over a significant period can be life-threatening. Treating kidney patients only recently became a success story as hemodialysis became routine in the 1960s. Now, with the help of technical perfection, dialysis guarantees a certain quality of life and longer life expectancy for an increasing number of kidney patients.

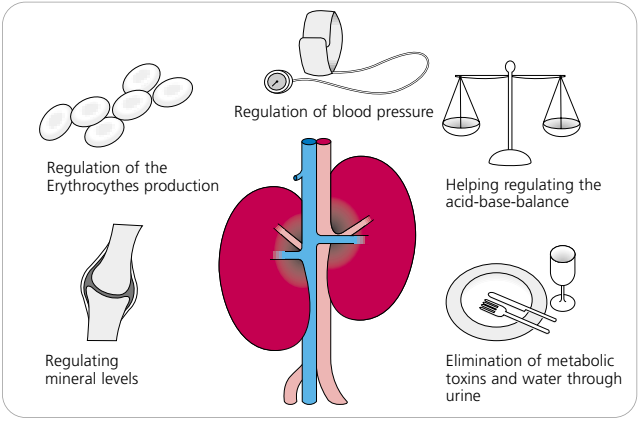
This publication will explain to investors, interested parties and patients the most important terms and information on the subjects of kidneys, diseases and dialysis, and answer the most important questions in a clear, concise manner. Here you will find explanations to questions including: what function do the kidneys perform, what causes chronic renal failure and which treatment alternatives exist? In addition, we will give an insight into how dialysis functions.



The kidneys in the body

What do healthy kidneys accomplish?

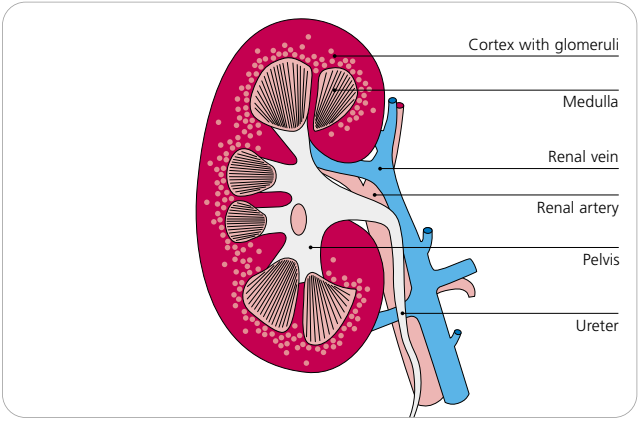
Kidneys are an important part of the body's metabolic processes. They accumulate urine and dispose it through the urinary tract. Excess water and toxins from metabolic processes, along with urine, are removed from the body as if through a filter. In addition, the acid-base-balance is regulated to prevent excess acidity in the blood. The kidneys also have an important function in regulating blood pressure by producing hormones. Hormones from the kidneys, such as Erythropoietin, control the production of blood cells in the bone marrow. Kidneys also influence the amount of calcium in the blood and the production of Vitamin D. This vitamin is needed in mineralization, which helps to provide stability of bones. The broad variety of the kidneys' functions is readily apparent. Kidneys come in pairs and, in adults, each kidney is about eleven centimeters (4.33 inches) long and weighs about 160 grams (5.6 ounces).



The functions of the kidneys

What causes kidney disease?

Kidney diseases can have differing causes. Various forms of infection in kidney tissue (glomerulonephritis) often leave lasting damage. Even high blood pressure (hypertension), a common ailment, can profoundly damage the kidneys. An underlying diabetes is oftentimes the cause of kidney disease and an excessive intake of certain medications can also reduce long-term kidney function. Various other, sometimes congenital, causes exist, such as polycystic kidney disease. Most kidney diseases develop quietly and are not noticed for many years. Therefore, some with chronic kidney disease do not visit a kidney specialist (nephrologist) until a late stage of the illness. Though seldom, some cases can develop quickly in a matter of days or weeks resulting in acute renal failure.



Cross section of a kidney

What effects does kidney disease have?

When kidneys are no longer able to adequately fulfill their duties, the functional efficiency of the entire organism is affected. If only the "filter" of the kidney is defective, too much protein will be released into the urine. Furthermore, it leads to edema (the collection of water) in legs or in lungs.

In many cases, however, too few toxins are removed. Once accumulated, these toxins can damage other organs. Disorders in the digestive tract can be as extreme as bleeding stomach ulcers. The poisoning can lead to heart rhythm disturbances or infection of the pericardium (heart lining). Even abnormal changes in the nervous system can be observed.

Most patients show a significant increase in blood pressure because of a dysfunction of the hormonal regulation. Medical treatment is absolutely necessary to lower the blood pressure.

In the advanced stage of the disease, decalcification of the bones begins and the dysfunction of blood cell production leads to anemia. Due to an insufficient removal of urine, the body retains too much water.

What are the goals in treating kidney failure?

If the performance of the kidneys, known as "clearance" to specialists, decreases by more than 10 to 15%, complications with dangerous consequences can be expected. Doctors call this stage of blood poisoning uremia. Untreated over a longer period, it leads to death. In treating advanced renal failure, doctors first work to prevent life-threatening complications from uremia while the long-term goal remains the full or nearly complete restoration of a patient's health, allowing a normal, everyday social and work life. Severely damaged kidneys can only be treated by replacing the organ's vital functions with an appropriate treatment - renal replacement therapy.

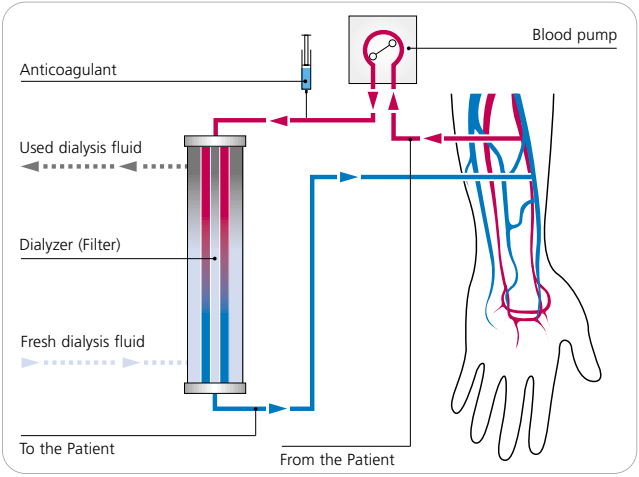
What opportunities exist for renal replacement therapy?

The best and most comprehensive form of renal replacement is the successful implantation of a healthy donor kidney. However, worldwide there are not enough donor organs available. Sometimes, important medical or personal reasons also make a kidney transplant impossible. Chronic kidney failure therefore requires – at least temporarily – treatment using an "artificial kidney". This treatment is known as "dialysis".

Various types of dialysis treatment have proven effective. If an actual "artificial kidney" is used, a filter cleans the blood in a process called hemodialysis. However, the peritoneum, or lining of the abdomen, is also available as a natural filter. It is used in peritoneal dialysis. The most important forms of renal replacement therapy will be explained in greater detail shortly.

Hemodialysis

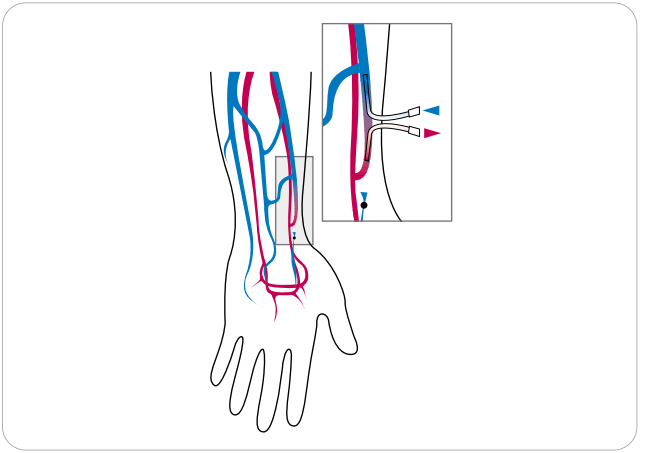
During hemodialysis, the patient's blood is passed through a filter outside the body and then reintroduced to the patient. Tiny pores in the filter membrane filter out toxins while vital components, such as proteins, are left in the blood. Excess water can also be removed through these tiny pores. The process is controlled by a dialysis machine that is equipped with a blood pump and monitoring systems that ensure safety. The machine can also administer drugs, e.g. Heparin, to prohibit blood clotting during the treatment.



Hemodialysis

Dialyzer

For hemodialysis, blood is taken from a vein, preferably on the patient's lower arm. To ensure that enough blood is available for treatment, a small operation is performed to prepare the forearm vein. A bypass is established between the vein and an artery to allow higher pressure and faster blood flow. This bypass is known as a "shunt". If no appropriate blood vessel can be used for the shunt procedure, a catheter can be placed in one of the larger blood vessels.



The shunt

There are various methods are available for use in therapy. The dialysis treatment itself can be administered in either a specialized clinic or at home.

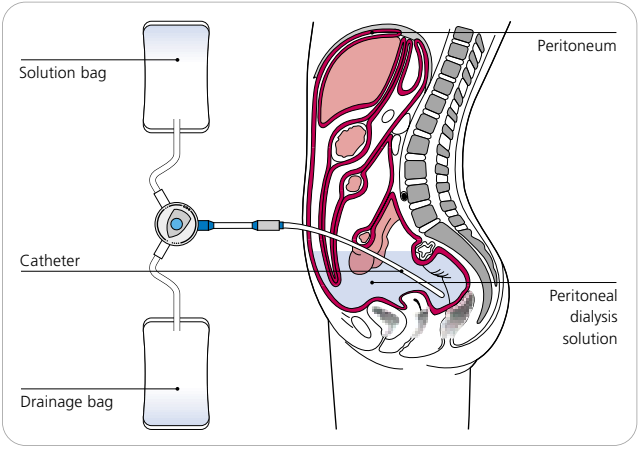
Dialysis in a clinic is usually performed three times a week on an outpatient basis and lasts four to five hours. Patients travel from home to the clinic. Experienced doctors and trained treatment personnel care for patients throughout the entire treatment. When not taking dialysis treatment, patients lead normal, everyday lives.

If a patient's condition allows, they can perform hemodialysis at home by themselves. The patient, and usually a partner, learn self-treatment in a training center. This form of treatment offers an independence that is beneficial for the patient's professional and social life.

Peritoneal dialysis

The peritoneum lines the walls of the abdomen and covers the internal organs. It has similar attributes to the artificial filter used in hemodialysis: its pores allow the passage of certain substances while retaining others. Peritoneal dialysis uses this naturally filtering organ.

A cleansing liquid (dialysis solution) is introduced through a catheter placed in the abdominal wall that ends in the pelvis behind the bladder. The metabolic toxins are brought to the abdominal wall in hair-thin blood vessels and pass through the pores into the cleansing liquid. Dextrose in the dialysis solution also pulls water from the body with the help of osmotic mechanisms. The used cleansing liquid is removed from the body through the catheter, along with the toxins and excess water. As with hemodialysis, the peritoneal dialysis can be performed at home or in a clinic.



Peritoneal dialysis

Kidney transplants

Many patients with end-stage renal failure hope for a "new" kidney through a transplant. However, there are not enough donor organs, usually taken from deceased donors, available. Patients that are medically fit for a transplant are first placed on a central waiting list. Waiting times as well as similar tissue types between donor and recipient are considered when allocating donor organs. This lessens the risk that a transplanted kidney will be quickly rejected by a recipient.

The donor organ is implanted in the groin area of the patient and connected to the patient's blood vessels. The kidney's ureter is connected to the patient's bladder. Damaged kidneys are usually left in the body. A donor kidney that functions well produces urine just like healthy kidneys and also helps to regulate blood pressure and

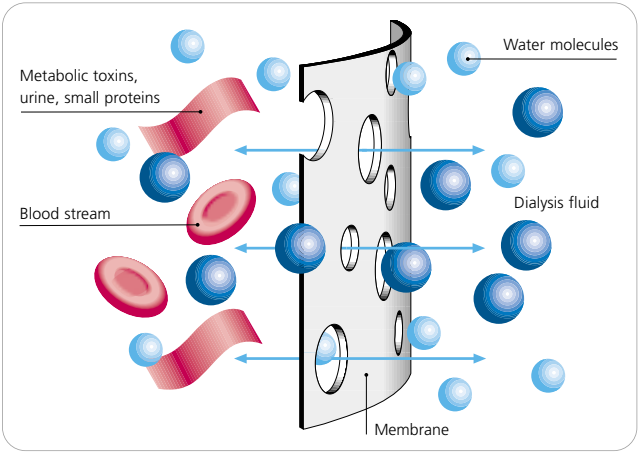
controls the production of blood cells.

Every transplant carries with it the risk of rejection by the recipient. Therefore it requires life-long medication to artificially weaken the body's defenses. This then leaves the body more susceptible to some illnesses. After a kidney transplant regular exams by a specialist are essential. As long as no complications arise, approx. 50% of these patients can live a comparatively normal life for an average of 10 years before the transplanted kidney's filtering ability diminishes.

How can metabolic toxins be removed from the body?

An average dialyzer is an artificial filter with about 10,000 microscopic dialysis fibers, which are also known as dialysis membranes. The fibers are about 0.3 mm or 300 µm wide and are hollow with semi-permeable walls. Blood runs through the dialysis fibers and the dialysate is pumped in the opposite direction. When blood is guided through the inner lumen of the capillaries, toxins up to a defined molecular size may leave the blood stream through pores in the capillary wall to the outer space. Here they are removed by a rinsing solution. Vital substances and blood cells remain in the blood stream, they are held back by the tiny pores.

The transfer of metabolic toxins through the membrane into the dialysate is based on physical transport laws. When two liquids (in this case blood and dialysate) with differing concentrations of substances are separated by a semi-permeable membrane, molecules attempt to offset the concentration difference. The molecules move from one liquid to the other in a process known as diffusion. Proteins and blood cells would naturally also work to balance out the differences but, because of their comparatively big size and the tiny pores, they cannot pass through the membrane and are retained.



Diffusion

To remove excess water from the body, especially in peritoneal dialysis, fluids contain sugar molecules. The concentration of the sugar in the fluid is higher than in the blood. Since the sugar molecules cannot pass through the membrane, the only way of offsetting the difference in concentration is for water to pass through the membrane and thus to compensate for the concentration difference. This process is also known as osmosis. In osmosis, as opposed to diffusion, molecules move in only one direction. By continuously introducing fresh dialysis fluid containing sugar molecules, excess water that the kidneys could not filter out and that would have collected in the body, can be removed.

Peritoneal dialysis is also based on the principles of osmosis and diffusion, with the patient's abdominal lining acting as the body's own dialysis membrane.

Fresenius Medical Care AG is the world's largest, integrated provider of products and services for patients with chronic kidney failure, a disease which affected more than 1,300,000 individuals worldwide in 2003. In our network of clinics in North America, Europe, Latin America and Asia-Pacific more than 119,250 patients received renal replacement therapies at the end of 2003. In addition, we are also the worldwide leading provider of dialysis products including hemodialysis machines, dialyzers and related disposable products.

More information on our company and the history of dialysis can also be found at: **www.fmc-ag.com**.

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