

## Hemodialysis

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Hemodialysis, also spelled haemodialysis, or simply dialysis, is a process of purifying the blood of a person whose kidneys are not working normally. This type of dialysis achieves the extracorporeal removal of waste products such as creatinine and urea and free water from the blood when the kidneys are in a state of kidney failure. Hemodialysis is one of three renal replacement therapies (the other two being kidney transplant and peritoneal dialysis). An alternative method for extracorporeal separation of blood components such as plasma or cells is apheresis.

Hemodialysis can be an outpatient or inpatient therapy. Routine hemodialysis is conducted in a dialysis outpatient facility, either a purpose built room in a hospital or a dedicated, stand-alone clinic. Less frequently hemodialysis is done at home. Dialysis treatments in a clinic are initiated and managed by specialized staff made up of nurses and technicians; dialysis treatments at home can be self-initiated and managed or done jointly with the assistance of a trained helper who is usually a family member.

Hemodialysis is the choice of renal replacement therapy for patients who need dialysis acutely, and for many patients as maintenance therapy. It provides excellent, rapid clearance of solutes.[2]

A nephrologist (a medical kidney specialist) decides when hemodialysis is needed and the various parameters for a dialysis treatment. These include frequency (how many treatments per week), length of each treatment, and the blood and dialysis solution flow rates, as well as the size of the dialyzer. The composition of the dialysis solution is also sometimes adjusted in terms of its sodium and potassium and bicarbonate levels. In general, the larger the body size of an individual, the more dialysis he/she will need. In North America and the UK, 3–4 hour treatments (sometimes up to 5 hours for larger patients) given 3 times a week are typical. Twice-a-week sessions are limited to patients who have a substantial residual kidney function. Four sessions per week are often prescribed for larger patients, as well as patients who have trouble with fluid overload. Finally, there is growing interest in short daily home hemodialysis, which is 1.5 – 4 hr sessions given 5–7 times per week, usually at home. There is also interest in nocturnal dialysis, which involves dialyzing a patient, usually at home, for 8–10 hours per night, 3–6 nights per week. Nocturnal in-center dialysis, 3–4 times per week, is also offered at a handful of dialysis units in the United States.

### Complications

#### Fluid shifts

Hemodialysis often involves fluid removal (through ultrafiltration), because most patients with renal failure pass little or no urine. Side effects caused by removing too much fluid and/or removing fluid too rapidly include low blood pressure, fatigue, chest pains, leg-cramps, nausea and headaches. These symptoms can occur during the treatment and can persist post treatment; they are sometimes collectively referred to as the dialysis hangover or dialysis washout. The severity of these symptoms is usually proportionate to the amount and speed of fluid removal. However, the impact of a given amount or rate of fluid removal can vary greatly from person to person and day to day. These side effects can be avoided and/or their severity lessened by limiting fluid intake between treatments or increasing the dose of dialysis e.g. dialyzing more often or longer per treatment than the standard three times a week, 3–4 hours per treatment schedule.

#### Access-related

Since hemodialysis requires access to the circulatory system, patients undergoing hemodialysis may expose their circulatory system to microbes, which can lead to bacteremia, an infection affecting the heart valves (endocarditis) or an infection affecting the bones (osteomyelitis). The risk of infection varies depending on the type of access used (see below). Bleeding may also occur, again the risk varies depending on the type of access used. Infections can be minimized by strictly adhering to infection control best practices.

#### Anticoagulation-related

Heparin is the most commonly used anticoagulant in hemodialysis, as it is generally well tolerated and can be quickly reversed with protamine sulfate. Heparin allergy can infrequently be a problem and can cause a low platelet count. In such patients, alternative anticoagulants can be used. In patients at high risk of bleeding, dialysis can be done without anticoagulation.

#### First-use syndrome

First-use syndrome is a rare but severe anaphylactic reaction to the artificial kidney. Its symptoms include sneezing, wheezing, shortness of breath, back pain, chest pain, or sudden death. It can be caused by residual sterilant in the artificial kidney or the material of the membrane itself. In recent years, the incidence of first-use syndrome has decreased, due to an increased use of gamma irradiation, steam sterilization, or electron-beam radiation instead

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of chemical sterilants, and the development of new semipermeable membranes of higher biocompatibility. New methods of processing previously acceptable components of dialysis must always be considered. For example, in 2008, a series of first-use type of reactions, including deaths, occurred due to heparin contaminated during the manufacturing process with oversulfated chondroitin sulfate.

### **Cardiovascular**

Longterm complications of hemodialysis include hemodialysis-associated amyloidosis, neuropathy and various forms of heart disease. Increasing the frequency and length of treatments has been shown to improve fluid overload and enlargement of the heart that is commonly seen in such patients.[4][5] Due to these complications, the prevalence of complementary and alternative medicine use is high among patients undergoing hemodialysis.

The principle of hemodialysis is the same as other methods of dialysis; it involves diffusion of solutes across a semipermeable membrane. Hemodialysis utilizes counter current flow, where the dialysate is flowing in the opposite direction to blood flow in the extracorporeal circuit. Counter-current flow maintains the concentration gradient across the membrane at a maximum and increases the efficiency of the dialysis.

Fluid removal (ultrafiltration) is achieved by altering the hydrostatic pressure of the dialysate compartment, causing free water and some dissolved solutes to move across the membrane along a created pressure gradient.

The dialysis solution that is used may be a sterilized solution of mineral ions. Urea and other waste products, potassium, and phosphate diffuse into the dialysis solution. However, concentrations of sodium and chloride are similar to those of normal plasma to prevent loss. Sodium bicarbonate is added in a higher concentration than plasma to correct blood acidity. A small amount of glucose is also commonly used.

Note that this is a different process to the related technique of hemofiltration.

### **Vitamin Deficiency**

Folate deficiency can occur in some patients having hemodialysis.