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A Short Note on Dialysis: Renal Replacement Therapy

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About the Study

When there is a sudden quick loss of kidney function, known as acute kidney injury (formerly known as acute renal failure), or when a progressive reduction in kidney function, known as chronic kidney disease, reaches stage 5, dialysis may be required. When the glomerular filtration rate is 10-15 percent of normal, the creatinine clearance is less than 10 mL per minute, and uremia is present, it is considered stage 5 chronic renal failure. Dialysis is used as a temporary measure in cases of acute renal injury or in individuals waiting for kidney transplants, as well as a permanent measure in cases when a transplant is not suggested or possible. In Australia, Canada, the United Kingdom, and the United States, the government pays for dialysis for people who need it.

The dialysis process can also be employed in research laboratories to segregate molecules based on their size. It can also be used to balance buffer between a sample and the solution that the sample is in, such as a "dialysis bath" or "dialysate." A tubular semipermeable membrane consisting of cellulose acetate or nitrocellulose is used in laboratory dialysis. Larger pore sizes allow larger molecules to flow through the membrane, while smaller pore sizes allow smaller molecules to pass through the membrane. Larger molecules cannot pass through the pores, however solvents, ions, and buffer can easily diffuse over the semipermeable membrane. This can be used to remove smaller proteins and chemicals from a complex mixture in order to purify proteins of interest.

The kidneys play a crucial role in overall health. When a person is healthy, the kidneys keep the body's internal water and mineral balance in check (sodium, potassium, chloride, calcium, phosphorus, magnesium, sulphate). The kidneys also eliminate the acidic metabolic end-products that the body can't get rid of through breathing. The kidneys produce erythropoietin, calcitriol, and renin, which are all part of the endocrine system. Calcitriol aids in the creation of bones while erythropoietin aids in the production of red blood cells. Dialysis is an ineffective treatment for replacing kidney function since it does not address the kidney's endocrine dysfunction. Diffusion (waste elimination) and ultrafiltration are used in dialysis treatments to replace part of these activities (fluid removal). Dialysis makes use of ultrapure (highly filtered) water.

Dialysis is based on the principles of solute diffusion and fluid ultrafiltration across a semi-permeable membrane. Diffusion is a feature of chemicals in water that causes them to travel from a high concentration area to a low concentration area. A dialysate, or special dialysis fluid, runs through one side of a semi-permeable membrane while blood flows through the other. A semipermeable membrane is a thin layer of material with holes or pores of varying sizes. The membrane allows smaller solutes and fluids to pass through, but it prevents larger things from passing through (for example, red blood cells and large proteins). When blood reaches the kidneys, the larger chemicals are sorted from the smaller ones in the glomerulus, simulating the filtering process that occurs in the kidneys.

Hemodialysis and peritoneal dialysis, the two most common types of dialysis, remove toxins and excess water from the blood in distinct ways. Hemodialysis eliminates wastes and water from the body by circulating blood outside the body *via* a dialyzer, an external filter with a semipermeable membrane. The dialysate flows in the opposite way as the blood does. The counter-current flow of blood and dialysate increases the concentration gradient of solutes between the blood and dialysate, allowing more urea and creatinine to be removed from the bloodstream.

The concentrations of solutes ordinarily found in urine (such as potassium, phosphorus, and urea) are unfavourably high in the blood, but low or absent in the dialysis solution, and regular dialysate replenishment ensures that unwanted solute concentrations are kept low on this side of the membrane. Mineral concentrations in the dialysis solution, such as potassium and calcium, are similar to those found in healthy blood.

The dialysis solution level for solute, bicarbonate is set slightly higher than in normal blood to increase bicarbonate diffusion into the blood, which acts as a pH buffer to balance the metabolic acidosis that is common in these patients. A nephrologist will usually prescribe the levels of dialysate components based on the needs of the specific patient.