Diabetes mellitus has long been a chronic disease affecting more than 230 million people worldwide with an additional 6 million developing diabetes each year(1). Diabetes mellitus is classified into two categories. Diabetes type 1 describes the condition in which the insulin-producing beta cells in the islets of the pancreas are attacked by the body's immune system. This results in the body's inability to produce insulin, which is required to metabolize glucose(2). Diabetes type 2 develops when the body becomes insulin-resistant. In this case, the amount of insulin secreted by the pancreas is not sufficient or the body cannot recognize or utilize insulin properly(3). The buildup of glucose in the bloodstream can lead to serious problems for the body. Serious complications for the body include blindness, kidney failure, nervous system damage, and heart disease or stroke(4). While current sufferers of diabetes are able to treat themselves with regular doses of insulin along with simple lifestyle changes, diabetes continues to be a prevalent condition that poses serious health repercussions to those affected. A variety of methods have risen out of the search to successfully cure diabetes. Pancreas and islet transplantation have been researched as possible solutions to diabetes. While there has been success with both types of implantation, the availability of pancreata for transplantation and islet isolation is limited, making it a poor solution for treating the large affected population. In addition, patients are subject to intense immunosuppression to prevent rejection of the transplants(5). Using photopolymerizable hydrogels for immunoisolation, researchers have also attempted to transplant encapsulated islets to create a bioartificial pancreas. In addition to protecting the islets from the body, the photopolymerizable hydrogel is still capable of allowing necessary molecules such as nutrients or oxygen to pass through the barrier. After 30 days of implantation in rats, researchers found that the isolated islets were viable and contained insulin(6). Another possibility being explored is the regeneration of islet cells inside the body, also known as islet neogenesis, using some sort of cell source such as embryonic stem cells or adult progenitor cells(7). As a result of islet neogenesis research, different proteins, such as INGAP (Islet Neogenesis Associated Protein), have been found to be involved with islet formation(5). Transdifferentiation of differentiated cells to beta cells is another possibility being explored. Some researchers have found evidence that differentiated exocrine cells are able to transdifferentiated into beta cells(8). Other research has explored transdifferentiation using liver cells transformed with telomerase and other factors to create insulin-producing cells that effectively countered diabetes when transplanted in afflicted mice(7). With the range of research currently being conducted, a solution to diabetes is getting closer to reality.
Abstract

Kidney failure is a large and growing problem in the world. End stage renal failure (ESRF) is caused by diabetes and other diseases leading to chronic inflammation, and affects almost 900,000 people (Nissenson). Sudden failure due to extenuating medical conditions like trauma is termed acute renal failure (ARF). While patients may regain kidney function, the condition has a mortality rate exceeding 50% (Humes). Standard treatments for renal failure are dialysis or allotransplantation. Transplantation provides replacement of all of the kidney’s functions; however, it is not a viable treatment due to the scarcity of transplantable organs. Xenotransplants have been researched to counteract the small supply of human organs, but is not a practical treatment option due to problems with rejection and immunosuppression (Hammerman). For now, most patients with renal failure receive hemodialysis (Nissenson). The dialysis replicates the blood filtration of kidneys, but fails to address the endocrine, metabolic, and immunologic functions. This omission leads to severe complications in dialysis patients over time.

In order to address these issues, researchers are investigating multiple avenues to improve or replace dialysis. Much of the new research is focused on incorporating kidney cells directly into treatments, with the hope that they will perform functions besides filtration. A large segment of the research involves tissue engineering and organogenesis, with the ambitious aim of replacing dialysis. Groups are investigating seeding new nephrons into damaged kidneys, as well as using stem cells to create a totally new kidney (Hammerman). Research led by H. D. Humes shows more promise for the short-term because it is concentrated on developing an additional device that is included in the standard dialysis treatment for ARF patients. Humes created the renal assist device (RAD), which is a filter cartridge containing viable kidney cells. The kidney cells allow some of the metabolic and immunologic functions of the kidneys to be restored, thus improving the health of the patient. Currently, the RAD has undergone Phase I clinical trials in ARF patients and Phase II trials are being pursued. Work is also being done by Ozgen, et al. to create a similar device that can be used over a longer term for ESRF patients.

Bibliography


This is essentially a review article on the progress of treatments for ESRD, with a focus on the current research being done on tissue engineering. There is good historical data on the development of dialysis, including some of the drawbacks to the method. A brief overview of transplantation is given, along with a brief report on some more current studies into immunosuppressives. Finally, the article gives an overview of the five approaches being used to find an alternate treatment method for ESRD. These include stem cell use, and creating a bioartificial kidney.