Apr 12th, 5:00 PM - 5:45 PM

Poster Session

Zarah Rahman

Jose E. Garcia Carbajal

Megan Farrell

Martha Brown

Minh Luong

See next page for additional authors

Presenter Information
Zarah Rahman, Jose E. Garcia Carbajal, Megan Farrell, Martha Brown, Minh Luong, Madaline Ngo, Teresa Dao, Sanchit Jain, and Angela Atkins

Blood

Zarah Rahman, Jose E. Garcia Carbajal, and Brooke Poe

Collin College

Abstract

The Blood is usually not what one would consider an organ; however, it requires as much care as any other organ. Blood is one of the most valuable fluids, because it transports all of the cells' needs through blood vessels that travel to different parts of the body. Many medical advancements and studies are being produced and analyzed with the goal of improving the condition of the patient's body. From big dialysis machines to microscopic nanoparticles or supplementing a lacking aspect in the body's nutrition to replacing blood volume/cells; something new is always being developed or discovered for improving the health of blood. These new advancements in technology, and new studies in the use of current treatments, are uncovering defects in the techniques that can result in patient illness and end up increasing the cost of healthcare. The development of these technologies improves disease diagnosis, treatment delivery, prognosis, and can ultimately lower the cost of care for the patient.

Keywords: [blood, dialysis, nanoparticles, vitamins, minerals, transfusions]

Dialysis

"The Dialyzer" was first invented by a Dutch physician named Willem Kolff in the 1940's (DaVita, n.d). His interest in the treatment of blood peaked when he witnessed people die of kidney failure and strived to invent a machine that performed the same function as the kidneys. Today, through Dr.Kolff's work, dialysis is the primary form of treatment used in patients that may suffer from problems with the kidney such as renal failure. The main function of the kidney is to filter excess salts, water, and waste from the blood; when the kidneys do not function properly they can alter the composition of blood leading to issues to arise within other parts of the body (National Kidney Foundation, 2015). To solve this issue, dialysis serves to act as the kidney and purify the blood within the body.

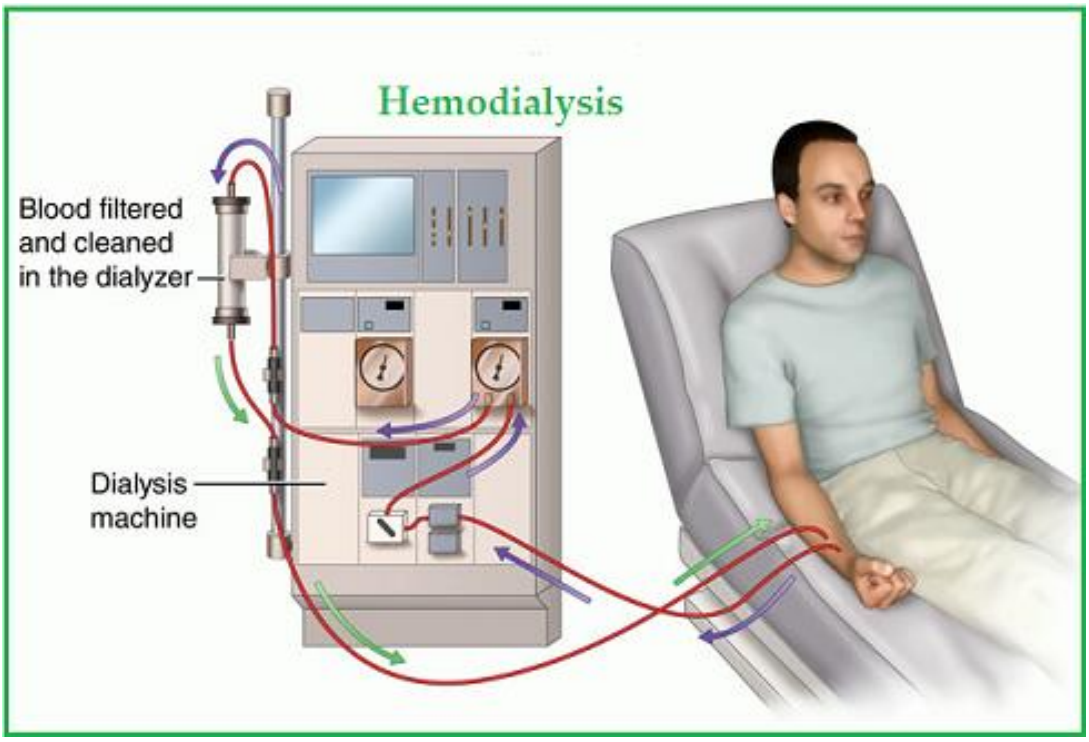
There are two general forms of dialysis: hemodialysis and peritoneal dialysis. Hemodialysis is the most common form of dialysis and uses a "man-made membrane" to clean the blood (Poinier, 2014). To begin treatment using hemodialysis, a doctor must first prepare a site where the blood will be drawn so it will be able to easily flow in and out of the patient's body. Examples of pathways for blood to travel to the dialyzer and back to the body include: a fistula (connecting an artery to a vein in the arm), a graft (uses a tube implanted into body to be a vascular access in the arm), and a venous catheter (a temporary tube, or catheter, used for vascular access). The patient's accessed blood vessels are then connected to a dialyzer, or artificial kidney, where blood is extracted, purified through a machine, and then replaced into the patient's body(Murali, Mullan, Chen, Roodenrys, & Lonergan, 2017). The purification process is the most significant aspect of dialysis. The dialyzer is separated into two sections by a thin membrane. This membrane prevents bigger particles, such as proteins, from passing through to retain the essential molecules while allowing smaller substances such as waste, salt and urea to

flow through (Poinier, Thompson, Husney, 2015). These smaller substances are then washed away by a solution, called dialysate, located on the opposite side of the membrane before being returned to the body. Advantages to hemodialysis include undergoing dialysis for a shorter amount of time, flexibility depending on the severity of the kidney issue, and having contact/moral support during the procedure. Disadvantages include dietary and fluid restrictions, discomfort during the procedure and difficulty doing activities.

In contrast to hemodialysis, peritoneal dialysis is more invasive and is most commonly seen in patients with chronic kidney diseases. Peritoneal dialysis uses the peritoneum- a membrane that lines the abdominal cavity- to filter the blood (National Institute of Diabetes and Digestive Kidney Diseases, 2015). To begin treatment with peritoneal dialysis, a doctor will place a catheter within the abdomen for a few weeks and observe the patient. A bag filled with the same washing solution used in hemodialysis, called dialysate, will then flow through the catheter and into the peritoneal cavity where it is kept for 4-6 hour periods (Wein, 2016). The filling of the peritoneal cavity with the dialysate solution is called exchange. The period in which the solution remains in the body is called dwelling. After the 4-6 hour period is over, the dialysate solution is drained and replaced. In this form of dialysis, the dialysate solution absorbs waste, urea, and excess fluids within the body and is completely drained before refilling the peritoneal cavity with the washing solution. This process ensures that the blood within the body is continuously being filtered and drained throughout the day. Advantages to peritoneal dialysis include the flexibility of choosing the location of where the patient would like to perform dialysis, the ability to move around and do activities, being able to perform dialysis individually, and not having any dietary restrictions (Mayo Clinic, 2016). Disadvantages include having to

change out the dialysate multiple times throughout the day, an increased risk of peritoneal infection if procedure is not done correctly, weight gain and discomfort.

The advancement of dialysis has improved drastically resulting in also improving the quality of blood and quality of life for those with kidney diseases.



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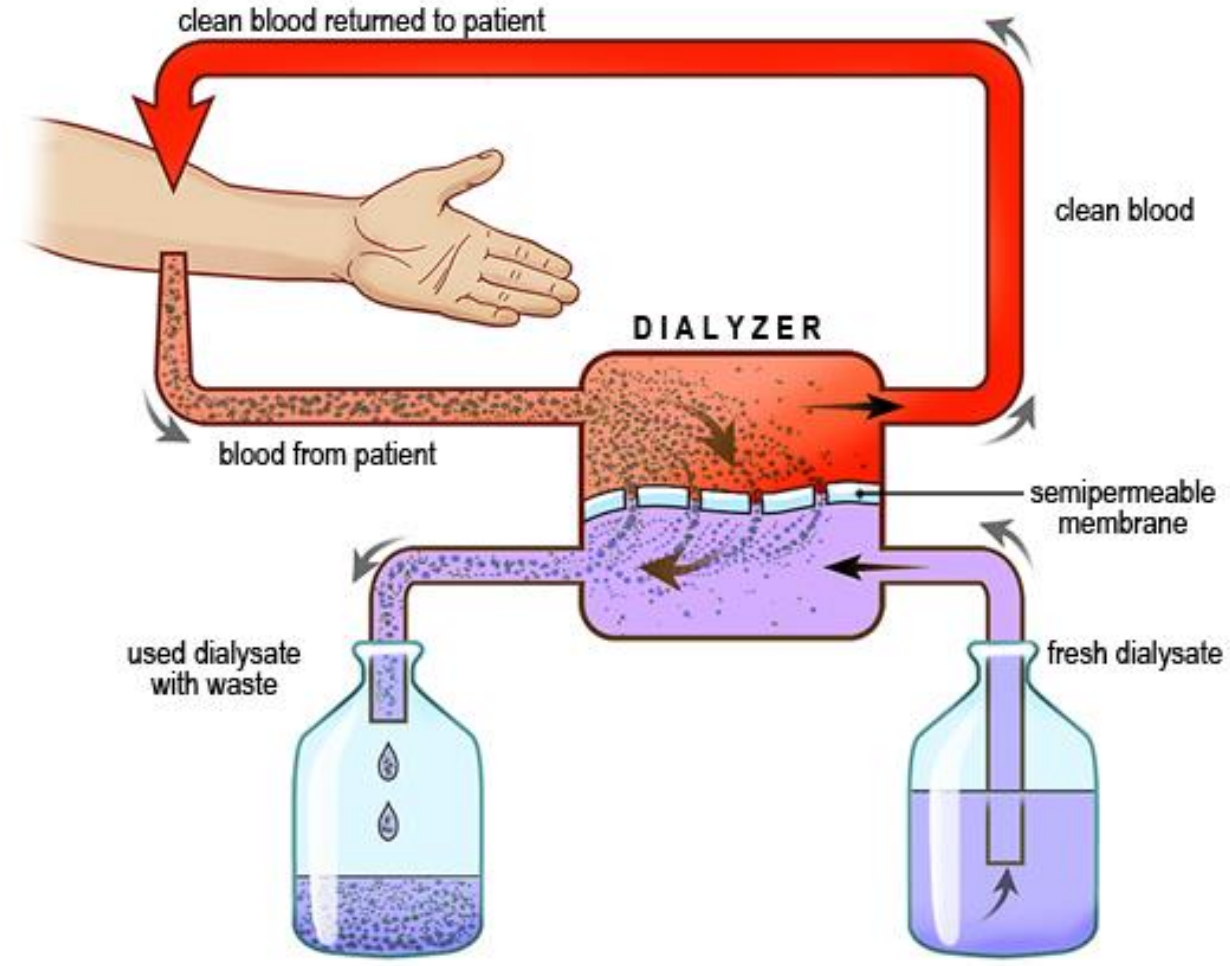

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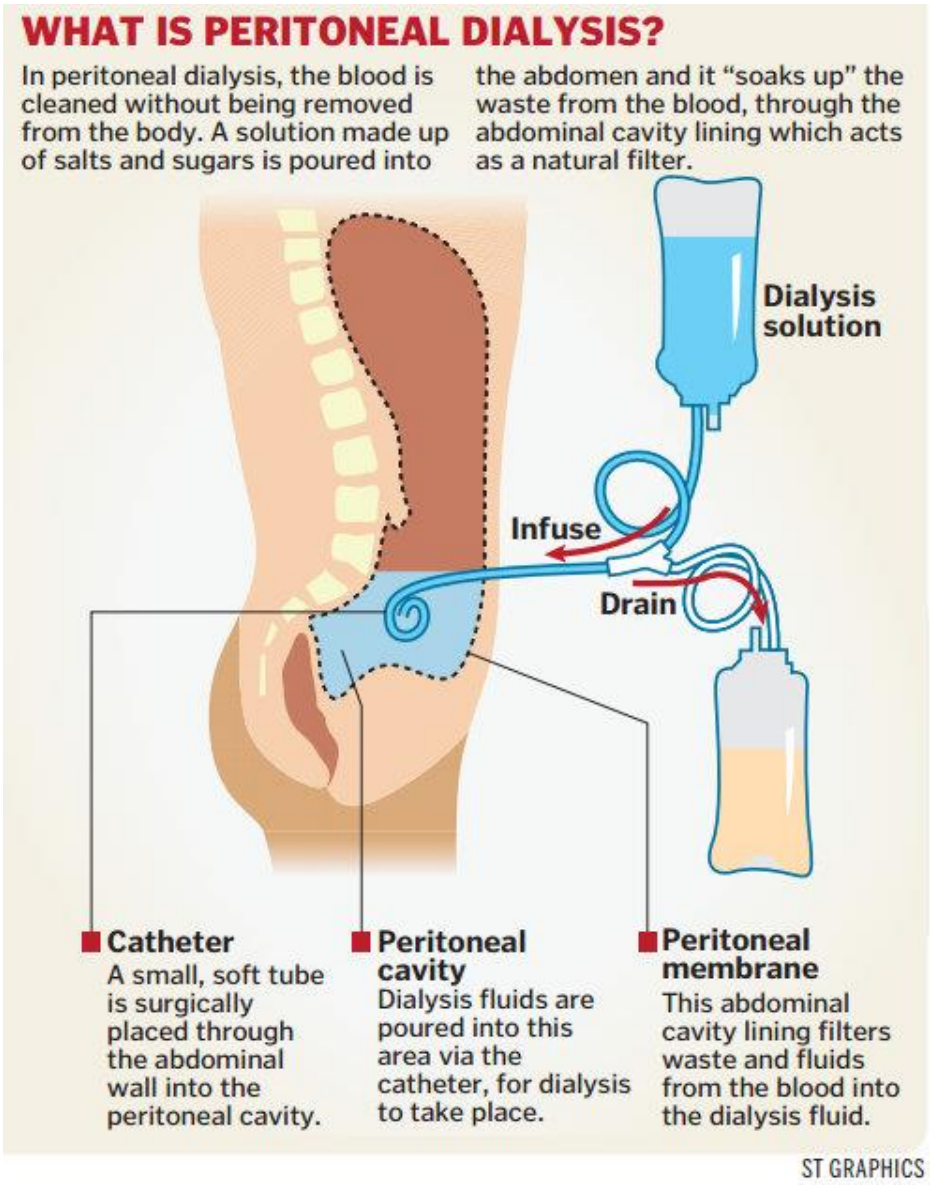

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Transfusions

In 1628, William Harvey was the first to detail and experiment on the circulation of blood within the body (Stankus, 2016). Through his research and experiments, many others around this time period attempted blood transfusions but to no avail. The first successful blood transfusion dates back to the 17th century performed by British physician Robert Lower in 1665. He had bled a dog nearly to death only to revive it by transfusing blood from another dog by tying their arteries. Today, blood transfusions have undergone massive changes to accommodate for the rapidly advancing medical society.

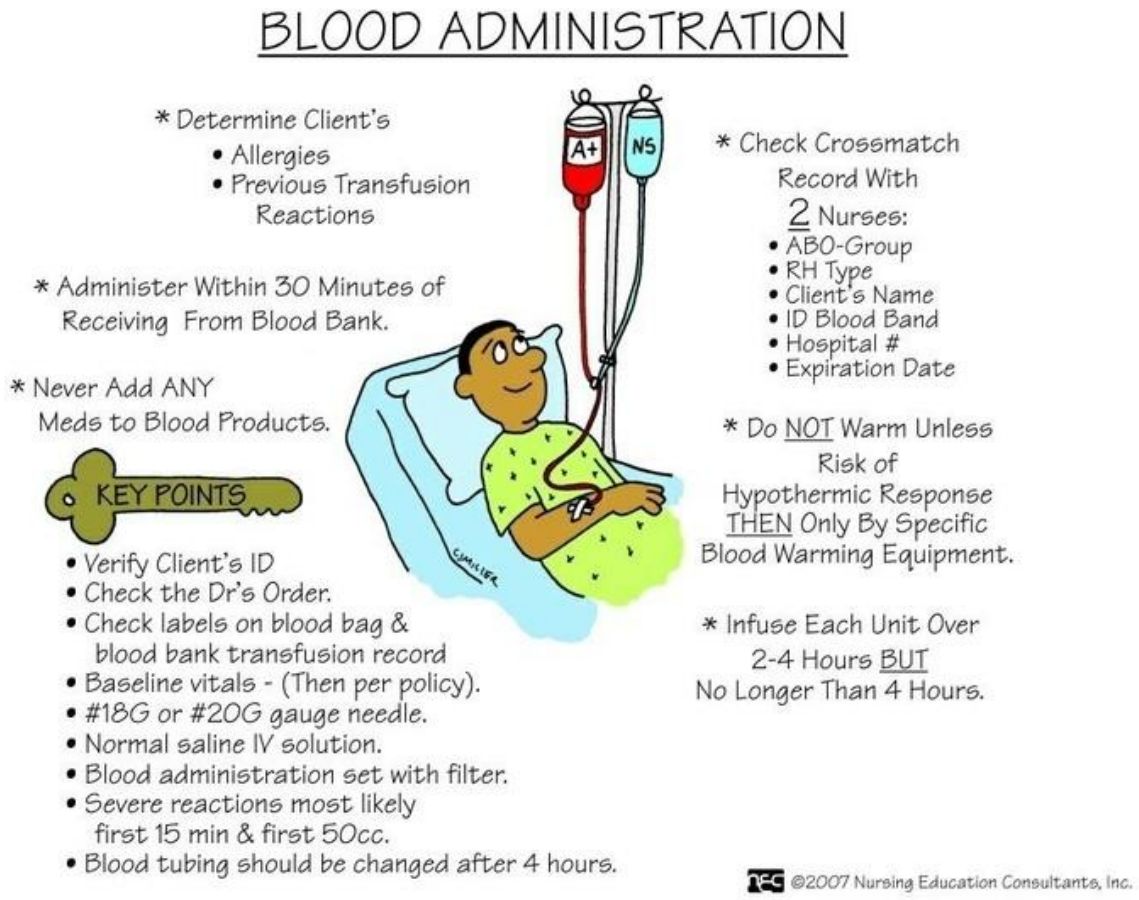
By definition, a blood transfusion is a procedure in which an IV, or intravenous line, supplies blood via blood vessels (Mayo Clinic, 2015). It is primarily used to replace blood cells lost from surgery, injury, or the body's inability to create blood (Dhabangi, Mworozi, Lubega, Cserti-Gazdewich, Maganda, & Dzik, 2013). The type of transfusion is determined by whether the blood as a whole needs to be replaced or if individual components of blood such as platelets, white blood cells, and red blood cells need to be increased.

In order for a blood transfusion to be effective, blood types must match (Yazdanbakhsh, Ware, Noizat Pirenne, 2012). There are 4 types of blood and each has a different recipient and criteria for donating. Additionally each blood type, depending on the person, is Rh positive or Rh negative. The Rh factor is a protein found on blood cells if he or she tests positive, if tested negative, there is no Rh factor (American Red Cross, n.d). The 4 blood types are A, AB, B, and O. Blood type AB is the universal recipient, meaning it can receive blood from all 4 types of blood. Blood type O is the universal donor, meaning it can give blood to any blood type. To give an example, a person with type AB blood may be Rh positive and receive blood from all blood types but donate to only blood type AB.

A blood transfusion typically begins with a doctor or nurse testing the patient's blood so they can locate donated blood that matches. The matching blood type is then processed to ensure the bloods purity. Specific elements of the blood such as white blood cells, platelets, and red blood cells needed to increase that of the patients is counted and adjusted before being administered through a cannula inserted into the arm and connected to a drip. The new blood or components of blood flow through the drip into the patients arm which then diffuses to all parts of the body (National Heart, Lung and Blood Institute, 2012). Other modes of treatment include having a central line or a larger cannula/tube inserted into a vein in the chest. This alternate mode of treatment is seen in patients that have a severe condition or have underlying health issues.

The advancement of research related to blood transfusions have greatly impacted today's society as it has made the procedure safer, and highly effective in treating patients with a low blood count or trauma. As stated earlier, blood transfusions were discovered through William Harvey and his experiment with dogs. Later experiments were tried, notably one by Jean Baptiste Denis, in which blood from a sheep was transferred into a human, but due to problems that occurred after the transfusion (blood attacked new/foreign blood), later experimenters realized that the blood types had to match (Mandal, 2014). By implementing this information in modern day and identifying the blood types of patients before administering blood to be transfused, a patient's life is saved.

Additionally, new technologies invented (such as the OrthoPAT) to purify or add components of blood/ new blood to a patient have increased the chances of survival and reduced the risk of mortality by salvaging a patient's own blood, processing it, and then returning the blood into the patient's system (Progenicare, 2013).



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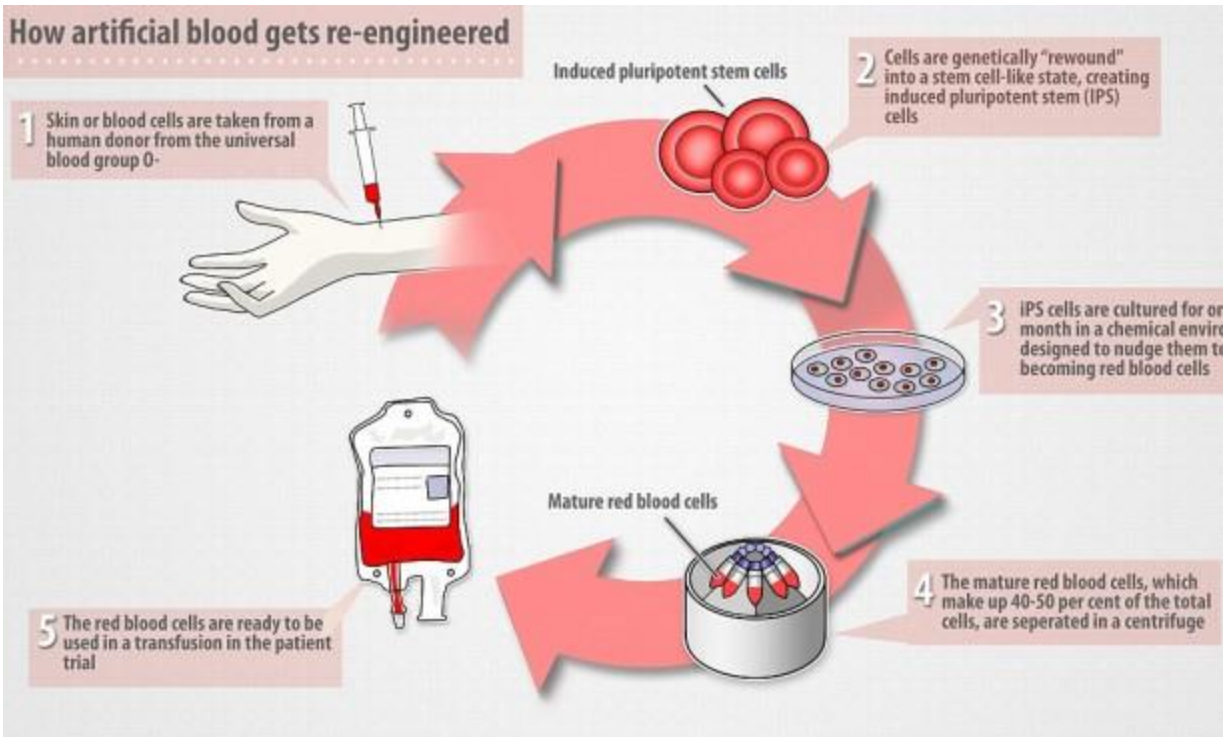

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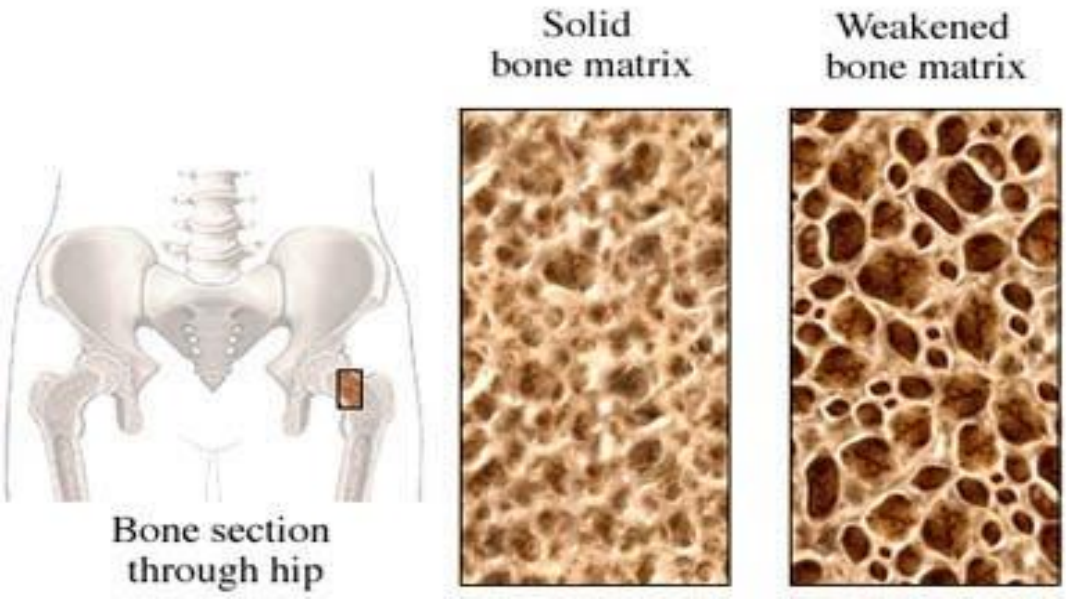
Vitamins and Minerals

Vitamins and minerals can be some of the most vital parts of the blood, because they allow the body to perform homeostatic tasks. Deficiencies in certain vitamins or minerals can lead to disorders in the blood. Many studies are being performed for the knowledge of how these deficiencies affect individuals or groups of people, and how they can be corrected through lifestyle changes or medication if needed.

One of the most common vitamin deficiencies is vitamin D deficiency. Vitamin D absorbs calcium, promotes bone growth, aids the body in maintaining a healthy bone mineral density, and lowers the possibility of bone fractures due to fragility. Vitamin D is produced by skin exposure to the sun, but lack of exposure can lead to a deficiency. Without the appropriate amounts of vitamin D the skeleton becomes fragile and can easily fracture. Many variations in among people of different genetic origin can affect the body's ability to produce, use, and maintain vitamin D. A study was conducted to determine if someone's genetic background has an influence on their body's ability to create and maintain vitamin D. The results of the study showed that people of black descent were more likely to have a certain gene that causes decreased levels of inactive vitamin D. On the other hand, people of white descent were more likely to have a different gene that also caused decreased levels of inactive vitamin D (Powe, 2013). This discovery can be utilized to create individualized care for patients of varying heredities.



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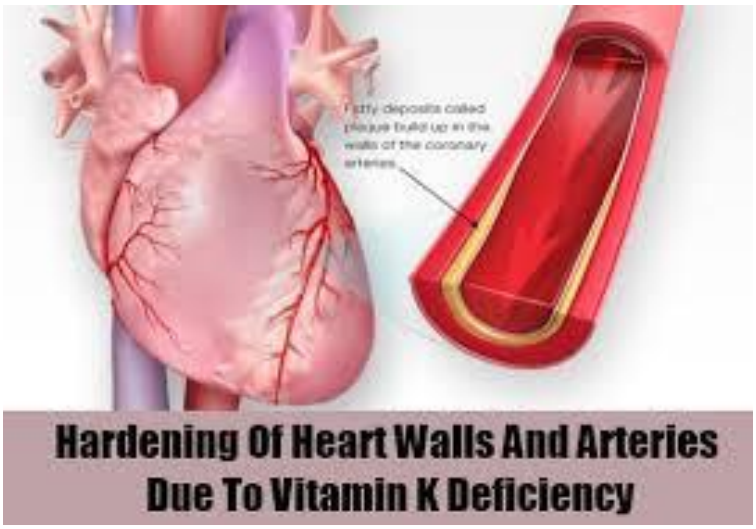
Another vitamin deficiency that can be harmful towards the body is vitamin K deficiency. Vitamin K deficiency can lead to cardiovascular disease. A study was done to observe the effect of using daily vitamin K supplements on hemodialysis patients, because other studies had suggested hemodialysis patients had a higher probability of having poor vitamin K levels. Vitamin K is important in managing the calcification of the arterial walls and the proper clotting of the blood. The results of a study confirmed that hemodialysis patients do tend to have lower vitamin K levels and the use of vitamin K supplements increased the levels of proteins associated with vitamin K (Westenfield, 2012).



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Vitamin B12 is an essential component in the processing of amino acids, which are an essential part of proteins. A deficiency in vitamin B12 can lead to muscular, nervous, or mental problems, and it can be related to coronary artery disease. In a study performed, the effects of vitamin B12 deficiency on the level of an amino acid that is processed by vitamin B12 were analyzed. The study focused mainly on people of Indian descent, because low vitamin B12 is prevalent in Indian men, especially in vegetarians and urban residents (Mahalle, 2013).

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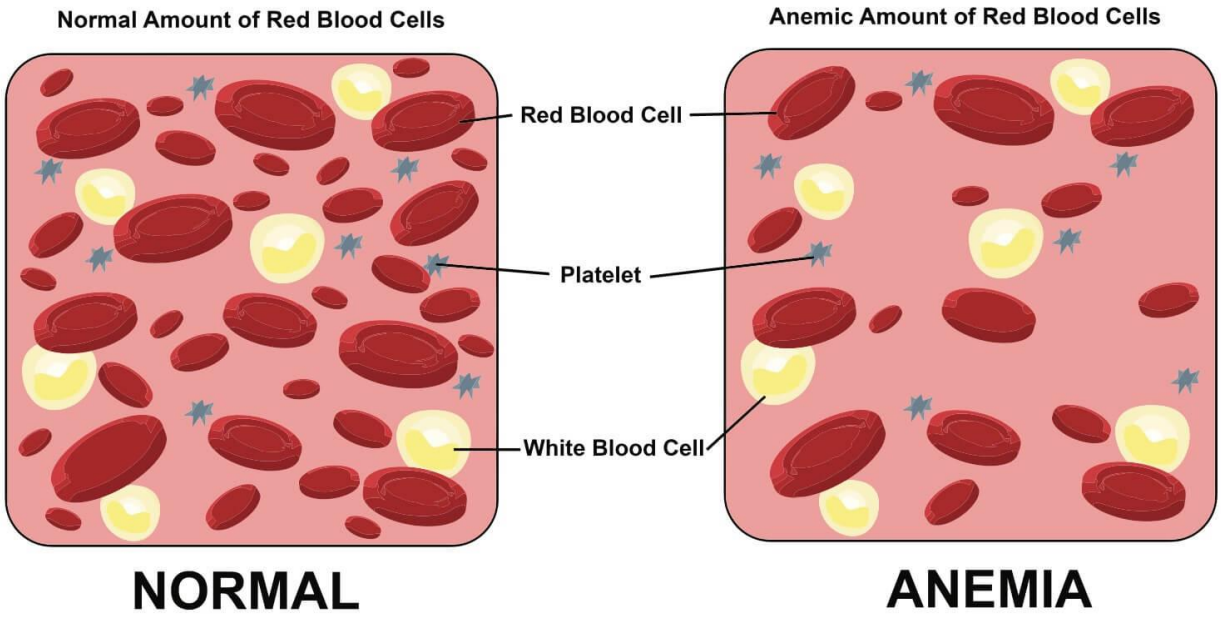
Although vitamins are important to the well-being of the body, minerals are also important to the health of an individual. Iron is one of these minerals. Iron deficiency can cause a low red blood cell count, which is called anemia. Anemia is one of the biggest medical issues in the world The World Health Organization (WHO) estimates that worldwide, 42% of pregnant women, 30% of non-pregnant women (15-50 years), 47% of preschool children (0-5 years), and 12.7% of men older than 15 years old are anemic, which results in 1.6 billion people being anemic. The issue of anemia is most common in low/middle-income countries, because they do not have the same access to nutritious food as high-income countries do. Some of the strategies to maintain iron deficiency anemia under control is to provide iron supplementation, to fortify foods with micronutrient powders, and to diversify the types of foods available. This supplementation of iron, among women, improves physical and mental capacity, productivity, and overall health; among children, it can improve their development (Pasricha, 2013). These precautions that were developed can help prevent an issue that affects a large portion of the world population with some simple changes to the diet of individuals.



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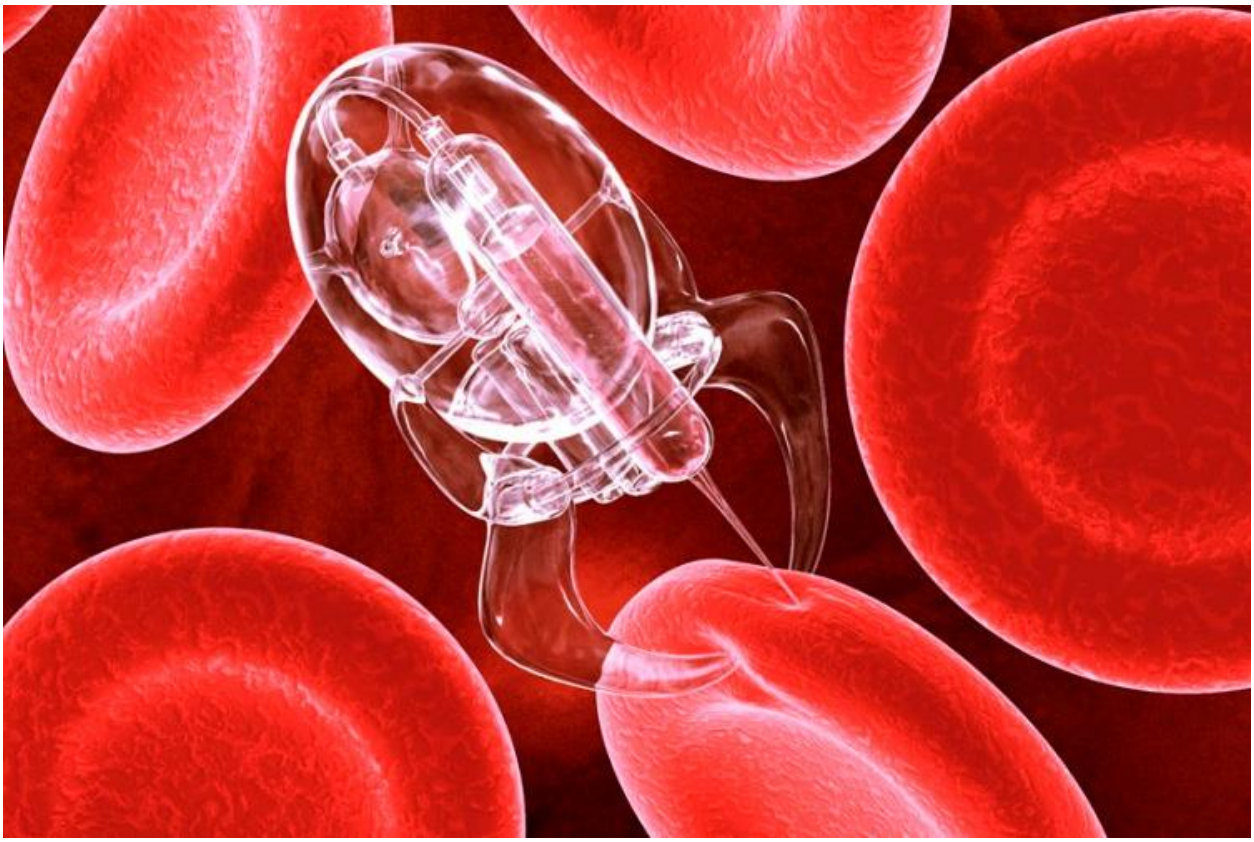
Nanotechnology

Nanotechnology has recently come into the light due to major technological advancements made in the 20th and 21st century. With contributions made towards the development and improvement of nanoparticles new ways to treat illnesses are being discovered. The overall goal of nanotechnology is to develop microscopic machines that function to monitor and aid the body in maintaining relative health.

One of the biggest feats being accomplished in the field of nanotechnology is the development of tissue-specific drug delivery systems, which can be used to deliver medication to specific tissues by attaching medications to the surfaces of nanoparticles that settle on the desired tissue types. The use of this method can be effective for targeting cancer cells and delivering medication to those cells, so the devastating effect of the cancer treatment is limited only to the cancer cells. The use of nanotechnology against cancer does not start at treatment; it begins at the identification process. Utilizing the same idea that the nanoparticles only attach themselves to certain types of cells, nanoparticles can be used to molecularly identify cancer cells. The identification of cancer cell can be done with the use of silica nanoparticles containing a dye that can be used to track the progress of the cancer (Ranganathan, 2012).

However, like many other medical advancements, nanoparticles still need to be improved if they are to be commonly used for the identification and treatment of disease. The nanoparticles being developed are made of materials that have minimal effect on human health or only decompose into non-harmful materials after use such as gold or silica. However, one of the biggest concerns is the possibility of hypersensitivity reactions, or allergies, towards the nanoparticles themselves. The possible dangers present with these reactions include problems

with the cardiovascular, pulmonary, digestive, muscular, and nervous systems of the body. In some cases these hypersensitivity reactions can lead to death. To study this, various samples of blood were taken and exposed to certain types of nanoparticles in different materials. The study did show some correlation between certain factors and the possibility of a hypersensitivity reaction, but it does recommend further investigation into the components of the nanoparticles and the development of individualized care (Szebeni, 2012) While these dangers currently limit the application of nanoparticles in healthcare they still look promising in the medical field. The discovery of these dangers can open access to further improving the health of the blood by developing nanoparticles that do not invoke hypersensitivity reactions in patients.



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