

How have medical advances improved transfusion and transplantation.

This essay analyses the historic advances that have helped doctors and scientists better understand and improve practises of blood transfusions and solid organ transplantations.

Since ancient times blood has been considered a life force, which almost all living creatures needed to live. Until only a few hundred years ago bloodletting was the most common medical treatment for all illnesses, which involved removing a patients 'bad blood'. As you can imagine patients often bled out and died, but this gave doctors one of the first ideas into blood transfusion, draining a healthy persons 'good blood' and giving it to a sick patient with 'bad blood' would logically make them better.

Originally, doctors attempted transfusing blood between animals (the first being successful in 1665 between two dogs) then animals and humans and then just between humans. However, this still led to many humans experiencing hyper rejection and consequently dying which drew the conclusion that everyone has unique blood. This caused the practice of blood transfusion to be banned by religious leads of the time, a tradition still carried out by Jehovah's witnesses to this day.

In the early 20th century, it was proved that everyone did indeed have unique blood, although it was also found that there must have been some way to trick our bodies into accepting blood from others. This was theorised when Karl Landsteiner mixed blood in petri dishes, a lot of the time the blood would attack the other and clump together. But in some cases, nothing happened. To explain this blood was grouped into different types. Landsteiner later won a Noble prize for his theory and contribution to medicine in 1930.

These different groupings of blood are now known as the ABO system. Scientists discovered that there are different proteins on the surface of blood (A or B), some people even have both proteins (AB) or neither (O). We also have antibodies in our blood that detect the foreign proteins from other blood and haemolyses it (meaning to attack and destroy it). This is why when blood of the same type is transfused nothing happens as the antibodies are the same as before. Another way blood is grouped is by its Rh factor, with positive Rh factor blood being able to receive both + and- blood but negative only being able to receive the same Rh factor. The knowledge of blood types and advancements in transfusion medicine meant doctors could safely replace the blood of injured soldiers in WW1 saving many lives.

Leading on from blood transfusion came the concept for solid organ transplantation, the idea of replacing damaged organs with healthy organs. The first major breakthrough in organ transplantation were skin grafts in the late 19th century. Following that was the first ever successful kidney transplant occurring in the mid-20th century, continuing with other vital organs, including a double lung transplant in 1986.

Originally organs were only matched by the ABO system like transfusions to prevent hyperacute rejection, as blood vessels in organs have the same ABO antigens on their surface. Nonetheless this was still not enough as solid organs are more complex than blood.

Scientists and doctors first observed this phenomenon in skin transplants. If the tissue can be kept alive, skin grafts between two different sites on the same person (autograft) have a 0% rejection rate. A graft transplanted between two genetically identical people (syngeneic graft) has a similar rejection rate. However, this changes when skin is grafted from two genetically different individuals (allogeneic graft) the graft initially survives but is then rejected in around 10-13 days. This is called acute rejection which is slower than hyperacute rejection but considering the graft is meant to last a lifetime, still fast. Acute rejection is also the most common type of rejection in organ transplantation. This result is consistent when an individual who rejected a graft is then regrafted by the same donor, the second graft will be rejected quicker than the first graft (usually 6-8 days). This is known as an accelerated reaction, just like our bodies remember a disease we have already fought it also remembers tissue it has rejected before.

In the 1950s scientists found that this recognition of what is not from our bodies depends on molecules that exist on the surface of our cells called human MHC or HLA. These molecules show off the genetic makeup of each tissue to our immune system. They are used to detect when a virus has infected cells and is no longer the same as before. Doctors originally tried to match HLA types like they did blood, and this was sometimes effective. But the number of HLA types is much vaster than those of blood, so finding an exact match is almost impossible. This wider variety in molecules has evolved as a defence, so that no single virus can infect a large segment of the population and bypass the immune system.

Nowadays doctors instead try to prevent this immune response against these molecules in foreign organs in a process known as immunosuppression. However, this results in transplant patients being more susceptible to dangerous infections. Nevertheless, it prevents them from rejecting the lifesaving organ.

Current clinical research is considering lab grown cells and blood. With the first transfusion of lab grown blood cells being transferred into a patient in 2022 (the RESTORE Trial). Similar research is taking place with cells grown in labs known as cholangiocytes organoids. Laboratory grown cells and blood are considered to be the future with significant advances predicted.

Medical advances have significantly improved blood transfusion and organ transplantation. With 4651 organ transplants taking place in the UK last year (2023-2024) but there is still estimated to be around 7500 people on the UK transplant list. Therefore, ongoing future research is critical.

I found this specific topic very interesting because of its links to medicine and history so I might consider biology as a degree. But I would like to explore other options.