Hemorrhage, or the condition in which excessive bleeding occurs and the blood flow cannot be stopped, is a leading concern in the medical field today; over 35% of pre-hospital deaths and over 40% of deaths within the first 24 hours are caused by hemorrhage. Large amount of blood loss leads to a low blood pressure, which could result in multiple organ failure, thereby leading to the individual’s death. Although many such injuries can be stopped by applying compression to the wound, compression cannot be applied to internal injuries or injuries on the torso, abdomen, pelvis, and back. In addition, if the patient is in hemorrhagic shock, compression alone is not enough to save the patient. Hemorrhage shock occurs when the patient has so much blood loss that it is impossible for the heart to pump a sufficient amount of blood to the body, resulting in a lack of oxygen reaching the tissues. If the problem is not treated, the cellular response caused by the lack of oxygen could lead to a complete failure of internal organs, thereby killing the patient. Therefore, a more effective method of stopping hemorrhage is needed, especially in locations where compression cannot be applied to stop hemorrhage [1].

CURRENT APPROACHES

One current method used in a hemorrhage situation is resuscitation, or the restoration of circulation after blood loss. Some products that have been used for resuscitation are colloids such as gelatin, human plasma or plasma proteins such as albumin, and blood transfusion with whole blood. Another method that has been used in a hemorrhage situation is the use of tiny sponges to clot up a wound [2].

Even though resuscitation can be used in many hemorrhage situations, many problems exist with the process. For example, using blood transfusion with whole blood, or blood drawn from the body from which none of the components, such as plasma, have been removed, could lead to an immune response in the patient. The immune response could then lead to a transfusion reaction, which occurs when the blood cells given to the patient during the blood transfusion are destroyed by the patient’s immune system. In addition, methods such as the use of colloids and human plasma proteins require specific storing conditions, are very expensive, have a short shelf life and clot the blood too weakly to completely stop the bleeding. In addition, bacteria can grow on blood products such as human plasma proteins, resulting in a risk of viral transmission [3]. In order to combat the problems seen by resuscitation, nanoparticles such as poly(lactic-co-glycolic acid-poly-L-lysine-poly(ethylene glycol)-[Arg-Gly-Asp](PLGA-PLL-PEG-RGD), which induce platelet aggregation, are being used, and the use of these nanoparticles have even been reported to induce faster clotting. However, nanoparticles use the reticuloendothelial system, which contain cells that are concerned with blood cell formation and destruction. Even so, nanoparticles could lead to undesired thrombotic, or the formation of blood clot inside a blood vessel, events since they regulate the formation of blood platelets. Therefore, a safer approach is required to combat hemorrhage [4].

POLYSTAT

In a normal scenario, when a patient loses blood, the platelets in the patient’s body gather cells around the wound, which creates a mass of cells that are then bound together by a strand-like protein called fibrin. If the pressure of the blood is greater than the strength of the support created by the fibrin, as is in the case of hemorrhage, the clot breaks and the bleeding continues [3]. PolySTAT, a synthetic material that can be injected when a person is losing blood, enhances the natural process of clotting by mimicking the body’s enzyme Factor XIII, which helps the strands of fibrin close a blood clot. When research was conducted using PolySTAT in rats, results showed that rats that were given polySTAT had blood that clotted more quickly and effectively than blood of rats that were not given polySTAT. The research proves that polySTAT does, indeed, enhance the body’s natural process of clotting. However, unlike fibrin, which can be cut by the body’s natural enzymes, the bonds formed by the synthetic polySTAT are not affected by the body’s natural enzymes. Therefore, in a case of hemorrhage, polySTAT is much more effective than the fibrin produced by the body. Since polySTAT enhances the body’s natural process of clotting, the problem of blood clotting too weakly to completely stop the bleeding, a problem experienced by many current approaches to hemorrhage, will not be seen with polySTAT. Because polySTAT enhances the body’s normal clotting
function, immune responses such as those experienced by patients given blood transfusion with whole blood will not be seen with the use of polySTAT. Also, polySTAT contains a peptide that makes the polySTAT bind only to the fibrin at the wound site, thereby eliminating the risk of formation of dangerous clots that could lead to stroke since polySTAT will not bind to the precursors of fibrins that circulate throughout the body [4].

Possible Applications of polySTAT

PolySTAT could save lives that would have otherwise been considered lost. Using polySTAT in a case of severe blood loss would provide the doctors with enough time to test the blood being given to the patient and make sure that the blood is compatible with the patient’s immune system before giving the blood to the patient since the doctors will not have to worry about more blood loss. Also, since polySTAT causes blood to clot faster than it would have otherwise, polySTAT could prevent the patient from reaching a state of hemorrhage before it occurs and because polySTAT is a synthetic material, it will not require specific storing conditions, and will likely be more affordable than current approaches to hemorrhage. Also, polySTAT could save the lives of many suffering from Hemophilia, a genetic disorder caused by a missing or defective clotting proteins, which leads to improper clotting of blood; Since polySTAT mimics an enzyme that aids in the clotting of blood, it could be used to aid those with hemophilia by taking on the role of the missing or defective clotting proteins, thereby stopping excessive blood loss from occurring, which is a major problem experienced by those suffering from hemophilia. Another possible application of polySTAT is use of the polymer in bandages [5]; Chitosan gauzes stop bleeding by interacting with the cell membranes to cause clumping of red blood cells and by sealing the wound through tissue adhesion. Research by Chan et al., which compared a nonwoven chitosan gauze containing polySTAT and a commercially-available chitosan-containing gauze, showed that the gauze containing polySTAT showed more rapid absorption when compared to the commercially-available gauze. In addition, rats that were given the chitosan gauze containing polySTAT had less blood loss and improved survival rate than rats with commercially-available gauze, which contained only the chitosan. These results suggest that polySTAT improves the function of a chitosan gauze [6]. In addition, synthetic polymers such as polySTAT, unlike natural blood products such as blood platelets, reduce infection and transfusion risks, thereby making them well suited for field use, including use in remote locations. Therefore, polySTAT could be used during wars, keeping soldiers suffering from a large amount of blood loss alive long enough for them to reach a medical provider [7].

CONCLUSION

Overall, polySTAT could save the lives of many suffering from hemorrhage, and potentially those suffering from genetic disorders such as Hemophilia. Current methods, which include the use of plasma proteins, require specific storing conditions and are very expensive. In contrast, polySTAT does not require specific storing conditions, and will likely not be as expensive as plasma proteins. Also, polySTAT will not cause immune responses like those seen by patients who received blood transfusions because polySTAT enhances the body’s enzyme factor XIII. However, polySTAT is an innovation that is still in its early stages and more testing and screening needs to be conducted to see if it binds with any unintended substances before it can be used in human trials. However, as of now, polySTAT seems like a promising approach to those experiencing hemorrhage, and potentially, even those experiencing Hemophilia. With motor vehicle crashes being the leading cause of death for U.S. teens, and with me being a teen, an invention like polySTAT could save my life as well as the lives of countless other teenagers who could, potentially, suffer from hemorrhage caused by a motor vehicle crash. Also, polySTAT could save the lives of many soldiers who experience hemorrhage caused by war-injuries.

SOURCES

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