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Blood Transfusion: Challenges, Corrective Measures and Related Research

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ABSTRACT

Blood is a fluid connective tissue and it performs many vital functions of the body like protection from foreign agents and transport of mineral, nutrients, hormones, gases and metabolic wastes. At the same time any alterations to its normal functions will lead to fatal effects. Hence it is essential to maintain its normal composition and volume by blood transfusion during conditions like accidents, surgeries etc. but many challenges are encountered at times, the main reason being lack of availability of compatible blood. A lot of research is going on in the field of blood transfusions the current review focuses on a few recent advances in the field.

INTRODUCTION

The concept of blood transfusion dates back 15th and 16th centuries where it was believed that blood transfusion from healthy and young person would invigorate and bring back youth in elderly and debilitated people. Later somewhere around 1628, theory of circulation of blood was postulated by William Harvey.

James Blundell and Dr. Leacock in 18th century experimentally concluded that only human blood should be transfused to humans. However during this period one third of human blood transfusions lead to adverse effect or even death until a remarkable contribution was made by Karl Landsteiner in 1901 who identified the ABO blood group system which is basis of the modern blood transfusion. In 1914 Hustin and L. Agote first demonstrated that blood coagulation can be prevented by using citrate Latter in 1943 P. Mollison and J. Loutit used acid citrate dextrose solution to store red cells storage.

In the recent days the focus of blood transfusion has moved from complete blood transfusion to isolation and use of specific blood components for specific and rational use of blood. Even today the mankind is facing many challenges in relation with blood transfusion and an extensive research is happening in this regard [1-11].

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CHALLENGES

Availability of ABO Compatible Blood

In today's world blood is collected, stored and supplied by blood banks most of which are maintained by hospitals or charitable trusts. At times the blood banks were not able to meet the demand mostly due to less availability of particular blood groups. As per WHO reports published in 2013, 70 countries have reported low blood donations as low as10 donations per 1000 people among which 38 nations are from WHO's African Region, 9 from the Western Pacific, 6 from South-Eastern Asia, 6 from the Americas, 5 from Europe and 6 from Eastern Mediterranean. Most of which are middle or low -income countries [12-31].

Red cell Alloantibodies

Blood banking deals with two types of antibodies. First type RBC Antibodies (anti-A, anti-B) are naturally present in the body and can be easily detected by Anti A and Anti B sera, whereas the other type are acquired by virtue of immunity and they are produced against RBC antigens after the first exposure. These antibodies react in an unexpected and varying manner. These antibodies if transfused may cause RBC hemolysis. Alloantibodies are more common in females because of pregnancy and blood transfusions. Occurrence of alloantibodies is higher in females due to childbearing and transfusions. 0.8% of blood donors, 2%–9% of patients with a history of blood transfusion and 9%–30% of patients with chronic transfusion therapy have shown alloantibodies [32-42].

Transfusion-transmissible Infections (TTI)

A Sevier treat is posted by TTI mostly in low and middle income countries due to lack of proper screening. Many infectious diseases like Human Immunodeficiency syndrome, Syphilis, malaria Hepatitis B and hepatitis C can be transmitted if the infected blood is transfused. According to WHO 2013 reports 1.08%, 3.7% and 1.03% of transfusions transmit HIV, Hepatitis B and Hepatitis C respectively in low income countries [43-55].

Storage Issues and Bacterial Contamination

Studies have found that red blood cells on long storage are losing viability and are reported to have diminished oxygen carrying capacity. More over improper packaging and storage conditions in low income countries are resulting into bacterial contaminations of the stored blood [56-64].

CORRECTIVE MEASURES AND RELATED RESEARCH

Blood Substitutes

Blood substitutes are the substances which are intended to supplement the blood in conditions like trauma, hypovolaemia etc. Research on blood substituents has started some centuries ago, many materials like plant resins, milk, beer and even urine were tested but all in vain. Later on few products like saline solution and Ringers solution were found effective but they merely act as plasma expanders. Currently the research focus has moved on to hemoglobin based blood substituents yet not even a single blood substitute is approved by US FDA though many products are under clinical trials. The research is diversified into categories like recombinant hemoglobin, polymerized hemoglobin, liposome-encapsulated hemoglobin and conjugated Hemoglobin [65-78].

a) Recombinant hemoglobin

Hemoglobin is produced by recombinant technology, transgenic Escherichia coli is used for its expression and purification. Reports shows that these type of substitutes have superior shelf life than normal Red blood cells hence they serve as an alternative but are a bit expensive.

b) Polymerized hemoglobin

Hemoglobin is extracted from red blood cells, then are polymerized into tetramers and then made into a solution. This solution serves as a temporary alternative in conditions associated with Sevier blood loss but proper care should be taken during polymerization as dissociated hemoglobin may result into nephrotoxicity and hepatotoxicity.

c) Liposome-encapsulated hemoglobin

This technique dates back to somewhere around 1950 where hemoglobin is encapsulated in a capsule with some limitations. But later on liposome-encapsulated hemoglobin has emerged with extended plasma retention time. But still there are few cases where immune reactions reported with its use.

d) Conjugated hemoglobin

It is a novel strategy where hemoglobin is conjugated with synthetic and inert polymers, like poly(ethylene) glycol (PEG) and Poly(L-lysine) (PLL) which resulted into renal toxicity, later on use of polymers like gluteraldehyde etc. also shown similar effects, further research is under progress with different polymers.

Antibody Screening of Healthy Blood Donors

As discussed earlier alloantibodies poses a threat by causing hemolysis after transfusion, some cases immune histocompatibility reactions are reported even with platelet concentrate reactions. Hence it should be made mandatory to screen the donor's blood by performing the IAT test [79-87].

Transfusion-transmissible Infections Screening

WHO studies shows that TTIs has been successfully controlled on high income countries but there is no much reduction in Low income and Middle income countries. Some studies even found that in these countries the donor's blood is screened only for Hepatitis B, Hepatitis C and HIV but less priority is given in screening other infections like Syphilis and malaria. Strict national policies should be made and implemented to look over the screening of the above TTIs [88-100].

CONCLUSION

Blood transfusion is a lifesaving process at times, but is being challenged by many factors like lack of specific ABO compatible blood, alloantibodies, Transfusion-transmissible infections, improper storage etc. which can be alleviated primarily framing and implementing proper National blood policy. But due to various reasons it is not being successfully implemented in many middle income and low income countries. However the use of Blood substitutes provides a ray of hope for the challenges encountered.

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