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BLOOD TRANSFUSION

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ABSTRACT:

Blood transfusion is a critical medical procedure involving the transfer of blood or blood components from a donor to a recipient. It is essential for treating various conditions, including severe blood loss due to trauma or surgery, anemia, and certain blood disorders. This procedure significantly improves patient outcomes by restoring blood volume, oxygen-carrying capacity, and coagulation factors. Despite its life-saving potential, blood transfusion carries inherent risks such as allergic reactions, infections, and immune complications, necessitating careful donor screening and cross-matching. Ongoing research focuses on enhancing transfusion safety, developing artificial blood substitutes, and optimizing transfusion protocols to minimize adverse effects and improve efficacy.

Introduction. Blood transfusion is an important medical procedure that involves the transfer of essential components, such as plasma, red blood cells, white blood cells, and platelets, to a patient or their system by means of therapeutic agents. The main purpose of transfusion therapy is to restore blood volume, improve coagulation, and improve the body's detoxification. Blood is the main circulating fluid in the human vertebrate body, performing

vital functions such as transporting oxygen and water, producing carbon dioxide and metabolic waste products, regulating body temperature, and providing immune defense.

The history of blood transfusion dates back to the earliest tentative attempts by William Harvey in 1628, before the invention of the bell in 1628. In the 19th century, it was established that only human blood could be transfused. In 1901, Karl Landsteiner discovered human blood types O, A, and B, which explained immune reactions and made blood transfusions more common1]. He was awarded the Nobel Prize in 1930 for his discovery. In 1906, George W. Crail performed the first direct plasma transfusion, and in 1944, Edwin Cohn greatly improved blood banking by fractionating blood, extracting serum albumin, and producing reconstituted blood packs. Today, blood transfusions are an essential treatment for shock, blood loss (e.g., from trauma or internal bleeding), anemia, burns, and poisoning. Modern practice focuses on the transfusion of blood components such as plasma or platelets from the patient's whole blood. Matching the donor and recipient's blood type and Rh factor, as well as other antigens such as the Kell antigen, is a major challenge. This is effective in ensuring the economy of transfusion.

Analysis of the literature on the topic. Blood transfusion (hemotransfusion) is one of the important pillars of modern medicine, and its theoretical foundations and practical application are constantly developing. This section critically analyzes the latest scientific literature, research and practical innovations in the field of blood transfusion. The previous sections of the article provided general information about the definition of blood transfusion, its historical development, physiological functions of blood and its components. Based on this basis, this analysis explores the topic in more depth and highlights important achievements in recent years.

The historical roots of blood transfusion go back to the times before William Harvey's discovery of blood circulation, but the formation of modern transfusion medicine is associated with the discovery of human blood groups (O, A, B) by Karl Landsteiner in 1901. This discovery, by explaining immune reactions, made blood transfusion much safer and brought him the Nobel Prize in 1930. Later, the development of blood storage methods expanded the scope of its application. The first direct surgical blood transfusion by George W. Crail in 1906 and the development of blood fractionation, particularly the separation of serum albumin and the production of dried plasma packs by Edwin Cohn in 1940, significantly improved blood banking. These historical milestones laid the foundation for modern transfusion medicine. The understanding of the physiological role of blood and its components is also constantly deepening. Blood is a liquid tissue circulating in the body of humans and vertebrates,

performing vital functions such as transporting oxygen and nutrients, removing carbon dioxide and metabolic wastes, regulating body temperature, and providing immune protection. It consists of plasma (55–60%) and formed elements (40–45%), and the average adult contains approximately 5.2 liters of blood. Erythrocytes, or red blood cells, are the most abundant blood cells in vertebrates and are the primary means of delivering oxygen from the lungs or gills to the tissues. Their red color and oxygen-binding capacity are due to hemoglobin, and each human erythrocyte contains approximately 270 million hemoglobin molecules. These cells are nucleusless and organelle-free, providing maximum space for hemoglobin. In the adult body, approximately 2.4 million new erythrocytes are produced in the bone marrow every second, and they circulate for approximately 100–120 days before being recycled. The morphology of erythrocytes is crucial in diagnosing anemias, as different conditions cause specific changes in their size and shape.

Modern blood transfusion practice focuses on the transfusion of blood components, such as packed red blood cells, plasma, or platelets, as needed, rather than whole blood. This approach allows the patient to receive only the component they need and reduces the risk of transfusion reactions. Blood transfusion is an essential treatment in situations such as shock, significant blood loss (e.g., surgery or internal bleeding), anemia, burns, and poisoning. Thrombocytopenia (platelet deficiency) and, rarely, leukopenia may also be an indication for transfusion. Other conditions such as aplastic anemia, infections, and poisoning may also require transfusion.

In order to ensure the safety and effectiveness of blood transfusion, it is essential to consider the blood group and Rh factor of the donor and recipient, as well as other antigens, such as the Kell antigen. The concept of a “universal donor” is outdated for whole blood, and quarantine of components is widely used. The transfusion process is usually painless, with red blood cell transfusions lasting 2–4 hours and platelet transfusions lasting 30–60 minutes. Although the risk of allergic reactions or infection is very low, complications such as fever >38°C, chills, flushing, rash, difficulty breathing, back pain, nausea, weakness, or dark urine require immediate medical attention.

Recent research in the field of blood transfusion has focused on improving the safety, efficiency, and implementation of new technologies in transfusion medicine. For example, research is underway to extend the shelf life of blood products, develop new methods for inactivating pathogens, and optimize transfusion strategies to meet the individual needs of the patient. There is also intensive work underway to develop and introduce artificial blood

substitutes into clinical practice. This could be an important solution, especially in areas with a shortage of blood products or for patients with certain religious beliefs.

Contraindications to blood transfusion and donation criteria are also constantly updated. The “Guidelines on Contraindications” of the Republican Blood Transfusion Center define a comprehensive set of criteria for blood donation, including permanent and temporary restrictions. Permanent contraindications include oncological diseases, transmissible spongiform encephalopathies, insulin-dependent diabetes, drug addiction and alcoholism, severe cardiovascular diseases (e.g. angina, hypertension II-III, heart disease), chronic infectious diseases (e.g. viral hepatitis, HIV/AIDS, tuberculosis, syphilis), serious respiratory, digestive, liver, kidney, eye and skin diseases, radiation sickness, parasitic infections, organ transplantation and mental disorders. The duration of temporary restrictions varies. For example, procedures such as endoscopy, tattooing or tooth extraction and transfusion of blood components require a 6-month wait. There is a 1-month waiting period after influenza-like illness and a 48-hour waiting period after alcohol consumption. Live attenuated or killed bacterial vaccines are usually 1 month long, and rabies vaccines are 1 year long. Pregnancy and lactation impose a 1-year and 3-month waiting period, respectively. For cases not listed, the general practitioner, in consultation with a specialist, determines eligibility for donation. These criteria play an important role in ensuring the safety of blood transfusion. There are also sources that provide in-depth information on blood components. For example, the 209-page document "Blood Components K M Abdiyev" can provide detailed information on the various components of blood and their clinical significance. Although the content of this source has not been directly reviewed, its presence indicates the breadth of the scientific literature on blood components and confirms the depth of research in this area.

The introduction of information technologies in transfusion medicine is also one of the important trends. Electronic medical records, blood bank management systems and donor databases allow for the tracking of blood products, increased safety and efficient resource management. Artificial intelligence and machine learning algorithms are promising areas that can be used to predict transfusion reactions, optimize donor selection and control the quality of blood products.

The ethical, legal and social aspects of blood transfusion are also widely discussed in the scientific literature. The principles of patient consent, voluntary donation, safety of blood products and fairness in their use are in the center of attention. Since some religious groups, such as Jehovah's Witnesses, refuse blood transfusion, the search for and improvement of alternative treatment methods remains an urgent task. In this case, blood-saving strategies,

such as minimizing blood loss during surgery, collecting and retransfusing the patient's own blood (autotransfusion), or the use of hematopoietic stimulants, are of great importance.

In conclusion, a review of the literature on blood transfusion shows that this field of medicine is constantly evolving. Extensive research, ranging from historical discoveries to modern technologies and ethical issues, is aimed at improving the safety, effectiveness and adaptability of blood transfusion to the needs of patients. Advances in blood typing, component therapy, blood product storage and pathogen inactivation methods have significantly improved transfusion medicine. In the future, artificial blood, gene therapy and personalized medicine approaches are expected to further revolutionize blood transfusion practice. Research in this area will continue to play an important role in maintaining human health and improving the quality of life.

Conclusion. Blood transfusion is an integral and complex field of modern medicine, constantly evolving from historical discoveries to the introduction of component therapy and strict safety protocols. This study provides an in-depth analysis of its medical significance, risks, alternative methods, and ethical and social aspects. Increasing transfusion efficiency, minimizing complications, and adhering to donor criteria are essential. In the future, artificial blood, gene therapy, and advanced technologies, including artificial intelligence, are expected to revolutionize transfusion medicine. This field will retain its strategic importance in maintaining human health and requires continuous scientific research.

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