Perfluorocarbons As A Blood In Future

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Abstract: Many people are losing their lives because of lack in supply of proper blood in right time. After collecting the blood from a donor a serious attention must be given to each unit of blood; proper typing, screening for pathogenic organisms & storing at proper temperature. Lack of attentiveness in these areas will make the blood useless, to overcome this situation, a viable blood substitute is needed. Perflurocorbons when used as a blood substitute doesn't need typing, screening tests for pathogenic organisms, and also perflurocorbons increases the rate of transport of oxygen. So it can be used as a blood substitute.

Introduction

Blood is a fluid connective tissue. Major function of blood is to transport oxygen from lungs to various organs & Carbon-dioxide from various tissues to lungs.[1] During the time of surgeries and other operative procedures like organ transfusion, amputation individual can lose their body blood, which results in the need of blood. Day by day in our country, the level of persons receiving blood is much more increasing than level of persons donating blood. Even after getting a proper amount of donated blood, the patients should face problems like such as same blood group and pathogen-free blood should be screened to check whether the blood is free from infectious diseases. The normal method of blood transfusion is mostly suggested, but it cannot meet the need of demanded blood all the time[2,3]

History of Blood transfusion

In 1628, William Harvey, a British physician and physiologist, first presented the theory of blood circulation. While in 1665, Richard Lower, another British physician, first reported on transfusion between animals at the Royal Society. In 1667, Jean-Baptiste Denys, a French physician, transfused the blood of sheep to a 15-year-old boy for the first time and the boy survived. In 1818, James Blundell, a British obstetrician, became the first to transfuse human blood to a patient with postpartum hemorrhage. In 1840, Samuel Armstrong Lane at St George's Hospital Medical School in London used whole blood transfusion for the first time to treat hemophilia. Then in 1900, an Austrian physician and immunologist Karl Landsteiner differentiated blood agglutinins and divided them into ABO groups, and subsequently, RBC transfusions have been performed for over 100 years as a treatment modality for moderate-to-severe anemia.[4,5]

Artificial Blood

Artificial blood or blood substitutes are solutions intended to replace transfusion of banked red blood cells. Alternatives to red blood cell transfusions are designed to overcome known limitations; short supply of donor blood, risk from contamination and clerical error and the requirement for cross-matching.

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The risks of allogenic blood transfusions are multiple and include infectious transmission, delayed postoperative wound healing, transfusion reactions, transfusion related acute lung injury, immunomodulation and potential risk of cancer recurrence.[6,7] Artificial blood is a new concept of biotechnology used to mimic and fulfill some functions of biological blood. Artificial blood aims to deliver an alternative to blood transfusion, which is transferring blood-based products from a person to another one.[8,9]

Perflurocorbons as Oxygen carriers

Perfluorocarbons (PFCs), are molecules with linear or cyclic carbon backbones that are highly substituted with fluorine and occasionally other halogens.[10] They are immiscible with blood, so they must be prepared as emulsions using a phospholipids as a surfactant instead of binding oxygen chemically as hemoglobin does, PFCs simply dissolve oxygen. PFCs have solubility for oxygen that is 20× greater than that of water. Their oxygen-dissociation curve is linear, meaning that the patient needs to be exposed to high fractional inspired oxygen for the PFC to carry meaningful amounts of oxygen. The advantages of PFCs arise from their completely synthetic nature; therefore, they should have no infectious risk. They can be produced on a large scale and with relatively low cost. Furthermore, they are cleared by the RES relatively quickly, with an intravascular half-life of 12–18 h.[11–13]

Background

Perfluorocarbons do not exist in nature but are produced by synthetic methods involving substitution of a hydrogen atom by a fluorine atom. The hydrocarbon chains in perfluorocarbons are in the maximally oxidized state. The energy of the carbon-fluorine bond is extremely high, as compared with the energy of the carbon-hydrogen and other bonds, which explains the extremely high stability of perfluorocarbons to oxidation and their very high chemical stability. The stability of perfluorocarbons results not only from the high energy, but also the non-polar nature of the carbon-fluorine bond and the rigidity of hydrocarbon chains coated with fluorine atoms. In addition, perfluorocarbons have high density, low boiling and melting points, low surface tension (significantly lower than that of water), and high gas solubilization capacity (up to 40-50% oxygen by volume).[15]

Mechanism of Oxygen transport by perflurocorbons

Perfluorocarbons (PFCs) deliver oxygen due to their physical characteristics and the convective delivery to tissues; this has been amply demonstrated in numerous animal models and in clinical trials. PFC emulsions have also been used for organ perfusion and augmentation of

oxygenation to cell cultures. By reason of their small particle size, PFC emulsions penetrate collateral capillaries of an ischemic microcirculation, both supplying oxygenation and possibly restoring flexibility of acidotically stiffened erythrocytes by reinstituting aerobic metabolism.[16]

Perfluorocorbons in future

- Perfluorocarbons in cardiopulmonary bypass
- PFC for brain cooling, drug delivery, gene transfer or as a contrast agent for ultrasonography of the lung.
- PFCs use in clinical use of liquids rather than air to ventilate the lungs.
- Perfluorocarbons in a combination of acute normovolemic hemodilution (ANH) preoperatively with application of an artificial oxygen carrier such as a PFCs during the operation, a procedure termed Augmented-ANHSM.
- Clinically perflurocorbons can be used for imaging, Ultra sound & treatment of target tissue
- PFC can be used for noninvasive detection & therapy of kidney diseases

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