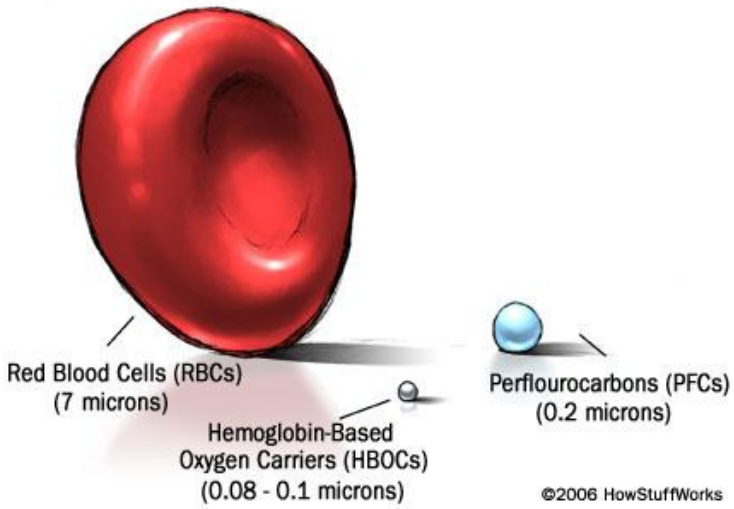
Blood Substitutes

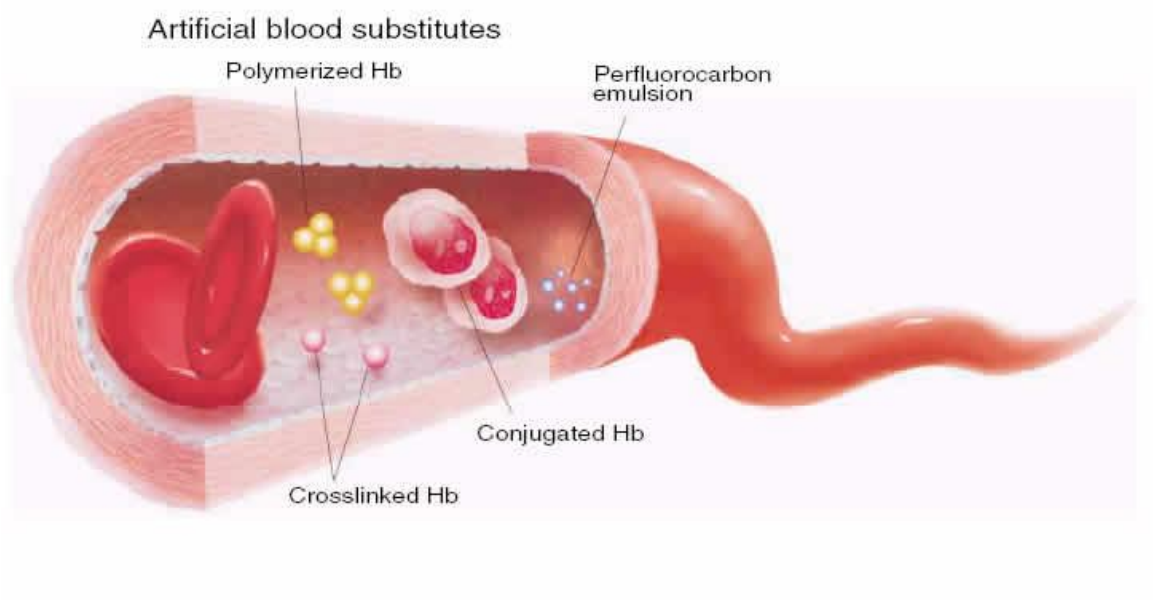
Artificial blood or blood substitutes are used to fill fluid volume and carry oxygen in the cardiovascular system which fulfill some functions of biological blood. . Since human blood performs many important function other then carry oxygen and fill fluid volume, this term “blood substitutes” is not accurate, and however, it is commonly used. The more accurate terms are volume expanders and oxygen therapeutics.

Volume expanders and oxygen therapeutics are the two types of blood substitute. Volume expanders are used to replacing the lost blood volume. A patient can tolerate very low hemoglobin level, can be 1/3rd of a healthy person, plus blood has a great ability transport oxygen, so the body will adapt by only increase the fluid volume after certain blood loss. Since the lost blood was replaced with volume expanders, the blood is diluted, and can flow more easily to all body parts, even small vessels. The body will automatically detects the low hemoglobin level and make more blood, the heart will pump more blood. In extreme cases, patients have survived with a hemoglobin level of 2 g/dl, about 1/7th the norm

Very low levels of hemoglobin can be dangerous, so in some cases, oxygen therapeutic is used o keep tissues oxygenated. There are two basic approaches to constructs an oxygen therapeutic, perfluorocarbons(PFCs) and hemoglobin derived from humans, animals, or recombinant technology. PFCs is a chemical compound which can carry and release oxygen, it does not mix with blood, so is can be used by mix with water. The liquid is also mixed with antibiotics, vitamins, nutrients and salts, and performs much vital function like the natural blood. PFC particle’s diameter are only about 1/40 the size of RBC, so they can travel through capillaries, and benefit blood-starved or damaged tissue. In some severe pulmonary or cardiac trauma, a method called liquid breathing can be used; liquid breathing is breathing liquid PFC solution because PFC can

carry oxygen so well.





The other method of oxygen therapeutic is using hemoglobin-based products. Pure hemoglobin separated from red blood cells cannot be used because it can cause renal toxicity and have incorrect oxygen transport characteristics. So various others steps are needed to make hemoglobin safe for oxygen therapeutic.

So what are the advantages of blood substitutes? In US, blood donations are increasing by about 2-3F% a year, but population is growing and aging, the demand is increasing between 6-8% a year. Even though the blood supply in the US is very safe, but this is not the case in other places. Blood transfusion is the second largest source of new HIV infections in Nigeria. In certain regions of South Africa it is believed that as much as 40% of the population has HIV/AIDS, although testing is not financially practical. A disease-free source of blood substitutes would be incredibly beneficial in these regions. The U. S. Military is one of the greatest proponents of oxygen therapeutics, mainly because of the vital need and benefits in a combat scenario. Since oxygen therapeutics are not yet widely available, the United States Army is experimenting with varieties of dried blood, which takes up less room, weigh less and can be used much longer than blood plasma. Water has to be added prior to use. These properties make it better for first aid during combat than whole blood or packed red cells. The shelf life for human blood is about 35 days when kept refrigerated, blood substitutes can stored in room temperature for about 1-3 years. oxygen therapeutics have major advantages over human blood in various situations, especially trauma. And last, artificial does not require blood test or create antigen problems.

In 2008 a review of clinical trial data found that hemoglobin-based blood substitutes may increase the odds of deaths and heart attacks. Currently, much oxygen therapeutics are under development, some are approved in foreign country, some are approved for veterinary use, and still running clinical trials. Since blood transfusions are often most critically needed in trauma situations where obtaining informed consent is either difficult, impossible, or difficult since the patient are on the edge of lifesaving care. Recently the scientific community has begun to look at the possibility of using stem cells

as a blood substitutes. The initial goal of blood substitutes is just to mimic blood's oxygen transport ability. There is additional longer range research about true artificial RBCs and WBCs which could in theory compose a blood substitute with higher fidelity to human blood.

References:

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