ALTERNATIVES TO RED BLOOD CELL TRANSFUSIONS

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Abstract

Allogenic red blood cell (RBC) transfusions are a common and routinely performed medical procedure, yet they are not risk free. Many of the risks could be eliminated with a single product: artificial blood substitutes. Scientists have been attempting to create artificial blood substitutes for several years. Many products have gone through rigorous clinical trials but ultimately never made it to market despite showing potential. Today, there are two main types of artificial blood products: hemoglobin-based and perfluorochemical-based. A total of seven studies were evaluated for this study. Based on the literature review, there is hopeful evidence that an artificial blood product might be viable for future use. Further research will be crucial to the future of artificial blood products in the field of transfusion medicine.

Introduction

Risks of allogenic RBC transfusions include, but are not limited to:

- Infectious disease transmission
- Transfusion related acute lung injury (TRALI)
- ABO incompatibility

Artificial blood products could potentially eliminate the aforementioned issues. Types of artificial blood products include:

- Hemoglobin-based products
- Perfluorochemical-based products

This study addresses the important clinical question: In patients who require RBC transfusions (P), is there a viable artificial blood product (I) that would reduce the need for allogenic RBC transfusions (O) when compared to traditional allogenic RBC transfusions (C)?

Methods

Two separate literature searches were completed through PubMed and Google Scholar- one in November 2018 and one in January 2019. In total, seven articles were selected for this study. Articles were selected based on relevance, study design, outcome measurements, and results. The seven selected articles include five randomized controlled trials and two applied research animal studies. The seven selected articles examine three different artificial blood products- HBOC-201, Hemospan, and perfluorocarbons.

Results

Two of the seven studies suggested artificial blood products were either just as effective or more effective when compared to allogenic RBC transfusions in emergency situations, such as hemorrhagic shock. On the other hand, several studies showed statistically significant differences in clinical chemistry and/or hematologic values for patients infused with RBC substitutes when compared to those transfused with allogenic RBCs.

Table 1: Summary of Results

Study	Number of Transfusions Required	Clinical Chemistry Studies	Vital Signs[1]
Arnaud et al (2005)	S	NS	NS
Goldman et al (2002)	S	S[2]	S[3]
LaMuraglia et al (2000)	S	S[4]	NS
Leese et al (2000)	N/A	N/A	S[5]
Olofsson et al (2006)	N/A	NS	S[6]
Olofsson et al (2008)	N/A	S[7]	N/A
Ortiz et al (2014)	N/A	N/A	N/A

S= significant
NS= not significant
N/A= not applicable

[1]*Vital signs includes temperature, blood pressure, respiratory rate, and pulse oximetry*
[2]*AST levels increased in patients who received HBOC-201*
[3]*Blood pressure increased in patients who received HBOC-201*
[4]*Serum urea nitrogen levels increased in patients who received HBOC-201*
[5]*Temperature increased 1 degree C over baseline in patients who received PFCs, which peaked 8 hours post infusion*
[6]*Blood pressure was significantly higher in subjects who received 500mL Hemospan*
[7]*AST, ALT, GGT, and bilirubin differed between study groups*

Discussion

Most of the studies suggested artificial blood products are an acceptable replacement for allogenic RBC transfusions

The studies suggested several advantages of artificial blood products, when compared to traditional RBC transfusions. Examples of said advantages include:

- Fewer required transfusions
- Fewer hypotensive episodes

Limitations included significant variability between studies. Examples of said variability include:

- Clinical setting
- Infusion criteria
- Outcome measurements

Further research is needed. Future studies of artificial blood products could include:

- Larger sample size in a well defined clinical setting
- Specifically defined infusion criteria
- Consistent outcome measurements (CBC, CMP, vital signs, etc)

Conclusion

There are currently no artificial blood products approved for use in the United States. However, several products have shown promising results in clinical trials. As such, the lack of artificial blood products is not due to a lack of efficacy of such products. Artificial blood products could reduce the risk of ABO incompatibility, contraction of infectious diseases, and shortages of blood supplies. Further research will be crucial to the future of artificial blood products in the field of transfusion medicine.