Cardiovascular effects of $\frac{1}{4}, \frac{1}{2}, 1$ and $2$ units blood transfusion: Physical model analysis vs. *in-vivo* experimental results

A.G. Tsai, B.Y. Salazar Vázquez, P. Cabrales, D.M. Tartakovsky, J.M. Friedman & M. Intaglietta

Depts. of Physiology & Biophysics and Medicine
Albert Einstein College of Medicine, Bronx, NY

Depts. of Mechanical & Aerospace Engineering and Bioengineering
University of California, San Diego, La Jolla, CA

2016
Modelling of $O_2$ delivery ($DO_2$) in treating normovolemic anemia with pRBCs transfusion

Assumptions:
1. Inert, inelastic arterial circulation that accommodates volume changes in the venous circulation.
2. Increasing Hct, increases blood viscosity, lowering cardiac output (CO).
3. Lowering CO increases blood residence in the pre- microcirculation increasing $O_2$ exit.
Blood viscosity as a function of hematocrit

- Men, Kameneva
- Women, Kameneva
- Stein
- Men, Salazar V.
- Stone
- Cokelet
- Plasma
Effect of Hct on flow & DO$_2$
Circulatory oxygen delivery (DO2) after transfusion in anemia

Effect of number of units transfused

% Oxygen carrying capacity deficit
Effect of transfusing fluids: pRBCs, plasma and increasing plasma viscosity
(in 6 g Hb/dL anemia and 2 hrs. after transfusion)
Cytokines in 50% anemia and after pRBC transfusion
Pretreating pRBC transfusion with the anti-inflammatory dexamethasone (DEX)

**Blood Flow**
(normalized to anemia)

- **Anemic**
- **1 pRBC**
- **2 pRBC**
- **2 pRBC + DEX**

**Post-pRBC transfusion**
Transfusing a unit of plasma, $\frac{1}{4}$, $\frac{1}{2}$, 1 and 2 units of pRBC have approximately the same effect on oxygen delivery.

If there are pre-existing inflammatory conditions then transfusion may not be as effective.

Stored and fresh RBCs cause on the average the same oxygen delivery but stored RBCs show a greater variability of results.