

FRACTIONATION OF HUMAN RED BLOOD CELLS BASED ON INTRINSIC MAGNETIZATION

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Red blood cell (RBC) transfusion is clinically used to treat hemodynamic instability and O₂ carrying deficits in patients with acute blood loss, and patients with chronic anemia caused by bone marrow failure/suppression. Currently, cold storage of human RBCs (hRBCs) can preserve hRBCs for a maximum of six weeks (i.e. 42 days), set by the United States Food and Drug Administration (US FDA). However, as stored RBCs age, they undergo biochemical and biophysical changes that are often referred to as the storage lesion, which decreases the efficacy of transfusion while increasing the risk for transfusion-associated adverse effects. It is well known that upon transfusion of stored RBCs, there is a population of RBCs (i.e. healthy RBCs) that circulate for more than 24 hours, and another smaller population (i.e. damaged RBCs) that are cleared within 24 hours post transfusion. This population of cells destined to be cleared quickly can be higher than 25% in units stored for a mean of 30 days. The objective of our current project is to remove aged RBCs based on hemoglobin content.

Under the influence of ultra-high magnetic fields and gradients, we have demonstrated that it is possible to fractionate RBCs into multiple factions based solely on difference in the intrinsic magnetization of the deoxygenated form of hemoglobin inside the RBCs (*i.e. labelless separation*). We hypothesize for our currently funded National Institute of Heart Lung and Blood project that healthy RBCs with higher Hb content correlate with longer half lives in transfused animal models than unhealthy RBCs which have lost some of their hemoglobin. In addition, material balances are being performed to track the hemoglobin molecules that are lost during the extended periods of storage. This work will reveal the mechanism behind the lost hemoglobin during RBC storage, deepen the knowledge about aged RBCs and RBC-associated exosomes, and facilitate bulk separation of RBCs without labeling the cells.

Therefore, it could be clinically beneficial if the damaged RBCs in any unit of RBCs could be separated leaving a population of only healthy RBCs behind for transfusion. When a recipient is transfused with a dose of RBCs that overwhelms their circulatory system's ability to compensate for the increased intravascular volume, heart failure can ensue. This condition is known as Transfusion Associated Circulatory Overload (TACO). It is the second leading cause of death related to transfusion reported to the FDA.