

Study Title

Quality assessment of red blood cell concentrates from teenage blood donors

Study Description

Background: Blood donors are a heterogeneous population with numerous genetic and biologic variables that contribute to variation in the quality of blood components including red blood cell (RBC) concentrates. Among these, donor age has been identified as a significant modifier of hemolysis (spontaneous and stress-induced) in cold storage of RBC concentrates. The age differences in RBC storage capacity were observed across different RBC component manufacturing methods (e.g. additive solution, filtration) suggesting a mechanism that is intrinsic to the RBC that may reflect age-specific differences in erythropoiesis, RBC biology, and iron metabolism. In support of this hypothesis, age has been recognized as an independent risk factor for iron deficiency in teen donors (16-18 years).

Rationale: Previous studies including NHLBI's RBC-Omics excluded blood donors under the age of 18. Consequently, the quality of blood components from teenage (16-18 years) donors have not been evaluated. In the US, high school students contribute 10% of the overall blood supply, with some centers relying on teens to provide as much as 25% of the blood supply. This population of blood donors is highly vulnerable to iron deficiency. Preclinical studies in mice have suggested that donor iron deficiency significantly reduced the 24-h RBC post-transfusion recovery in recipient mice. Therefore, increased risk of iron deficiency in teenage donors may impact teenage donation-derived RBC transfusion efficacy and patient outcomes. Outcomes from this proposal are expected to provide new knowledge about age-specific differences in RBC biology and risks of iron deficiency linked to storage capacity, hemolysis and immunomodulatory properties.

Hypothesis and research aims: This project will test the hypothesis that age-specific differences in RBC biology and risk of iron deficiency contribute to variation in the in-vitro quality of RBC concentrates. In Aim 1, we will define the means and variation of in vitro correlates of RBC storage outcomes (stress and spontaneous hemolysis, RBC deformability, RBC damage-associated molecular patterns, immunogenicity, and metabolism) in RBC components donated by teenage (20 years) versus adult (>35 years) donors. In Aim 2, we will conduct multivariate analyses to identify parameters (e.g., manufacturing procedures including additive solutions, iron status, donation frequency) and biomarkers (e.g., RBC metabolites, ratio of young versus older erythrocytes in the blood bag) associated with age-specific differences in RBC storage capacity.

Study design: We propose to conduct a stratified, case-control study with teens (20 years old) and adult (>35 years old) donors. Eligible donors will be identified and recruited at each participating center using blood donor registries. Control donors will be matched by sex,

race/ethnicity, and donation history in prior 12 months. Other viable information to be considered include ferritin levels and intake of iron supplementation. Each center will acquire leukocyte reduced (LR)-RBC concentrates from 30 teenage donors (20 years, depending on each center's minimum age for donation) and 30 adult donors (?35 years). Each LR-RBC unit will be stored for six weeks under routine blood banking procedures (1-6? C) and will be evaluated (hemolysis, metabolism, immunogenecity) at three time points: 1-7 days, 14-21 days, and 35-42 days.

The second part of the project will focus on multivariate analyses to identify teenage-specific modifiers of RBC storage outcomes. The initial step would be to determine the means and distribution of all tested variables (e.g., hemolysis, RBC DAMPs/metabolites) and test for statistical significance among the two age groups. This step would be followed by evaluation for interactions between age and of confounding variables (e.g., ferritin, iron supplementation, donation frequency, component manufacturing methods) that can further modulate the quality of RBC components from teenage donors.

Study Status

Completed

Publication Number

160

Teams

CC

Study Leaders

Kanias
