Determination of Red Blood Cell Lifespan in Premature Very Low Birth Weight Infants
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Purpose
Determination of red blood cell (RBC) lifespan is important in understanding the pathophysiology of anemia in premature infants. Such determination is also necessary in order to evaluate the pharmacodynamics of erythropoietin in the stimulation of RBC production aimed at reducing or eliminating the need for RBC transfusions to treat the anemia. We have developed a method for multi-density biotin labeling of RBCs that can be used to determine the RBC lifespan of both the adult donor RBCs and neonatal RBCs concurrently. The current investigation is aimed at comparing the in vivo lifespan of neonatal RBCs with adult donor RBCs in critically ill, very low birth weight infants. We hypothesized that in vivo lifespan of neonatal RBCs is substantially shorter than lifespan of adult donor RBCs.

Methods
Separate populations of neonatal autologous and adult allogeneic donor RBCs were labeled at two discrete biotin densities. The two biotin labeled RBC (BioRBC) populations were transfused into six premature infants (mean±SD: birth weight: 808±180 g, gestational age: 25.7±0.7 weeks, and study age: 2.5±1.7 days). Serial samples of discarded blood were analyzed for BioRBC enrichment by flow cytometry. A pharmacodynamic hemoglobin mass balance model was used to account for the dynamic changes due to laboratory phlebotomies, RBC transfusions and growth (assuming constant blood volume per kg). The disposition of the transfused BioRBCs was assumed to be due to senescence. All modeling were conducted using WINFUNFIT, using ordinary least squares fit to each individual subject’s Hb amount-time data.

Results
General agreement between the model fit and enrichment data was observed. The in vivo lifespan of neonatal and adult RBCs were similar 62±13 and 69±14 days, respectively, P=0.17.

Conclusion
This study demonstrates the utility of concurrent multi-density BioRBC method in determining in vivo RBC lifespan. Contrary to our hypothesis and to previous published infant studies, in vivo RBC lifespan of neonatal and adult RBC were not statistically different.