Unpredictable Potassium Changes in Donated Blood Following Warming

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Introduction: Common clinical practice for administering donated packed red blood cells uses countercurrent warming to prevent hypothermia. The maximum temperature for warming is currently 42 degrees since blood will hemolyze at a rate of 2.26 mg Hgb/ 100cc/min when heated to 50 degrees, but blood warmed in a water bath does not have significant hemolysis below 40 degrees (1). No published data demonstrate if there is clinically significant hemolysis using current standard practices with countercurrent warming devices set to 42 degrees. Since a rise in potassium has been shown to be a sensitive indicator of as little as 1% of hemolysis (2), we measured the potassium of donated blood before and after warming through a countercurrent device. Since hyperkalemia could also be of concern, recipient potassium levels were also studied.

Methods and Materials: Potassium levels from 12 donated packed red blood cell units were measured both before and after warming using Hotline countercurrent heat exchange (SIMS Level 1, Rockland, MA) at modest flow rates. Units were handled in the usual clinical practice, each kept in a cooler bucket until use, then allowed to drain by gravity through a Hotline device, with average flow rates of 80 ml/min and outlet temperature of 34.8 degrees Celsius. Simultaneous samples were drawn immediately before and after the large bore warmer tubing for analysis. Recipient arterial blood gases were measured immediately before and again 3-5 minutes after transfusion of the heated red blood cells. Medications known to alter potassium were avoided. All data are expressed as a mean +/- standard deviation. A paired t test was used for group comparisons, and relationships between potassium levels and blood unit storage duration were examined using regression analysis.

Results/Discussion: Average potassium values measured in the packed red blood cell units before warming (18.6 +/- 7.8 meq/l) were not different from the values after warming (18.5 +/- 6.3 meq/l); both potassium levels demonstrated wide variability (see figure). The serum potassium levels of the recipients before blood administration (3.7 +/- 0.7 meq/l) were similar to levels after transfusion (3.8 +/- 0.7 meq/l), with much smaller variability. Interestingly, there was no significant relationship between any of the measured potassium levels and storage duration of the blood.

Conclusion: The results above indicate that potassium levels on average are unchanged after heating though a Hotline. However, in individual units an unpredictable increase or decrease may be observed. It is not clear if these changes are a result of warming or simply reflect a very heterogeneous potassium distribution in a unit of packed red blood cells.

References:

1. British Journal of Anaesthesiology. 1974;46:742-746.
2. Journal of Trauma. 1992;33:89-94.