Red cell irradiation – time for a change?

What is this research about?
Transfusion of red blood cells (RBCs) is a life-saving procedure. However, transfusion is not without risk. In very rare cases, transfusion can cause an often fatal disease called Transfusion-Associated Graft versus Host Disease (TA-GvHD). TA-GvHD occurs when donor white blood cells, transfused along with the RBCs, take up residence in the recipient’s body. The donor white blood cells sense that they are in an incompatible host and attempt to ‘reject’ the recipient. To reduce the risk of TA-GvHD, RBCs are separated by centrifugation from the other portions of a whole blood donation and subsequently filtered to further remove white blood cells (‘leukoreduced’). However, small numbers of white blood cells always remain within the RBC unit. While patients with a healthy immune system are not generally at risk, patients who have a weak immune system (newborns and the very young; immunodeficient patients) are at higher risk of developing TA-GvHD. Patients who receive a directed donation from a close relative are also at risk. When high risk patients need RBCs, the units are irradiated before transfusion. Irradiation damages any remaining white blood cells in the unit, so that they cannot cause TA-GvHD. However, irradiation is a double-edged sword as it also damages RBCs. Guidelines are in place to optimize RBC quality while ensuring maximum white blood cells damage. The Canadian guidelines state that RBC units can be stored in a refrigerator for up to 42 days before transfusion, and that irradiation of the unit can take place at any time during this storage period. However, a unit must be used within 28 days of irradiation to ensure the quality of the RBCs. At no time can storage of a RBC unit exceed the 42 day limit, so units that are irradiated after the first 14 days of storage will have a remaining shelf life of less than 28 days after irradiation. In 2013, Canadian Blood Services provided over 57,000 irradiated RBC units. However, since quality control testing is not performed on irradiated blood products, there are limited data available on the effect of irradiation. In this study, the researchers were seeking information on how the timing of irradiation of RBC units affects the amount of damage caused to the RBC, and whether the guidelines currently followed are suitable.

What did the researchers do?
The researchers used a set of 896 RBC units, prepared using standard Canadian Blood Services procedures and stored refrigerated in ‘SAGM’ storage solution. These units were divided into groups and irradiated on different storage days (between storage days 8 and 40). After irradiation, the units were stored for up to 28 days, or until day 42 after they were produced, whichever occurred first. This was in line with the guidelines for storing and using irradiated RBC. At different times after irradiation, the level of RBC damage was determined by measuring hemolysis and potassium levels, which reflect the extent to which RBC are damaged.

What did the researchers find?
- The longer RBC units are stored the greater the level of damage, as shown by both higher hemolysis and potassium levels. This was true before and after irradiation.
- Forty (4.5 %) of the RBC units tested had levels of damage that would be unacceptable for transfusion based on Canadian guidelines.

In brief...
Current Canadian guidelines on irradiation of red blood cell units may not be enough to ensure transfusion of high quality units - depending on when irradiation takes place, irradiated units may show higher than acceptable levels of red blood cell damage.
In addition to the length of storage, donor gender and age were also linked to the level of RBC damage.

The most important factor predicting the amount of RBC damage was the length of storage time after irradiation. RBC damage was greatest in units irradiated within their fourth week of storage (days 21 – 28) and stored for more than 14 days after irradiation.

What is the impact of this research?

This is the largest study investigating this issue to date. The findings suggest that the timing of irradiation heavily influences RBC quality. For RBC units irradiated in their fourth week of storage and stored for more than 14 days after irradiation, the levels of RBC damage may exceed acceptable levels. Canadian Blood Services’ goal is to provide RBC units that are both safe and of the highest quality. Irradiation remains an effective method to reduce the risk of TA-GvHD. However, this research suggests that Canadian guidelines for the timing of irradiation and the length of time that RBC units in SAGM can be stored after irradiation might need to be reconsidered to avoid transfusion of poor quality units.

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