TITLE: Narrative Review of Strategies for Blood Product Shelf-Life Extension

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Background

Over 90% of potentially survivable United States (US) battlefield fatalities were associated with severe hemorrhage from 2001 to 2011, making prehospital blood transfusion vital to success in medical military operations. However, near-future conflicts with pronounced casualties and trauma may increase a more sustained demand for blood. Thus, finding innovative ways to prolong the shelf life of blood products is crucial in the future of trauma care. We reviewed various methods to extend the shelf-life durations of blood products and their possible effectiveness/implementations within an austere environment setting.

Methods

We performed a literature review spanning from 1959 to 2023 by searching PubMed and government regulation documents using a combination of several keywords. Additional pertinent studies were identified by cross-referencing primary articles. Clinical experience of each author was also considered.

Results

We identified several effective methodologies that can be utilized to prolong blood product storage durations within an austere medicine setting: Additive Solution 7 (AS-7, SOLX), extension of storage with current anticoagulants, supplementation with nicotinic acid or ascorbic acid to anticoagulant solutions, dilution of fresh whole blood with longer stored whole blood, deoxygenation/anaerobic storage during red blood cell (RBC) cold storage, improvements in the cryopreservation of RBC, trehalose use in lyophilization of RBC, thermal holding of whole blood, and the effects of variable temperature cycling on whole blood.

Conclusion

Several studies reveal promising combinations of methods that would allow for shelf-life extension during the storage of blood products and introduce new possibilities that could logistically improve infrastructure to support an extended blood duration supply if needed. Current practices for blood storage can be feasibly manipulated to extend a blood bank; however, more novel implementation that requires massive changes to existing infrastructure may be too expensive for rapid, widespread, and sustained use. More research would be necessary to elucidate the specific implementation of these combined practices to weigh out the estimated risk of transfusing extended stored blood products within resource-limited environments.