CONFLICT OF INTEREST

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Does modern combat still need fresh whole blood transfusions?

In combat, massive blood loss of military as well as of civilians is a major cause of death. Having blood available in the military theater at all times is therefore of vital importance. Fresh whole blood (FWB) has been used repeatedly by the US military to resuscitate severely bleeding trauma patients.[1] FWB is blood that is donated by military and hospital personnel on site and stored for less than 24 hours in citrate-phosphate-dextrose solution at room temperature. The US military supports transfusion of FWB either when standard blood components are not available or if transfusion of the available blood components are not adequately correcting life-threatening bleeding. Although warm FWB has the theoretical advantage of supplying all the appropriate blood components with maximal functionality, usage of untested FWB proposes a risk of infectious disease transmission and bacterial contamination as well as logistic difficulties in obtaining identical match donors at the right time. Transfusion of FWB has also been associated with a higher incidence of adverse reactions through the presence of white blood cells (WBCs). These reactions include febrile nonhemolytic transfusion reactions, human leukocyte antigen alloimmunization and transfusion-associated graft-versus-host disease (TA-GVHD).[2] Hence, in a recent article by Gilstad and colleagues[3] clinical symptoms of TA-GVHD were observed in a trauma patient who was resuscitated with FWB.

Usage of FWB is often endorsed because of the potential damaging effects of prolonged refrigerated stored RBCs. Yet, frozen storage of RBCs at ultralow temperatures halts the cellular metabolism and subsequently prevents the progressive RBC deterioration that has been linked to adverse clinical outcome.[4] During the years, frozen blood components have become more utilizable. Notably, implementation of frozen platelets (PLTs) and fresh-frozen plasma in transfusion medicine has abandoned the need for FWB usage. Consequently, in 2001 the Dutch military blood bank eliminated the use of FWB on site and implemented the routine usage of universal frozen blood components.[5,6] In this regard, leukoreduced blood components are frozen at –80°C within 24 hours after collection. After thaw, RBCs, fresh-frozen plasma, and PLTs can be utilized up to 14 days, 7 days, and 6 hours, respectively. The Dutch military has demonstrated that frozen blood components can provide an adequate blood resource, even when standard blood components cannot be replenished on time. This allows for a better inventory control, especially in remote or primitive locations.

Usage of frozen blood components has the advantage that it is safe. This is because blood components have been collected and preserved under standard conditions

and because these components have been routinely tested for infectious agents before freezing. Furthermore, it was also demonstrated that frozen PLTs have a higher in vivo efficacy than liquid-preserved PLTs due to their procoagulant state.[4] Usage of frozen RBCs has advantages as well. The necessary deglycerolization washing step considerably reduces the amount of detrimental substances such as WBCs, cytokines, and other biologically active substances in the RBC unit that can affect transfusion outcome.[4] However, frozen RBCs are more costly. A unit of frozen RBCs costs approximately twice the amount of a refrigerated stored RBC unit. In addition, thawing and washing of cryopreserved RBC units requires skilled personnel and takes up to approximately 90 to 120 minutes. Yet despite these disadvantages, stockpiling a frozen RBC inventory proved to be an effective and safe blood resource in combat casualty care.

To date, fresh whole blood is still being used in combat to restore the hemostasis in severely injured trauma patients. Studies that demonstrate that FWB is superior to frozen blood component treatment in a trauma setting are lacking. Despite the absence of a clear beneficial effect of FWB over component therapy, there are well-recognized risks associated with FWB infusions in military settings. This makes the infusion of fresh whole blood rather questionable, especially in the light of frozen blood components alternatives. The article by Gilstad and colleagues furthermore supports the statement that FWB practices should be abandoned in the military theater.

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The authors declare that they have no conflict of interest relevant to the manuscript submitted to **TRANSFUSION**.

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Comparison of source plasma quality in three different apheresis protocols

Two different plasmapheresis techniques are mainly used to obtain plasma for fractionation. The PCS2 (Haemonetics Corp., Braintree, MA) is based on centrifugation only, whereas the Auto-C (Fenwal, Inc., Lake Zurich, IL) utilizes a combination of centrifugation and tangential filtration. The *Turbo Mode* program in the Auto-C increases the rates of blood drawing from 100 to 120 mL/min and returning rates from 130 to 150 mL/min. Despite a close association between source plasma quality and the yield of plasma proteins during plasma fractionation, studies directly comparing the quality of source plasma obtained with the PCS2 and the Auto-C *Normal Mode* and *Turbo Mode* were carried out in the late 1980s for a small set of coagulation factors[1,2] and in 2003 for residual cells and protein composition at a single apheresis machine.[3-5] We compared the levels of coagulation factors and activation markers in plasma made by the PCS2 and the Auto-C *Normal Mode* and *Turbo Mode*.

MATERIALS AND METHODS

Selection of plasma units

Thirty regular donors (donation interval, 7 days) donated plasma units each with the PCS2 (software G1), the Auto-C *Normal Mode,* and the Auto-C *Turbo Mode* within a period of 12 weeks consecutively. After the introduction of respective apheresis protocol, a 3-week staff training period was inserted. The IgG levels of all participants were in a steady state.[6] According to German guidelines[7] individuals weighing less than 60 kg of body weight donated 650 mL of plasma including citrate. Subjects weighing 60 to 80 kg or more than 80 kg donated 750 or 850 mL, respectively. Blood was mixed with 4% (wt/vol) sodium citrate in a 1:16 ratio.

Samples

Samples from plasma units were frozen within 2 hours after plasma collection and stored at –38°C or lower until measurements.