Battlefield Use of Human Plasma by Special Operations Forces

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Abstract

Recently a select group of Special Operations medical providers have carried fresh thawed human plasma as a resuscitative fluid on the battlefield at the evacuation phase of Tactical Combat Casualty Care (TCCC) and in rare occasions at the tactical field care phase of TCCC. Plasma in certain circumstances should be considered as an adjunct to treatment of coagulapathic battlefield casualties. Plasma does however have limitations due to logistical constraints. The long term solution is to develop a field stable variant of plasma which would make this life-saving fluid available to a broader range of care providers. Recent studies have shown that the development of lyophilized plasma is feasible.

Special Operations Forces employed the use of fresh-thawed human plasma for hypotensive resuscitation of combat casualties in August of 2007. Plasma use in the treatment of casualties in the Global War on Terrorism (GWOT) had been limited mostly to the Combat Support Hospitals (CSH) in both Baghdad and Balad during Operation Iraqi Freedom (OIF) and CSHs in Operation Enduring Freedom (OEF). Recently a select group of Special Operations Forces (SOF) medical providers have been carrying fresh-thawed human plasma as a resuscitative fluid on the battlefield, at the evacuation phase of Tactical Combat Casualty Care (TCCC), and on rare occasions, at the tactical field care phase of TCCC. This solution has been reserved for operations that are high-risk and have extended evacuation times.

Patients with an abbreviated injury score (AIS) of four to six usually arrive at the CSH with an acquired coagulopathy. This patient population represents five to seven percent of combat trauma patients. Acquired coagulopathy is known to occur in patients with multiple injuries. Conventional resuscitation practice focuses on rapid reversal of acidosis, prevention of hypothermia, and control of hemorrhage; however, recent studies have shown that early attention to coagulopathy may improve patient outcome.[1,2]

Medical intervention may also then augment this coagulopathy by hemodilution with large fluid volumes, the administration of colloids, massive transfusion with stored blood, and the subsequent development of hypothermia. However, there is an acute coagulopathy before significant fluid administration that may be attributable to the injury itself. This derangement reflects the severity of tissue damage and carries a worse prognosis. The presence of an early coagulation abnormality has implications for both management and outcome. [3-6]

Plasma not only raises acidotic pH levels in trauma patients, but also contains all viable clotting factors. Early coagulopathy could be reversed by administering plasma before arrival to the CSH and thus reduce overall use of other resuscitative fluids on trauma patients. Operational medical providers with access to plasma could have a dramatic impact on patient survival.

"We hypothesize that the early, increased use of plasma in these severely injured patients helped control the coagulopathy of trauma more efficiently and, as a result, required less crystalloid and red blood cells (RBCs) per hour during the first 24 hours of resuscitation. Additionally, the use of plasma instead of crystalloids and RBCs helped prevent or limit the development of dilutional coagulopathy.[7] Conversely, we believe that patients who received less plasma and more crystalloid and RBCs in the low and medium plasma to RBC ratio groups entered the "bloody vicious cycle," and died significantly sooner from uncontrolled hemorrhagic shock. The rate of blood products and crystalloid may have also been reduced for the survivors in the high plasma to RBC ratio group as a result of not requiring active resuscitation during the entire 24 hours after initiating a massive transfusion. We suspect that both improved hemostasis and survival, and the lack of need to be actively resuscitated, contributed to the decreased rate of products and crystalloid transfused in the high plasma to RBC ratio group."[8]

Current TCCC guidelines recommend the use of Hextend® as the primary resuscitative fluid of choice

during the tactical field care phase of combat casualty care and, when possible, the use of whole blood during the evacuation phase. Hextend's® mechanism of action is to pull fluid from the interstital space and bring it into the vascular system therefore increasing blood pressure and hopefully increasing tissue perfusion. Fluids such as Hextend® and hetastarch only provide vascular volume and some electrolyte replacement. They do nothing to reverse coagulopathy and lowered pH in trauma patients.

Studies by U.S. Army Institute of Surgical Research (USAISR) have suggested that dilution of clotting factors with colloids such as Hextend® and hetastarch could have negative effects on patient outcome. Hextend's® effect on coagulation and induced coagulopathy have been widely demonstrated in clinical and experimental studies and has been attributed to the inhibitory effect of this colloid on clotting factors, platelet function, and fibrin polymerization.[9-17]

Therefore, Hextend® may be a less than optimal fluid of choice for casualties in shock. Hextend® is, however, the fluid of choice for TCCC due to it being the best FDA approved field stable fluid available today.

Whole blood is the fluid of choice for resuscitation. The logistics of whole blood is similar to that of plasma and blood should be made available forward in some instances. Pushing blood far forward has inherent problems due to transfusion reactions, lack of training, and age of available war stock.

Transfusion reactions in the field are difficult to manage. Plasma has a lower threshold for transfusion reactions. Blood also requires a filtered administration set and must be primed prior to use with normal saline. This can be difficult and in some instances has been unsuccessful due to lack of training and the stresses of combat. Even the simplest tasks become difficult in combat. Also, blood older than 30 days may be a less than optimal resuscitative fluid, since "old blood is bad blood."[18] Current theatre blood stocks average 30 days in age. Buddy transfusions are also an option for TCCC but buddy transfusions are extremely time consuming and can take upwards of one hour to implement.

The use of plasma forward is an obviously viable solution by SOF providers. Currently a limited number of operational care providers draw a predetermined amount of frozen AB+ plasma from existing war fighting stock. Plasma is maintained in accordance with DoD guidelines by using Hemacoolers, a commercial off the shelf (COTS) cryo-freezer, which was developed by the U.S. Army Medical Materials Development Administration (USAMMDA). Plasma is stored at -22 degrees Celsius.

SOF medical providers thaw plasma using warm water baths prior to high risk operations. Thawed plasma is maintained for up to three days at two to four degrees Celsius and then if unused, it is destroyed. Plasma is carried by operational medical personnel on the battlefield using Golden Hour technology to maintain the temperature requirements. Golden Hour containers are DoD approved coolers that maintain blood products at two degrees Celsius with no power requirements for 72 to 96 hours. Golden Hour containers are often left on infiltration/exfiltration and evacuation platforms and can be called forward as required or left for use during casualty evacuation. Four units of plasma can be carried in a single Golden Hour container.

SOF providers administer plasma thru an 18 gauge catheter using a standard 15-gtt IV tube. Plasma is warmed with an Enflow™ IV fluid warmer. Enflow™ warmers have been approved by Walter Reed Army Institute of Research (WRAIR) for use with blood and blood products. Plasma may also be given intraosseously (IO).

Due to logistics of storing plasma and plasma availability, this lifesaving technique is reserved for occasions when the stated operational needs are met. This technique has the potential to increase survival on a greater scale if the logistical concerns of storage, demand, and waste are met. Plasma waste is currently at 30 to 40% of overall war stocks. This is approximately 10,000 units annually in the operational theatres.

A solution for improving survivability of casualties on the battlefield today is to transition this lifesaving technique to other SOF forces now and eventually to all theatre forces. Increased fielding could increase waste, but addressing coagulopathy early may decrease overall use of resuscitative fluids, resulting in significant logistical dollars saved.

The long-term solution is to develop a field stable variant of plasma. Lyophilized (freeze-dried) plasma is one such solution. The development of lyophilized human plasma (LHP) would not only solve this logistical problem, but could also bring this lifesaving technique further forward to the tactical field care phase of combat casualty care. LHP was used during World War II as a resuscitative fluid of choice on the battlefield but was abandoned in the 1950s due to contamination with human papillomavirus (HPV). Pooled donor sources of plasma were used and techniques for screening of hepatitis were unavailable. Screening for bloodborne pathogens is now available and blood banking safety is markedly improved in the last 50 years.

The U.S. Special Operations Command (USSOCOM) has recently undertaken a research and development effort to study the feasibility of again freeze drying human plasma. The feasibility study completed

in December 2007 showed that the development of LHP is feasible. Initial data shows that lyophilized plasma had all clotting and liable factors found in fresh-thawed plasma and is also stable in higher temperatures. Additional data is forthcoming. This study was conducted by USSOCOM and HemCon® Inc., a company with lyophilization technologies, in conjunction with USAISR. Studies conducted by WRAIR have also shown efficacy of LHP.

The U.S. Army has placed an urgent operational need on the development of LHP. The U.S. Army Medical Materials Development Agency (USAMMDA) has recently earmarked funding for the development of LHP. USSOCOM has also placed high priority on developing LHP. Their requirements are for a field stable variant of LHP that will be contained in a ruggedized container for use far forward on the battlefield by operational providers.

The fielding of the USSOCOM requirement is now slated for 2010. An urgent operational fielding of LHP should be implemented now to bring this lifesaving technology to battlefield as soon as possible. The cooperation of USSOCCOM, USAISR, USAMMDA, WRAIR, FDA, and industry could help to bring LHP to our Soldiers in a timelier manner with out sacrificing safety. Our Soldiers who risk their lives daily deserve no less.

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MSG Murphy has spoken on Soldier requirements at numerous military conferences such as ATACCC, SOMA, and the Battlefield Healthcare Conference. He has also served on the Tactical Combat Casualty Care Committee since 2007.

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