

Fresh Whole Blood Transfusion for a Combat Casualty in Austere Combat Environment

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ABSTRACT

There are many challenges to treating life-threatening injuries for a healthcare provider deployed to a remote location in a combat setting. Once conventional treatment protocols for exsanguinating hemorrhage have been exhausted and no medical evacuation platform is available, a nonconventional method of treatment to consider is a fresh whole blood (FWB) transfusion. A FWB transfusion can be a life-saving or life-prolonging intervention in the appropriate setting. The authors present the case of a combat casualty in hypovolemic shock and coagulopathy with delayed medical evacuation to a surgical team. While the ultimate outcome was death in this case report, the patient arrived to a surgical team 15 hours after his injury, alert and oriented. In this scenario, FWB transfusion gave this patient the best chance of survival.

Introduction

A healthcare provider deployed to a remote location in a combat setting is at a distinct disadvantage when facing the challenge of treating life-threatening injuries. The environment is often too austere to allow practice to the typical “standards” of modern, hospital-based military medicine. The comfort of a rapid air medical evacuation platform is arguably the greatest asset of the military medical system in a deployed environment. When a remote region loses this vital asset because of terrain, weather, or security, the healthcare provider, operating in an austere environment, is forced to consider nonconventional methods for keeping combat casualties alive.

Once standard treatment protocols for exsanguinating hemorrhage have been exhausted, and no medical evacuation platform is available, FWB transfusion should be considered. The use of FWB in Level 2 and Level 3 combat support hospital facilities has been documented in the Iraqi and Afghanistan conflicts to be associated with

improved survival.^{1,2} When FWB is collected at these facilities, the process is supported by ancillary staff and follows well-developed protocols.³ No such protocol is in common use by conventional military forces, though a protocol for emergency whole blood collection has recently been developed, which could serve as the basis for training deploying personnel to cope with the difficult clinical scenario.⁴

Operational Context of Patient Care

The casualty whose case we present was cared for in the context of a large (300–350) enemy force attacking a small, remote American outpost. The enemy forces executed a highly coordinated attack, suppressing the outpost with fire superiority. In addition to the overwhelming enemy firepower, multiple buildings caught fire from exploding ammunition. The fire destroyed the majority of the buildings on the outpost and threatened to spread to the aid station as this casualty was receiving treatment.

During the 12-hour intense battle, the medical team treated a total of 43 casualties, including penetrating abdominal wounds, severe facial trauma, gunshot wounds with vascular compromise, and minor shrapnel wounds. The medical team evacuated 16 casualties for further treatment from the Forward Surgical Team.

Case Presentation

A 21-year-old active duty Soldier sustained multiple shrapnel and gunshot wounds as he defended his combat outpost from enemy fighters. His wounds included penetrating shrapnel wounds to the left lower quadrant of the abdomen and left upper thigh, a gunshot wound to the right upper arm, and open fractures of the left tibia and fibula. The Soldier received “buddy aid” from a fellow Soldier that included tourniquet application to the left upper thigh, an improvised splint for the leg fracture, and

application of pressure bandages to the other wounds. The wounded Soldier remained under cover from enemy fire until a security element repulsed an attack and allowed for evacuation to the outpost aid station.

The injured Soldier arrived at the remote Level 1 aid station with a delay of 6 hours from the time of injury due to ongoing enemy activity. He presented with cool, pale skin, a Glasgow Coma Scale (GCS) score of 13 (eye response 4, motor response 5, verbal response 4), a patent airway, tachypnea, tachycardia (pulse of 150 beats/min), and hypotension with only a carotid pulse palpable.

Initial attempts to obtain large-bore intravenous (IV) access were unsuccessful, requiring the use of a sternal intraosseous (IO) device for initiation of hypotensive fluid resuscitation with 500mL of Hextend® colloid solution per Tactical Combat Casualty Care (TCCC) protocol. With no clinical response to the first bolus of Hextend®, an additional 500mL was administered in an attempt to treat the patient's hypovolemia. While the colloid solution was administered, the treatment team addressed other aspects of the patient's care. The tourniquet was assessed and found to be effective with no palpable distal pulses or significant bleeding from the wound. The fractured leg was evaluated and resplinted. All wounds were dressed, his pain was managed with IV morphine titrated to effectiveness while observing his respiratory efforts, and a Hypothermia Prevention and Management Kit (HPMK) was used. After 2 hours of observation, the Soldier's pulse rate or GCS score did not show significant improvement.

The critical nature of the casualty's injuries was discussed with the on-scene commander. A medical evacuation platform would not be available until the tactical situation permitted. A numerically superior enemy force continued to occupy the surrounding high-ground, which posed a catastrophic threat to any attempt at aeromedical evacuation. The estimated time for the medical evacuation platform was 14 hours after the initial injury of the patient—8 hours after arriving at the remote aid station. The delay of medical evacuation to a higher level of care required alternative methods of fluid resuscitation to prevent the casualty from developing irreversible shock and coagulopathy. This delay led to the consideration of performing an FWB transfusion. The remote aid station did not store packed red blood cells, plasma, or platelets. A "buddy transfusion" was initiated using type-specific blood based on identification tags and verbal confirmation with donor and recipient. The aid station had neither the capability to perform ABO testing nor the use of rapid screening tests for infectious disease detection that are routinely used at Level 2 and 3 facilities.

After administration of the first unit of 500mL of whole blood, the patient's tachycardia decreased from 150 beats/min to 125 beats/min, his femoral pulse became palpable, and his GCS score improved to 15.

The FWB collection was performed using a standard blood collection bag containing citrate phosphate dextrose (CPD) anticoagulant. After venipuncture with a 16-gauge needle, the donor was bled until the bag was filled to approximately 450mL. The blood collection bag was immediately connected to the peripheral IV line, and the blood was infused via gravity into the patient. The patient was monitored closely with vital signs every 10 minutes and direct observation from the healthcare provider. The donor increased his fluid intake and was observed for signs and symptoms of hypovolemia, such as dizziness, hypotension, confusion, and tachycardia—none of which were detected.

Approximately 30 minutes after the completion of the first unit of whole blood, the patient's vital signs and mental status deteriorated to a heart rate of 150 beats/min and a GCS score of 13. When the decompensation was recognized, an additional unit of blood was collected and administered using the same technique as the initial collection and administration. With continued observation after the second unit of FWB transfusion, the patient's vital signs deteriorated again after 30 minutes, necessitating another unit of FWB collection and administration. A total of 5 units of FWB were transfused to the patient with a similar clinical response after each transfusion. On administration of the fifth unit, a CH47 Chinook Helicopter arrived at the outpost to transport the patient to the nearest forward surgical team (FST).

When the patient was finally evacuated, approximately 15 hours after sustaining his injuries, the vital signs recorded by the flight medic were a GCS score of 15, alert and oriented, blood pressure of 58/24 mm Hg, and a pulse rate of 136 beats/min. After a flight time of approximately 10 minutes, the patient arrived at the nearest FST. His vital signs on arrival to the FST were a GCS score of 15, alert and oriented, blood pressure of 75/12 mm Hg, and a pulse rate of 140 beats/min.

After a rapid evaluation, the patient was immediately prepared for the operating room. An exploratory laparotomy was performed with identification of ischemic bowel, of "old blood" in the peritoneum, and of diffuse retroperitoneal bleeding. The patient went into cardiac arrest during the laparotomy, and aggressive attempts at resuscitation were not successful. The patient's time of death was pronounced at 22:35 Local, 16 hours after the injury occurred. The autopsy report declared

the multiple ballistic injuries with significant abdominal bleeding as the cause of death.⁷

Discussion

An FWB transfusion can be a life-saving or life-prolonging intervention in the appropriate setting. A combat casualty in hypovolemic shock and coagulopathy with delayed medical evacuation to a surgical team is an appropriate patient to consider for this procedure. While the ultimate outcome was death in this case report, the patient arrived to a surgical team 15 hours after his injury, alert and oriented with a GCS score of 15. In this scenario, FWB transfusion gave this patient the best chance of survival.

There is potential for catastrophic side effects when performing this procedure. The greatest risk is administering an ABO mismatch between donor and recipient. Rentas et al.⁵ reported a 3.7% error rate for blood group documentation on military identification tags in a U.S. Army garrison setting. This risk should be considered and prevented with additional ABO typing for military personnel operating in remote locations or on high-risk missions. Any potential for ABO donor–recipient mismatch should be eliminated when possible.

If there is concern regarding the accuracy of the ABO type of the donor or recipient, it may be safer to transfuse whole blood from a type O donor with low anti-A and anti-B antibody titers if these titers are known. The risk of a fatal adverse event from ABO mismatch is much higher from incorrect type-specific transfusion than from the use of low-titer type O whole blood in a non-type O recipient.⁶ Current Department of Defense guidelines advocate the use of only type-specific whole blood transfusions. Furthermore, measurement of anti-A and anti-B titers is not commonly performed. More widespread implementation of remote FWB transfusions for isolated military units would be facilitated by adoption of a rigorous program of verification and documentation of blood types and antibody titers before deployment.

Deployed military personnel must adapt their procedures and skills to overcome the challenges of operating in austere environments. Casualties suffering from exsanguinating hemorrhage must be supported until surgical intervention is possible. FWB treats hemorrhagic shock by restoring circulating volume and oxygen-carrying capacity. It also treats coagulopathy by providing fresh platelets and coagulation factors from plasma while avoiding the dilutional coagulopathy caused by asanguinous fluids. It cannot substitute for surgical intervention indefinitely, but in combination with aggressive

measures to control hemorrhage, it can sustain life while awaiting evacuation.

Disclaimers

The authors have nothing to disclose.

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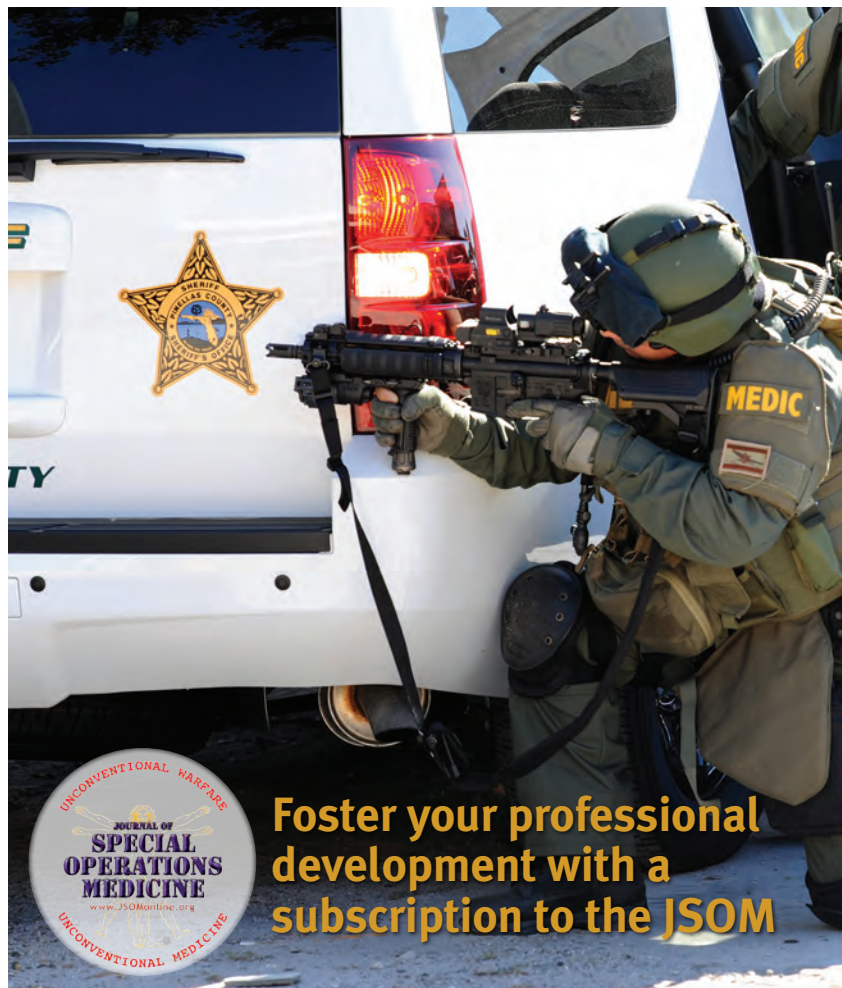
CPT Cordova served as a medic in the 25th Infantry Division and deployed to Iraq and Afghanistan as a squadron physician assistant in the 2nd Infantry Division, and the 4th Infantry Division, respectively. He currently serves as the orthopedic physician assistant at Keller Army Community Hospital at West Point, New York. He has a bachelor's of science and a master's of physician assistant studies from the University of Nebraska Medical Center. E-mail: christopher.b.cordova.mil@mail.mil.

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Dr. Spinella is the director of the Critical Care Translational Research Program in the Division of Critical Care, Department

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in critically ill patients requiring transfusion. Dr. Spinella also is a consultant for the U.S. Army Blood Research Program and the Norwegian Navy Blood Research Program. His passion for improving outcomes for critically ill patients requiring transfusion stems from his 12-year active duty career in the U.S. Army Medical Corps. His 1-year deployment to Baghdad, Iraq, in 2004–2005 led to extensive experience with traumatic hemorrhagic shock and many publications that have transformed the practice of resuscitation of the critically ill. For his contributions, he was awarded the Bronze Star and the U.S. Army's Best Invention Award in 2007 for his part in the development of the concept of damage control resuscitation. He separated from the U.S. Army at the rank of Lieutenant Colonel and was also awarded the Combat Medic Badge for providing care under fire.



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