VIEW

Fresh Whole Blood for the Near-Peer and Immature Theater Conflict

Closing a Critical Gap

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Abstract

Living in South Korea during the fall of 2017 through spring of 2018 proved to be politically tense and professionally exciting for the medical enterprise. Increased rocket testing and inflammatory political rhetoric from North Korea increased global scrutiny and media coverage of the region. A very real concern for renewed kinetic war permeated almost every strategic staff meeting. Provision of blood products in the theater to sustain force preservation became a top priority for operational health service support (HSS) planning. According to a report from the United States Institute of Surgical Research in 2018, "US forces in Korea lack an adequate blood supply system, adequate capability to administer damage control resuscitation in the field or during evacuation, and lack adequate surgical treatment capabilities to support combat operations."[1] Currently, the Armed Services Blood Program (ASBP) has sustainment plans in place for mature theater operations; i.e., operations greater than 30–60 days post commencement of hostilities. Multiple systemic reviews of operational plans and rehearsal of concept exercises illuminated a critical blind spot in the event of a renewed fight in Korea. The United States lacks a realistic and standardized process to provide an adequate blood supply system for the first 30–60 days of conflict. "Current USFK [United States Forces Korea] efforts to improve training in walking blood bank (WBB) procedures are a step in the right direction toward improving blood availability, but are inadequate to bridge the capability gaps identified in combat casualty care resources."[2] The concept of operations for blood supply to US forces is urgently needed in the event of a transition to hostilities in Korea. This article provides a framework to enable readily available fresh whole blood (FWB) to bridge the critical time gap between the first shot being fired and plausible execution of current medical supply plans that rely on functional air and sea supply chains.

Introduction

The Air Force Medical Service's (AFMS) FY19 Strategic Communication Plan contains three main themes. Strategically, it aims to achieve full-spectrum medical readiness, drive AFMS transformation, and strengthen the joint warrior medic with priorities of delivering integrated operational support and trusted care with a readiness focus on expeditionary medicine, partnerships, and innovation. The ability to deliver blood products in the area of responsibility (AOR) in a manner that saves cost (in terms of dollars and lives), reduces time (logistics on delivery of blood products), and impacts quality (both preservation of a fighting force and life itself) is a necessity. The amount of WB required during the initial 30–60 days cannot be overlooked. Modeled casualty estimates do not account for US or host-nation casualties or biological or chemical munitions, nor do these models take high-rise housing into consideration. Seoul represents a true modern megacity, with an estimated population of ~10,000,000 people in Seoul proper and ~25,000,000 in the metropolitan area.[3] Blood requirements for traumatically injured soldiers in Iraq and Afghanistan provide a systematic framework to comprehend the total amount of blood that will be needed. The civilian population can be considered as having the same risk for traumatic injury as combatants in the event of a kinetic strike on the Seoul metropolitan area. The chairman, Coagulation & Blood Research Department, US Army Institute of Surgical Research, states the criticality of this issue well:

> Recent experience (Afghanistan and Iraq) shows that for every 1,000 wounded, at least 10% are at risk of early death due to exsanguination (first 3-6 hours) and will need substantial blood support. These 10% represent [over 40%] of transfused WIA [wounded in action] who will receive massive transfusions (>10U RBCs or WB in 24 hours). For 1,000 wounded, we would anticipate 100 patients consuming about . . . 1,500+ WB units mostly in the first 3–6 hours after injury during damage control resuscitation and surgery. One could estimate that for every 1,000 wounded, at least 2000 WB units or component equivalents (roughly 2,500 RBCs, 2,500 FFP, 400 apheresis platelets, etc.) would be required in the first 3-6 hours following injury. Clearly, this blood requirement cannot be met solely by relying on WBB resources. A plan for rapid supply of blood from forward-deployed [INDO]PACOM units and CONUS must be established and rehearsed.[4]

The complex logistics required in contested environments pose an increased risk to mission and force. As complexity increases, so does the possibility the chain can be disrupted by a failure, constraint, or attack upon any portion of the supply chain. Stringent regulatory requirements ensure the quality of stored blood products. They require proper cold-chain management; inventory tracking; skilled

personnel to collect, monitor, and administer the blood supply; and specialized shipping capabilities.

Transition from armistice to kinetic hostilities results in an immediate increase in the requirement for HSS, including access and distribution of blood products. Blood is central to modern trauma strategies to save lives and conserve the fighting strength. An effective operational plan that can overcome the logistical complexities requires a well-defined process map and identification of key stakeholders in the flow of the process. Establishment of standardized guidance via the implementation of a Department of Defense (DoD)-wide prescreening process will identify and provide the essential ingredient: the blood donor. These identified personnel provide a source of fresh whole blood (FWB) available at day zero of conflict at the time an emergency occurs without further logistical requirements. This article proposes a strategy to provide blood products as far forward as possible to bridge the critical capability gap in a tactical, operational, and strategically economical manner compared with current HSS plans.

The Contested Environment in Korea

Contested environments present significant additional considerations for the provision of HSS that differ from recent experiences in Iraq and Afghanistan. The amount of blood required to effectively treat estimated trauma casualties sustained in the first 30 days of a North Korean attack would be astronomical. The 2019 Committee on Tactical Combat Casualty Care (CoTCCC) guidelines recommend whole blood as the preferred resuscitation fluid.[5] The classic staple, normal saline, is absent from the recommendations due to a broad body of evidence showing that saline contributes to metabolic derangements causing harm in trauma. Currently, the 121st Combat Support Hospital (CSH) has approximately 30 units of packed red blood cells available. At best, this would resuscitate a couple of major traumas. Multiple factors such as lack of intensive care unit capabilities as well as robust host-nation hospital system result in trauma being deferred to the civilian system in Korea. The physicians assigned to the CSH for one- to two-year tours do not see a significant volume of trauma cases. When looking at the blood demand in the event of war, one cannot consider US casualties in isolation.

Incoming fires on South Korea are expected to include conventional explosives, chemical weapons, biological agents, or a combination of these. These fires would be expected to have a primary impact on the civilian population. The large number of expected Korean casualties will overwhelm the civilian medical system and prevent US forces from utilizing host-nation hospitals as currently done during armistice. Like at other OCONCUS locations, a significant number of US family members accompany their service members to bases in South Korea. The presence

of these civilians creates additional casualties that will strain the blood supply in a transition to hostilities.

Noncombatant evacuation operations (NEO) will consume significant manpower and resources. With sufficient warning of an attack, an orderly evacuation of noncombatants would follow a directive from the US Ambassador to South Korea. These NEO operations could be another source of fresh blood for US forces. Each eligible adult could donate a unit of FWB while at NEO assembly points awaiting evacuation. The collection at multiple locations would require personnel and equipment to collect, process, and store the blood. FWB is only good for 21 days under ideal storage conditions. NEO assembly points are neither staffed nor equipped to provide this service. Surprise attack poses increased strains on the NEO system.

A surprise attack by North Korea would be expected to make the roads out of Seoul impassable. The "fog of war" created by sudden panic and disorientation makes systematic collection of blood impossible. The service members would report to their war-fighting locations, while their dependents would report to NEO assembly locations with minimal baggage. The psychological impact on service members reporting for war without confirmation that their family members are safe cannot be underestimated. This could result in service members absence until their family members are transported to the NEO assembly point, resulting in a decrease in effectiveness of the fighting force. Medical professionals are not immune to this effect. Depending on a "tenuous at best" and "just trust us it will work" process with multiple unsupportable assumptions does not instill confidence in the war fighter. Current plans to import blood cannot meet the modeled casualty estimations and must be rewritten.

Current blood supply models depend on pre-positioned frozen blood stores or importing blood via air or sea shipment. Current in-theater ability to thaw frozen blood has a capacity of around 200 units per 24-hour period. This amount represents a minuscule contribution compared to expected blood requirements. There is no guarantee that the United States will have air and sea superiority early in a conflict with North Korea. Until air and sea routes of importation are secured, medical support functions will have to rely on blood already available in theater. Using the Korean Red Cross as a source of blood presents another possible alternative.

South Korean practices are very similar to the US blood bank system. In fact, if an American goes to a host-nation hospital and requires a blood transfusion, they receive Korean blood. We have, by practice, accepted that the Korean blood bank system meets acceptable quality standards by sending trauma patients to Korean hospitals. Thus, purchasing blood from the Korean system appears valid. This ar-

gument fails because it focuses solely on quality. The reality of early combat in South Korea will be an issue of quantity and capacity—not quality. In the event of war, the Korean medical system will be inundated with civilian casualties demanding care. The United States should not rely on contracts with the Korean blood system to provide the limited resource to the US military at the expense of Korean citizens. Could the United States utilize patients with clearly nonsurvivable wounds as potential sources of FWB?

Early in the war—when medical supplies, blood, and evacuation options are extremely limited or nonexistent—medics could use mortally wounded patients as a source of FWB. A unit under fire and running low on ammunition would take ammunition from a wounded teammate who is unable to contribute to the fight. Reallocation of resources to the area of greatest need is a well-grounded military principle. This logic would imply that to phlebotomize critically wounded patients who have no reasonable chance of survival would similarly reallocate a critical and finite resource. Current medical practice attempts to keep these patients comfortable with pain medication and companionship while iteratively evaluating their status. Rather than use limited medical resources on these patients, why not use these soldiers as a medical resource for salvageable war fighters? This option represents an emotionally extreme ethical dilemma, though it does not factually differ from organ donation, which is a widely accepted medical practice in the United States.

Organ donation exists in the United States, though typically limited to brain-dead or terminal patients (and specific instances of living donors for bone marrow and kidney transplants). War differs from peacetime medical operations, because military physicians are forced to make quick and calculated decisions between conserving the fighting strength or saving the few who may be more critically wounded with limited medical supplies. Reverse triage addresses this scenario. In war, some patients who may be salvageable during peacetime must be labeled as expectant. Hastening the inevitable death of an expectant warrior to save the life of one or more of his teammates represents an option under extreme circumstances. This drastic measure, while possible, would require a deeper ethics discussion before implementation. So far, discussion has focused on casualties and constraints based on fires into Seoul. North Korean ballistic missiles must also be considered.

North Korean ballistic missiles can reach the full length of the South Korean peninsula. Open-source reporting has also confirmed North Korean missiles capable of reaching Japan, Guam, and the continental United States. This places all major aerial and naval ports of embarkation, as well as major staging areas, within range. North Korea's possession and willingness to use chemical and biological agents further complicates the threat to those air and sea ports. If these

ports were to become contaminated with chemical or biological agents, it is doubtful command authorities would allow assets to land or dock in the contaminated areas. Before the air and sea supply lines can be optimized, the theater ballistic missile and chemical/biological threat must be eliminated or at least reduced to an acceptable level. Optimizing the air and sea supply lines will have a profound impact on delivery of all critical war supplies, including blood.

Once blood arrives in Korea, it must be transported to the patient, or the patient must be brought to the lifesaving resource. Due to the mountainous South Korean geography, a significant number of tunnels and bridges exist between the Greater Metropolitan Seoul Area and the southern port of Busan.[6] Compromise of these bridges or tunnels will greatly impact evacuation efforts via train or automobile. Gridlocked roads and impassable bridges and tunnels, coupled with mass southward migration of the civilian population, will prevent timely distribution of blood. The same factors will complicate the evacuation of patients from the north to medical facilities located further south. Blood needs to move north from southern ports of embarkation, and the patients need to move south from the northern battlespace. The same movement-restricted environment applies equally to patients and blood supply. Ariel movement will also be disrupted.

Movement via air will be greatly restricted during the first 7–30 days of war. Limited rotary wing assets currently reside on the peninsula. The United States has finite capacity, which is unlikely to be tasked for purely medical reasons. Until incoming fires have been attritted, commanders cannot be expected to risk these limited assets to evacuate patients from frontline areas. Assuming personnel were dispatched to support patient movement, they will have limited options for receiving facilities to offload patients. The same restrictions will apply to areal movement of blood. Fixed-wing delivery options will also be extremely limited until enemy air defenses are reduced and air superiority is gained.

The US military medical system has been a victim of its own success in Iraq and Afghanistan. Recent experiences with 97-percent survival rates for wounded combatants have become the new expectation. Denied and contested environments inherently do not allow for the same level of medical care as locations with established and well-resourced theater combat support hospitals. To maintain the trust of the war fighter, the United States will do everything possible to ensure survival of wounds. The United States must establish a plan to provide life-sustaining and lifesaving medical care in contested or denied environments. Low-titer FWB represents a proven, safe, and economical manner to provide point of injury blood for combat resuscitation.

"Low titer group O whole blood can be considered the standard of care in resuscitation of major hemorrhage."[7] Currently, many military units prescreen their

personnel to act as emergency blood donors.[8] This practice is most commonly referred to as a walking blood bank (WBB). In the Special Operations Forces community there are two notable programs: the Ranger O Low Titer (ROLO),[9] utilized by the 75th Ranger Regiment, and the Standardized Tactical Universal Donor-Korea (STUD-K) program, utilized by Special Operations Command Korea (SOCKOR)[10] and United States Forces Korea (USFK).[11] The WBB does not replace the formal blood bank system. The intent has always been to augment the blood supply in times of exceptional need. Now is the time to move beyond conventional thinking and create a standardized DOD-wide system that is simple, yet responsive enough to provide blood any time and any place that US service members find themselves in harm's way. "Severely injured combat casualties requiring transfusion have a significant mortality rate (range 10–20%) and have the greatest potential to benefit from early and appropriate transfusion strategies."[12] Recent analysis of casualties from Afghanistan clearly shows, "Among medically evacuated US military combat causalities in Afghanistan, blood product transfusion prehospital or within minutes of injury was associated with greater 24-hour and 30-day survival than delayed transfusion or no transfusion."[13] FWB is the solution, especially in contested or denied environments.

The use of FWB resuscitation decreases mortality and morbidity in war fighters wounded in combat.[14] Transfusion of FWB at the point of injury (POI) can decrease mortality rates of "potentially survivable" injuries. The use of low-titer type O whole blood has been used during many prior conflicts. Low-titer type O blood can be given to anyone on the battlespace with extremely low and acceptable risk of adverse reaction. The current military definition of "low-titer" is less than a 1 to 256 dilution of Anti-A/Anti-B antibodies.[15] Lt Col Ethan Miles of the 75th Ranger Regiment has spearheaded a recent revitalization of this very old concept. SOCKOR used a modified version of his program to scale for use in the Korean theater. This protocol was adopted by 8th Army and implemented by units throughout USFK.

Fresh low-titer whole blood represents a safe cost-effective method to make blood available at the POI. A prescreened donor requires only a simple blood donation bag to be able to provide a unit of warm whole blood. Prescreening donors within the combat units prior to deployment eliminates any need for the supply and distribution chain, because the donor pool has already been established. Use of prescreened WBBs also eliminates very expensive and potentially unreliable infrastructure that requires power to cool and rewarm blood products and the associated technical personnel. FWB from a living donor can be directly infused to a patient without the need for any additional expensive equipment.

Currently the Air Force, Army, and Marine Corps all have varying levels of involvement and operating procedures for use of FWB. Most of the programs are run by junior medical officers. Their supervisors possess varying levels of expertise or comfort with this type of program. A plethora of data shows low-titer whole blood can be used safely and efficiently.[16] The required level of safety and certainty during mass casualty in wartime scenarios cannot be expected to match peacetime levels. This is supported by a 2010 policy from the Under Secretary for Health Affairs, Dr. Charles Rice: "The use of non-FDA-compliant blood is sometimes necessary to save lives and may be the only alternative during combat operations or mass casualty events."[17]

Current DOD protocols for accessions require testing for blood type, HIV, hepatitis, sickle cell disease, G6PD deficiency, and other conditions based on a premise of population health, its impact to readiness, and safety. Antibody titer testing should be added to the accession predeployment test profile on all personnel with type O blood. Approximately 40 to 50 percent of the US population has type O blood. Additionally, 25 to 75 percent of personnel with type O blood will have low Anti-A/Anti-B antibody titers. A recent 2019 study in Texas showed that 87 percent of 3,274 type O+ male donors were low-titer.[18] With successive titer testing, it appears that individuals display a tendency toward lower titers. This indicates that titer testing may not be required after the second test if donors have been identified initially as low-titer.[19] Due to the significant cost associated with current models that perform titer testing prior to every deployment, the military should establish service members' titer with a onetime test. Testing for transfusion-transmitted diseases should be completed concurrently with titer testing.

Current accession testing includes hepatitis and HIV as noted above. Many of the additional confirmatory tests at the ASBP included on standard blood bank panel include Chagas disease, West Nile virus, human T lymphocytes virus, malaria, Zika, babesiosis, among others. While this broader level of testing is appropriate for safety in the much larger and regulated blood banking system, it is not required in the context of this program, because the mortality rate is reduced and all those potential issues in morbidity can be treated afterward.

The risk of a transfusion-transmitted disease will be higher under this program than the formal blood banking system. This recognized risk can be mitigated. HIV and hepatitis C (HCV) do not represent the same threat they did 50 years ago. HIV has become a chronic disease that can be managed, not the relative death sentence it was in the 1980s. HCV is still a major issue, but modern drugs are almost capable of a complete cure.

Conclusion

US servicemembers may be asked to put their lives directly in harm's way. These warriors deserve every opportunity to survive their period of service, whether one tour or an entire career. Exsanguination has been a leading cause of death in every conflict. The use of tourniquets greatly decreased loss of life due to extremity hemorrhage, but this success has been predicated upon early evacuation and early surgical intervention. The situation described above as well as unseen future conflicts in a peer-to-peer or near-peer fight will prevent early evacuation and early damage control resuscitation. A well-established program to prescreen all military members and identify eligible donors, coupled with trained and empowered medics able to perform pre-hospital blood transfusions, will provide the best option to close the critical capability gap.

Now is the time for the DOD to establish a uniform process to prescreen and standardize training and procedures across all military departments. Establishment of a DoD-level program will improve joint medical interoperability. Economic feasibility and interoperability are critical to programmatic sustainability. Establishing a safety net against future disruptions of conventional supply and distribution is vital for combatant survivability in contested environments. Programs established by the 75th Ranger Regiment and SOCKOR serve as proof of concept. These proven and established programs must be scaled and implemented across the whole of the DOD. ✪

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Colonel Keller currently commands the Special Warfare Operational Medicine Squadron at JBSA-Lackland. His previous assignments ranged from squadron doctor to theater special operations command surgeon during his 15 years supporting Air Force special operations. Dr. Keller maintains board certification in emergency medicine with special interest in pre-hospital emergency medical services and combat trauma care. He earned his MD from the Medical College of Georgia and a masters in strategic studies from the Air War College and maintains a faculty appointment in the Department of Military and Emergency Medicine at the Uniformed Services University of the Health Sciences.

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