Revolutionary innovations and technical advances in the disciplines of medicine, surgery, and anesthesia are inextricably connected to military conflict. The demonstrated lifesaving value of these novel approaches in high-acuity trauma has provided the impetus for translation of these elements into injury care in the civilian environment. One element of this battlefield medical revolution is the implementation and refinement of forward surgical care. All US military services have unique configurations of this surgical team to match their expeditionary capacity. The US Army Forward Surgical Team (FST) is a small, mobile surgical unit fielded since the 1990s, but not ubiquitously used until the current contingency operations in southwest Asia. The FST has been used in a variety of ways during the current conflict with or without augmentation by a forward support medical company, Area Support Medical Company, and Brigade Medical Company also known as C-Med. Far forward stand-alone FST have often been emplaced to provide a surgical capability for patients in austere operational environments and to optimize casualty survival in situations of high-risk operations and/or with potential for protracted evacuation.

**Keywords:** Forward surgical care, nurse anesthesia, trauma.

In the US Army Forward Surgical Team (FST) model, the surgical team performs lifesaving interventions, specifically surgical hemorrhage control for battlefield casualties within the “golden hour” of injury. After initial resuscitation, casualties are then “packaged” for medical evacuation to a higher level of care. The FST by doctrine includes 20 staff members, including 3 registered nurses, 3 licensed practical nurses, 2 surgical technicians, 4 medics, 1 detachment sergeant, 1 administrative officer, 4 surgeons (3 general and 1 orthopedic), and 2 Certified Registered Nurse Anesthetists (CRNAs). By doctrine of the Field Manual 4-02-25 (March 2003) and Army Training and Evaluation Program 8-518-10, the team is capable of continuous operations with a divisional or nondivisional medical company for up to 72 hours, with a planned caseload of 30 critical patients. A functional operating room (OR) can be established within 1 hour of being on the scene and broken down to move to a new location within 2 hours of ceasing operations. The FST can sustain surgery for 24 total operating-table hours and has the ability to separate into 2 component teams that function independently at disparate locations. In these split operations, the team must be split to maintain functionality by maintaining logistic, operational, surgical, and anesthesia support with CRNA coverage.

Nurses first provided anesthesia to wounded soldiers during the Civil War. Nurse anesthetists have been the main providers of anesthesia care to US military personnel on the front lines in the history of modern warfare. In 1914, Dr George Crile, a pioneer in American surgery, and his nurse anesthetist, Agatha Hodgins, who became the founder of the American Association of Nurse Anesthetists (AANA), went to France with the American Ambulance Group to assist in the establishment of hospitals that would provide care for the sick and wounded of the Allied Forces. Nurse Ellan Orkin was a prime example of the courage, dedication, and leadership exhibited by nurse anesthetists in support of our troops during World War II. In a field that was in its infancy, she received rudimentary training and became a nurse anesthetist in 3 days. She then landed with the 164th General Hospital supporting the main body of the invasion of Normandy on D-Day armed only with vials of sodium pentothal. She continued to serve troops with honor during World War II, as did her sister. The commitment and sacrifice of the CRNA community in combat surgical support have been maintained through the current operations of Iraqi Freedom and Enduring Freedom. In 2003, LTC Steve Hendrix, CRNA, participated in the rescue mission of PFC Jessica Lynch. COL Gale Pollock, CRNA, was promoted to major general and became the 22nd chief of the US Army Nurse Corps, the third CRNA to serve in that position. Later, she was appointed acting surgeon general of the US Army.

Trauma resuscitation protocols have changed drastically in the past decade secondary to the analyses of lessons learned in the conflicts in both Iraq and Afghanistan, and subsequent changes in clinical practice have occurred. In the fourth US revision of *Emergency War Medicine* published in 2013, US Army Surgeon and General Trauma Consultant Col Brian Eatridge noted:
One of the legacy medical achievements of this war was the development of a new resuscitation paradigm, coined damage control resuscitation. The focus of this novel strategy is the concept of early management of the coagulopathy of trauma by using a balanced resuscitation of plasma to augment red blood cell (RBC) transfusion. We used this new approach to balanced resuscitation of battlefield trauma to resuscitate a patient. Further anesthesia management included adjuncts to this therapeutic regimen to include an aggressive emphasis on thermoregulation.

The ATLS and the OR temperature were increased to a setting of “hot” on the environmental control unit. Trauma care now focuses on minimizing crystalloid solution and makes an effort to transfuse the patient sooner with a mixture of packed RBCs and fresh frozen plasma (FFP) until whole blood can be prepared for the unit. We also focused on early administration of hemostatic agents. We use coagulopathy testing modalities when available to facilitate resuscitation but not slow resuscitation waiting for results. We gave a 1,000-mg dose of tranexamic acid before the start of surgery. The goal is to administer tranexamic acid within 3 hours of the initial injury, after which it is shown to be detrimental. We concluded the surgical portion of the resuscitation with an additional dose of 1,000 mg of tranexamic acid.6,7

Transxamic acid in trauma is a novel therapeutic agent with a well-developed safety profile in elective surgery to minimize blood loss. There is current evidence in elective surgery that tranexamic acid has a benefit of decreasing periprocedural blood loss. The CRASH-2 Trial and the US Military Application of Tranexamic Acid in Trauma Emergency Resuscitation (MATTERs) trial both demonstrated a survival advantage of the drug in injured patients, especially those who received transfusions, and even more profound survival advantage was noted in casualties after massive transfusion.6,7

Calcium should also have a continued place in trauma management, although not all would agree on this. We should continue to have a weight-based risk-benefit profile for the use of calcium. We know we need calcium to continue the coagulation cascade, and it is the only factor that is derived from our diet as a coagulation factor. The interesting theoretical question that arises from doing trauma care on local nationals is the difference in a balance and unbalanced diet.8 We pose the bigger question on that topic: do we need to consider the use of calcium sooner in these patient populations because of the increased risk of malnutrition in third- and fourth-world countries? We recommend the use of 1 g of calcium with every 2 to 4 U of packed RBCs and monitoring ionized calcium levels to maintain the level of at least 1 mmol/L.6,7

The Lethal Triad

Incumbent in the new philosophy of resuscitation is the central focus on the management of the lethal triad of acidosis, coagulopathy, and hypothermia after injury. We focus here on each piece of the triad and discuss interventions for each.

• Hypothermia. In the last several years there has evolved a new perspective on temperature control. We have always understood that hypothermia has a critical impact on the patient because enzymatic and physiologic processes have optimal kinetics in a fairly tight range of temperature and pH. New data have forced us to finally embrace warm ORs. Hypothermia is one of the most preventable surgical and anesthetic complications.

Temperature is controlled by 4 variables: convection, conduction, evaporation, and radiation. Depending on the phase of the surgery, some of these variables change the percentage of surgical heat loss.

• Conduction (10% of Heat Loss). Heat energy is transmitted through a substance by the transfer of the energy of motion of the molecules to adjacent molecules. Air is a poor conductor of heat, so air traps in clothing protects against this form of heat loss. Direct contact: Lying on a cold bed. We increased the ambient room temperature, and this had a secondary effect on warming the bed, although minor.9-12

• Radiation (50% to 60% of Heat Loss). A hot object emits radiation over a wide range of wavelengths, predominantly infrared. When heated, a bar of steel will glow red, then orange, then blue, then white. This radiation carries away heat, and the object cools. Radiation is the most important form of heat loss normally and in the OR. It may account for up to 50% to 60% of an unclothed patient’s heat loss at room temperature. Radiant heat loss increases when the body is surrounded by cool objects and decreases by radiation from warm objects near the body. For example, space blankets (silver polyethylene terephthalate [Mylar] film) passively reflect the body’s radiated-heat energy back to it. We placed the tent (Alaska Tent & Tarp) and environmental control unit on the heat setting. The ATLS and OR temperatures were kept on hot, and, judging by the final patient temperature, we were able to maximize this route of temperature control.9,12

• Convection (30% of Heat Loss). The air layer adjacent to the body surface is warmed by convection and expands and rises because heated air is less dense. The
resultant convection current carries heat away, like the “heat waves” one can see above the highway on a hot day. We applied warm blankets in this case and used forced-air warming (Bair Hugger, 3M) to provide what protection we could to the patient.

Now this section will focus on heat control for transport.9-12

• Surface Evaporative Heat Loss (20% of Heat Loss). This is the loss of latent heat through vaporization of moisture on the body surface. It accounts for about 20% of heat loss at room temperature, and it can be more in extremely warm environments or when greater areas of moist skin are exposed (eg, larger incisions). The amount of heat lost is proportional to the water vapor–pressure gradient between body and air and to the total amount of skin exposed. We used a humidified moisture exchanger. The patient was not sweating at this point and appeared to be vasoconstricted, which helped with this mechanism.9-12

There are additional options for heat protection. Irrigation fluids were warmed in a microwave in the tent. The warming time is 4 min/L with rotational mixing to avoid creating hot pockets. We did not warm intravenous (IV) fluids because the only warming device was a microwave, and we believed that this was not a safe means for warming IV fluids. The whole blood was at the live-donor temperature, and it was brought to us warm. We used an infusion system with induction heat technology (Belmont Rapid Infuser, Belmont Instrument Corp) for rapid transfusion. The head was covered with a military-issue, heat-reflective head cover (Thermoflect, Encompass Group). Temperature was monitored throughout the case via nasopharyngeal access, with a final temperature of 36.7°C (98.0°F). Wide fluctuations can be noted with this route unless the patient is intubated, in which case it reflects brain temperature (blood flow past the cribiform plate).

• Acidosis. Normal pH is defined as maintenance by a healthy individual of a physiologically normal pH of 7.35 to 7.45. This is accomplished through a complex balance of hydrogen ions (acids) and buffers predominately controlled by the pulmonary and renal systems. In acute trauma, these systems often have great trouble maintaining a normal pH secondary to the metabolic derangements of shock.8 Acidosis is defined as an arterial pH below 7.35 in trauma patients, and the major contributor is poor perfusion of tissue. Anemia due to acute blood loss, peripheral vasoconstriction in response to hypothermia and continued blood loss, and an overall decrease in cardiac output severely impair oxygen delivery to the tissues. The resulting tissues’ oxygen demand far exceeds oxygen delivery. The body needs energy and is forced to make functional energy. This is accomplished by the body’s cells being forced to utilize anaerobic metabolism instead of the normal aerobic metabolism, resulting in the production of lactic acid as a byproduct.13

When a trauma patient’s perfusion worsens, lactic acid rapidly accumulates in the tissues; this causes the body’s pH to drop, resulting in a severe metabolic acidosis. This process frequently occurs in the presence of normal or only slightly abnormal vital signs.

An additional cause of acidosis in the trauma patient is the practice of excessive resuscitation using unbalanced crystalloid solutions.7,14 Normal saline has a pH of 5.5, and this is far more acidic than the desired normal blood pH. In large-volume resuscitations, normal saline predictably causes its own metabolic acidosis because of the high chloride content.13 This hyperchloremic metabolic acidosis only serves to compound the existing lactic acidosis of trauma. There is evidence that excessive use of normal saline with its high chloride content may increase systemic tissue inflammation and can contribute to the coagulopathy of trauma.7,13 Lactated Ringer’s solution is not a substitution for normal saline. Lactated Ringer’s has a pH of 6.5, contains lactate, and is incompatible with many medications and blood products.8

Finally, a trauma patient may have respiratory acidosis as a result of hypoventilation due to respiratory depression or obstruction, which results in hypercapnia (increased carbon dioxide levels). This respiratory acidosis in trauma can have multiple causes, and a thorough investigation can help with additional treatments as needed.8 With severe acidaemia (pH < 7.20), disastrous consequences in numerous metabolic processes can occur.7,10 For the trauma patient, the most harmful effect is that the coagulation system can become severely impaired. In one study, the function of part of the coagulation system was reduced by 55% to 70% when the pH dropped from 7.4 to 7.0.17,18 In such circumstances, agents such as tromethamine, or tris-hydroxymethyl aminomethane, can be used for recovery. Tromethamine has several advantages in trauma-related acidosis. Nahas et al19 found that tromethamine supplements the buffering capacity of the blood bicarbonate system, accepting a proton, generating bicarbonate, and decreasing the partial pressure of carbon dioxide in arterial blood (Paco2). It rapidly distributes through the extracellular space and slowly penetrates the intracellular space, except for erythrocytes and hepatocytes, and it is excreted by the kidney in its protonated form at a rate that slightly exceeds creatinine clearance. Unlike bicarbonate, which requires an open system for carbon dioxide elimination to exert its buffering effect, tromethamine is effective in a closed or semiclosed system and maintains its buffering power in the presence of hypothermia. Tromethamine rapidly restores pH and acid-base regulation in acidosis caused by carbon dioxide retention or metabolic acid accumulation, either of which has the potential to impair organ function.7,19

Trauma calculations for dosing tromethamine acetate in the treatment of acidemia are as follows:
Loading dose: 0.3 mol/L
Example: 1 mL of 0.3 mol/L
Solution = KG × Base Deficit
Maximum dose: 15 mmol/kg
Example: 3.5 L of a 0.3 mol/L Solution in a 70-kg
Patient = 70 kg x – 9.1 = 637 mL

An alternative to using tromethamine in trauma is the traditional method of using sodium bicarbonate. This system is dependent on keeping the patient normothermic. The evidence to support the use of bicarbonate is limited at best, and a calculated risk-benefit evaluation should be undertaken before using it. The administration of bicarbonate does produce carbon dioxide, which requires the anesthesia provider to monitor laboratory values closely, and changing minute volumes may be required to clear this additional carbon dioxide. The additional risk of using bicarbonate is that one can see a reduction in the ionized calcium levels related to the use of sodium bicarbonate. This may have added effects on the patient’s coagulation status, which we are trying to treat as well. Careful and controlled consideration must be taken before using sodium bicarbonate. Until the civilian world embraces the benefit of tromethamine, we may only have the option of using sodium bicarbonate.

The mathematical dose calculation for sodium bicarbonate in a trauma patient is as follows.

Normal Bicarbonate Level – Base Deficit × Patient Weight (kg) × 0.3
25 (Normal) – 10 (Base Deficit) × 70 kg × 0.3
Example: 15 × 70 kg = 1,050 × 0.3 = 315 mEq

In practice, we give only half the dose for 167 mEq, or 3 amps of sodium bicarbonate.

- Coagulopathy. The blood-administration ratio in trauma has become a controversial topic. Questions of how much crystalloid first (if any), how much blood, when to start, ratio of blood components, and end goals have all been debated. In the military, the debate has shifted to accept early use of blood, minimal crystalloid, a 1:1:1 ratio of packed RBCs to FFP and platelets, based on findings of several studies that demonstrated survival advantage using this resuscitation strategy. The most important part of this paradigm may not be the specific ratio of RBCs to plasma, but rather the principle of intervening to manage coagulopathy with a proactive approach. Traditional trauma or massive transfusion protocol paradigms have relied on international normalized ratio (INR) values, with elevations in the INR prompting the administration of FFP. This technique ultimately requires reacting to resuscitative difficulties instead of preventing them. This type of “damage control” trauma resuscitation has improved outcomes in US soldiers who require massive transfusions (> 10 U packed RBCs in 24 hours). In the FST, there is a limited supply of blood available; according to Army doctrine the FST has the capacity to receive 50 U of type O+ and O− packed RBCs, although the components available can vary depending on many logistical factors. In an established theater of operations, type A or AB FFP is also available in varying amounts, as well as cryoprecipitate. However, because of storage logistics, the FST is not currently fielded with platelets. The limited availability of this blood product along with the potential to encounter several catastrophically injured individuals simultaneously requiring massive transfusion can quickly exhaust blood stores and place patients at risk. This risk is mitigated by using fresh whole blood during massive resuscitative efforts.

Fresh whole blood has been used in the resuscitation of soldiers since World War I. The use of fresh whole blood is not approved by the US Food and Drug Administration (FDA) and is unique to the military for several reasons. First, the supply of packed RBCs and other blood components is typically readily available in the modern trauma center. Massive transfusion protocols in these hospitals are capable of delivering several units of type-specific blood products to the trauma team for their resuscitative efforts in the emergency room and OR. The second reason is the potential for transmission of bloodborne disease, although the rate of bloodborne diseases using current blood banking techniques is incredibly low. It would be difficult to persuade any healthcare practitioner to stray from what has proved to be a very safe blood banking and administration program to use fresh whole blood during traumatic resuscitation. Finally, the ability to get fresh whole blood would mean having individuals in the community be on call to have blood taken from them for use 24 hours a day, not to mention the periodic testing for bloodborne diseases.

In the military, nearly everyone knows his or her blood type; it is on everyone’s dog tag (although it is wrong about 4% to 10% of the time), and all service members are tested for bloodborne diseases. In fact, an HIV-positive soldier is restricted from deploying, in part because of the use of fresh whole blood in theater. Troops are immunized by regulation for hepatitis A and B. The fresh whole blood donation program takes advantage of these facts as well as the fact that all these soldiers are immunized by regulation for hepatitis A and B. The fresh whole blood donation program takes advantage of these facts as well as the fact that all these soldiers are in immediate proximity to the blood donation site. To initiate the process, an announcement brings these selfless soldiers to give their blood to help save a life. They do not know if it is an American or a foreign national fighting alongside Americans or an enemy combatant, but they come to donate. The process of getting the first unit of blood to the patient often begins long before the causality hits the FST doors. The process of organizing the “walking blood bank” is often the responsibility of the laboratory personnel assigned to the medical support entities co-located with the FST or to the FST itself.
when functioning independently. Along with the task of organizing the blood bank when blood is needed, these responsible individuals coordinate the prescreening of a pool of donors. These individuals have blood drawn and sent for testing. These samples are first used to establish ABO type. Because fresh whole blood contains all components, it needs to be type specific, as no universal donor is available for whole blood. Potential donors are tested for hemoglobin and hematocrit, HIV, hepatitis B and C, and malaria, and a rapid plasma reagin is performed for syphilis. They are also questioned about personal activities that potentially place them at risk. These individuals are then entered into a database along with test results. In the event of blood bank activation, these individuals are used first to reduce the risk to the recipient. When these individuals are exhausted, unscreened soldiers are put through the process of screening on-site and blood is drawn and tested using rapid-result type testing. The same laboratory blood samples are sent out to FDA-approved laboratories for testing; results of these tests are obviously not used in the emergent determination of donor eligibility but are used to verify rapid tests. If a positive result is found, then appropriate testing and treatment are conducted on the donor. The prescreened donors are also retested using the rapid result tests to verify safety. Unless the patient is in extremis, the results of communicable diseases are usually verified before the blood is used. The plan is rehearsed to minimize the potential for clerical errors, which are well known to be the most common cause of ABO incompatibility. If two different blood types are being drawn, 2 completely separate teams should be used if possible, to minimize contamination. Assuming all has gone well, a 450-mL bag of fresh whole blood is delivered to the resuscitation area. These units can be kept at room temperature for 8 hours and refrigerated for 24 hours.

Levels of Care

In battlefield medicine, patient movement using available aeromedical assets plays a major role in the lifesaving capabilities of every level of care in the battlespace. Conforming to North Atlantic Treaty Organization (NATO) nomenclature, these levels of care are referred to as roles. Role I is the most basic of care: point-of-injury care or care at a battalion aid station, where limited treatment and triage of patients can occur. These aid stations are staffed by physicians and/or physician assistants and combat medics.

The role II medical company can provide basic and advanced emergency treatment; they have blood supplies, laboratory support, X-ray imaging, and other medical assets, including dental, physical therapy, occupational therapy, and combat stress counseling, depending on configuration. They also have some patient-holding capacity with or without critical care support. In the modern battlefield, these units are frequently “pulsed up” with an FST, making them role II+. They are collocated in the same area as the FST. This adds the element of damage control surgery. These groups have a synergistic effect on each other, and together these teams are the foundation of far forward surgical care for those too unstable to transport further.

Role III care is everything in role I+ and more. An example is a combat-support hospital. This is a 248-bed field hospital with most of the amenities of a modern hospital. These hospitals can provide damage control surgery and definitive surgical treatment. They typically have an array of surgical specialties, including neurologic, vascular, and thoracic surgery along with orthopedic, general, and trauma surgical services.

Role VI hospitals are full-spectrum hospitals, providing all services of a modern hospital. These facilities are fixed-site hospitals typically located outside the area of active conflict. Between every level of care, there is a necessary aeromedical asset. At nearly the same time that the call comes in, reporting casualties are en route to any role I through III facility, and the plan is concurrently being developed to get the patient moved to the next level. This movement almost always involves air movement. Exceptions to this would typically be a result of poor visibility, dangerous tactical conditions, or inadequate availability of air assets. In these situations, ground vehicles are sometimes used; some are specialized patient-moving vehicles, and sometimes they are the fighting vehicles with a medic onboard. Like the escalating roles of care described earlier, there are escalating roles of care in aeromedical evacuation. When a nonmedical aircraft or vehicle is used, it is called casualty evacuation ("casevac"). Typically, minimal or no medical care is given with this type of evacuation. Next is medical evacuation ("medevac"), where specially trained medics and nurses can provide minimal emergency resuscitative care, typically in specially equipped helicopters.

Finally, the highest level of care in the battlespace is aeromedical evacuation. At this level, specialty teams of technicians, medics, nurses, and physicians can provide critical care transportation in highly modified aircraft. These are usually specially equipped fixed-wing airplanes. Before transporting patients by any means, the patient must be appropriately prepared for the trip. Transport of patients out of the theater is done by strategic evacuation and, in the cases of high acuity patients, accompanied by a US Air Force Critical Care Air Transport team. There are, of course, circumstances in which the ability to stabilize the patient requires that the patient be taken to the next level of care. However, typically, the patient must be in a stable state before transfer; this luxury of a relatively stable patient frequently happens at the role II or II+ facility and higher. Stabilization from the battlefield many times is nothing but a tourniquet providing life-
sustaining hemostasis until the patient can reach surgical treatment. That said, preparing a patient for transfer from a role II facility or higher has to take into account several aspects of patient injury and treatment. Once in a role II hospital (or higher), the team resuscitates the patient, provides damage control surgical intervention as necessary, and holds the patient in the intensive care area to continue the resuscitative efforts until the patient is stable enough for transfer. There are recommended clinical parameters that should be met before arranging for transfer out. These parameters include stable vital signs and laboratory values: heart rate below 120/min, systolic blood pressure above 90 mm Hg, hematocrit higher than 24%, pH above 7.3, and temperature higher than 35°C are some of the goals that should be reached before moving patients. Once the patient achieves a relatively stable state, the patient can be prepared for air travel.

When thinking about transferring a patient by air, we must think about a few gas laws.\(^23\) (Don’t worry; no calculators needed, just concepts.) According to the Boyle law, when the pressure of a gas decreases, the volume of that gas increases.\(^24\) Per Dalton law, when atmospheric pressure decreases, the partial pressure of oxygen also decreases. These concepts are important when transferring a patient via air.\(^25\) A gas bubble in liquid will double in size at 5,400 m (18,000 ft) above sea level; so, things like a small pneumothorax that could be “observed” on land needs to have a chest tube placed in it before taking a patient to altitude or it may turn into a catastrophic event in the air. Endotracheal tube cuffs are filled with saline, and air is removed from IV bags. Patients stable on room air may need oxygen support because of a decrease in the partial pressure of oxygen. These are a few of the considerations that must be taken into account simply because of the reduction in atmospheric pressure. In addition, there is a reduced threshold for intubating and sedating and even paralyzing patients for the safety of the crew and the patient. Conventional observation and evaluation of the patient is impossible in an aircraft because of noise, vibration, and the confined space of the aircraft. The patient will experience wide swings in temperature. Part of the lethal triad of trauma is hypothermia, so the patients are always wrapped. Specialized blankets that wrap around the patient with chemical heating devices in them are available and are frequently used in transport. These devices are designed to make access to the patient possible and to accommodate lines and tubes coming from the patient. The patient will also be exposed to loud noise. Earplugs are placed, and eye protection is placed on all patients traveling via rotary-wing aircraft. Changes in acceleration typically do not create any major concerns for the patient; however, patients with elevated intracranial pressure are placed with the head toward the nose or large swings in intracranial pressure can occur with takeoff and flight (usually there is a slight nose-up attitude of a fixed-wing aircraft). Adjustments to ventilators and other monitoring equipment are necessary when at altitude. These are just a few of the considerations when transferring the critically ill via aircraft.

**Recommendations for Combat Trauma**

- Early on, recognize the need for massive transfusion and implement the program early.
- Keep INR less than 1.4 and keep tissue saturation greater than 92%.
- Prevent dilution of clotting factors.
- Use whole blood if available and if the FDA ever approves this.
- Use blood component therapy at a ratio of 1:1:1. Prevent coagulation problems before getting into trouble.
- Use the freshest packed RBCs to minimize the deleterious effects of the storage lesion inherent in stored packed RBCs.
- Limit crystalloids to a minimum and allow permissive hypotension with the exception of trauma to the central nervous system. Target systolic blood pressure to approximately 90 mm Hg. This will help prevent clot disruption.
- Give platelets early.
- Thawed FFP should be AB+ (universal donor) but can be A+ if the AB+ supply is depleted. Make type-specific if at all possible.

**Further Considerations: Cryoprecipitate?**

Current laboratory options for the FST do not include monitoring fibrinogen levels, so a calculated experience-based decision for the transfusion of cryoprecipitate is needed. Cryoprecipitate is a concentration of factors II (fibrinogen), VIII, and XIII, and von Willebrand factor. The use of cryoprecipitate can be justified because the deficiency of fibrinogen occurs earlier than other clotting factors and may go unnoticed in the trauma patient. An experience-based decision must be made and should be made by the anesthesia provider.

**Conclusion**

Despite the austere environment, battlefield trauma care is at the forefront of trauma care. The systems in place on the battlefield, starting with the highly skilled combat medic caring for his or her injured friends and fellow soldiers to the medics, nurses, CRNAs, and physicians in the role IV hospital, have saved countless lives. The remarkable efforts of the soldiers on the battlefield are echoed by the remarkable efforts of the healthcare providers, at all levels, to preserve the fighting force. Nurse anesthesia has been and will continue to be at the leading edge of combat anesthesia.

The principle of advanced damage control surgery and advances in anesthesia principles have provided for better
outcomes for soldiers in surgery. We advocate embracing these principles in civilian trauma protocols.

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DISCLAIMERS

The views expressed in this course are the opinions of the authors and do not reflect the official policy of the US Army, the Department of Veterans Affairs, the Department of Defense, or the US Government. The authors have made every effort to ensure the accuracy of dosages cited herein. However, as more research is being completed with the end of the wars in Iraq and Afghanistan, the field of trauma resuscitation is changing. It is the responsibility of every practitioner to consult appropriate information and sources to ascertain correct dosages and current information for each situation. This is especially important for any unfamiliar drugs, information, or protocols and procedures. The authors cannot be held responsible for this changing field of study.

DISCLOSURES

The authors have declared they have no financial relationships with any commercial interest related to the content of this activity. The authors did not discuss off-label use within the article.

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