Chapter 29

WHAT ARMY PHYSICIAN ASSISTANTS NEED TO KNOW ABOUT ELIMINATING POTENTIALLY SURVIVABLE DEATHS ON THE BATTLEFIELD

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Introduction

The diversity of the physician assistant (PA) profession in the armed forces offers opportunities for PAs to lead the way in eliminating preventable deaths on the battlefield. Army PAs are subject matter experts in the application of Tactical Combat Casualty Care (TCCC) for their assigned units, which places them in a position to impact combat medic training and the development of TCCC guidelines. During the Iraq and Afghanistan conflicts, combat casualty care evolved to dramatically improve delivery of life-saving measures to service members at the point of injury and beyond. Data collection from battlefield casualties has led to paradigm shifts in many types of battlefield care, with the ultimate goal of eliminating preventable deaths on the battlefield. The evolution and implementation of TCCC principles continues to change the definition of preventable deaths.

In a 2011 article, "Eliminating Preventable Death on the Battlefield,"[1] Kotwal et al reported the 75th Ranger Regiment's casualty survival rate from October 2001 to March 2010, which was higher than the rate for the Department of Defense as a whole. The article described the concepts the unit implemented to achieve their superior casualty survival rate: tactical leader prioritization of TCCC medical training for all unit members, tactical leader ownership of the casualty response system, and using feedback from the trauma registry to drive medical treatment protocols in the prehospital setting. This model should be thoroughly understood by all PAs, communicated to the unit leadership for implementation, and embraced by all deploying units.

Emerging capabilities in damage control resuscitation (DCR) and advanced resuscitative care (ARC), coupled with forward delivery of these interventions, are changing the definition of a potentially survivable death on the battlefield. The ability to deliver DCR and ARC interventions demonstrates great potential to improve battlefield survivability. This chapter will describe how the Army PA can continue to lead Army medicine by taking a key role in the development and execution of the use of fresh whole blood (FWB), resuscitative endovascular balloon occlusion of the aorta (REBOA), ARC, and prolonged field care (PFC).

Background of Tactical Combat Casualty Care and the Committee on Tactical Combat Casualty Care

In the final years of the 20th century, battlefield medicine was driven by advanced trauma life support (ATLS) principles.[2] While ATLS remains the standard of emergency department trauma care, it was not designed to address the most common causes of potentially preventable death on the battlefield.[3] The TCCC guidelines resulted from a 2-year study by the US Special Operations Command,[2] and the groundwork for their early adoption took place in the special operations community. Although TCCC is still evolving, the current guidelines embody the core principles of battlefield medicine as it is practiced today. In 2001, the Committee on Tactical Combat Casualty Care (CoTCCC) was formed.[4] As of 2019, the CoTCCC falls under the Joint Trauma System (JTS), has 42 members, meets biannually, and provides several updates per year. The JTS TCCC Guidelines for Medical Personnel Clinical Practice Guideline (CPG), listed in the Resources section of this chapter, provides the current TCCC recommendations.

Tactical Combat Casualty Care Phases

According to Butler et al, the goals of TCCC are to treat the casualty, prevent additional casualties, and complete the mission.[4] To accomplish these goals, there are several factors specific to TCCC and the distinct phases that must be considered, which include[4]:

1. The care team and the patient may be receiving accurate fire while care is being rendered. This requires that treatment be performed selectively at appropriate times and in a focused, deliberate, and timely manner.
2. Interventions should be focused on the leading causes of preventable death in combat: limb hemorrhage, airway obstruction, tension pneumothorax, junctional hemorrhage, and noncompressible torso hemorrhage (NCTH).
3. Evacuation times may be much longer than what is commonplace in civilian hospital systems.
4. Multiple casualties may be sustained in a single incident.
5. TCCC practitioners must often plan for and care for injuries in austere environments under adverse weather conditions.

Basic knowledge of TCCC begins with understanding the TCCC phases, defined as follows:

- **Care under fire.** Care that occurs at or close to the point of injury while the injured person and the care provider are under effective hostile fire. Equipment is generally limited to what can be carried by the medical provider. Care is limited to limb tourniquet application.[3]
- **Tactical field care.** Similar to care under fire, but there is no effective hostile fire. Medical equipment is limited to that which was brought on the mission.[3]
- **Tactical evacuation care.** Describes the care provided in both casualty evacuation (CASEVAC) and medical evacuation (MEDEVAC) scenarios. It begins with staging a casualty for evacuation and ends with delivering the casualty to the next level of care, with continual reassessment of previous interventions. Medical capability is augmented by both pre-staged equipment and personnel or dedicated medical evacuation assets and personnel.[3]

In order to understand the "why" behind the TCCC guidelines, it is important to know the data that drives the guidelines. The driving data point is the leading cause of preventable death on the battlefield.

Leading Causes of Preventable Death on the Battlefield

The leading causes of death on the battlefield as identified by Butler et al at the inception of TCCC were extremity hemorrhage, airway compromise, and tension pneumothorax.[2] More recent studies comparing data from before and after the widespread institution of TCCC training and interventions highlight a steep reduction in preventable deaths on the battlefield.[5,6] With the widespread issuance of ceramic hard plate body armor and Kevlar (DuPont) helmets and vests, injury patterns in Operation Iraqi Freedom and Operation Enduring Freedom shifted to include more extremity injuries and fewer head and torso injuries.[7] Widespread issuance of and training on tourniquets, nasopharyngeal airway adjuncts, and chest seals have served to equip battlefield first responders with the tools to address aspects of all three leading causes of preventable battlefield death.[8] Additionally, empowering 68W combat medics with the ability and training to conduct more advanced interventions, such as supraglottic airways, needle chest decompression, and in some cases cricothyrotomy, has affected causes of death far forward from even the battalion aid station.[9–11]

A further innovation has been treatment of both junctional hemorrhage and NCTH. The military has introduced junctional tourniquets and hemostatic impregnated gauze in an attempt to improve battlefield survivability of junctional hemorrhage. Unfortunately, treatment for NCTH remains difficult at Role 1. While an extended focused assessment with sonography for trauma (e-FAST) exam can assist in the decision to transport a casualty to definitive management, and tranexamic acid (TXA) and FWB can address coagulopathy and hemostasis, the mainstay of treatment for NCTH is rapid transport to surgical management.[12]

Fresh Whole Blood

The next innovation in advancing medical capabilities beyond the TCCC phases at the point of injury and Role 1 was administration of FWB (Figure 29-1). FWB entails blood recently acquired from local

Figure 29-1. Major Christopher Cordova, PA-C, conducts trauma training scenarios, incorporating TCCC principles and fresh whole blood transfusion capability, to PA students (Captain Alixandra Mackey, Lieutenant Mitchell Andreas, and Lieutenant Benjamin Williams) at the Fort Carson Medical Simulation Training Center in January 2018.
Photographs courtesy of Captain Tiffany Pittman.

volunteer donors, generally through the use of walking blood banks, in which volunteers are called en masse to donate blood for patients in hemorrhagic shock. Although cold stored whole blood is preferred over FWB because it has been prescreened and transfusions can be started immediately, it may not be available in all forward deployed locations. Army PAs are commonly deployed to remote locations without the logistical support to store whole blood or blood component products, so FWB collection from donors is likely the only blood product available in most scenarios. The blood collected through this method does not go through regulated testing; therefore, the resulting product is not approved by the Food and Drug Administration (FDA). In order to implement a successful FWB program, planning should occur well before the execution of this capability.

Use of FWB is an important capability available to frontline medical providers with the potential to prolong survivability of critically injured patients.[13] However, FWB must be employed in conjunction with other DCR principles.[14] The implementation of FWB transfusion protocols must be guided by the recommendations of Strandenes, Fisher, and JTS CPGs.[15–19] Army PAs deployed or preparing to deploy should thoroughly review these protocols. The protocols must be adapted to individual trauma teams of forward deployed units, and the tailored protocols must be repeatedly trained and implemented by the provider-led trauma team, well before the unit is deployed to a combat environment.

Implementation

FWB transfusion is currently widely implemented at most Role 1 facilities and executed at the point of injury and during air medical evacuation in combat theaters. The JTS Whole Blood Transfusion and Damage Control Resuscitation CPG, listed in the Resources section of this chapter, provides the most recent recommendations for implementation. Planning is paramount! The implementation and execution of a successful FWB protocol must be integrated well before the combat training center rotation and combat deployment. Through proper coordination, the Armed Services Blood Program (ASBP) can screen soldiers for transfusion-transmitted diseases (TTDs) and anti-A/anti-B titer less than 1:256 (low-titer group O whole blood [LTOWB]). The ASPB documents screening results in the Theater Medical Data Store (TMDS) blood module. This critical predeployment action enables faster administration of FWB at the time of need because it eliminates point-of-care (POC) blood typing for the donor and recipient.

Equipment

Upon completion of screening, the next focus is acquisition of equipment required to execute the transfusion. Blood transfusion kits or sets are available for purchase through a variety of medical companies. These products contain the items required for performing an FWB transfusion, such as blood type test kits (if blood was not prescreened), like the EldonCard (Eldon Biologicals) to test recipients and donors; blood collection bags; intravenous (IV) tubing with a filtered chamber; and typical items used to obtain IV access. PAs must also ensure possession of Standard Form 518, Blood or Blood Component Transfusion Medical Record, to properly document the medical intervention.

Blood collection bags differ from other standard IV fluid bags in their additives and anticoagulants that allow for preservation of donated blood. Each bag contains either citrate phosphate dextrose (CPD) or citrate phosphate dextrose adenine-1 (CPDA-1), which prevent blood clot formation by binding calcium in the donor's blood and thus inhibiting the coagulation pathway. CPD allows for 21 days of refrigerated storage in case an FWB donation is not utilized immediately, while CPDA-1 allows for up to 35 days of refrigerated storage.

The use of proper IV tubing, containing a micron filter, is essential to further mitigate the risk of blood clots. These administration sets filter blood and any clots that may be formed and, combined with the use of blood collection bags containing CPD or CPDA-1, significantly reduce the likelihood of clot formation and transfusion into the recipient.

Storage of blood should be avoided but is possible at room temperature up to 6 hours, after which it must be refrigerated. However, it is still considered FWB up to 48 hours after donation.[17] Blood storage devices can extend capabilities in combat missions. Portable storage devices like the Golden Minute Container and Golden Hour Medic Thermal Blood Transfer Container (both manufactured by Pelican BioThermal) are available. Storage options requiring a constant power supply may be obtained for a fixed military medical treatment facility (MTF).

Importance of Training

All medical capabilities should be rehearsed repeatedly, utilizing the most realistic scenarios possible, in order to execute the capability during a high-stress trauma situation. Executing an FWB transfusion should not be taken lightly. This capability should be rehearsed thoroughly with critical focus on the administrative details in order to avoid incorrect administration of type-specific blood.

As the primary trainers of medical skills to unit medics, Army PAs should be deeply involved in the implementation and execution of an FWB training program. Mastery of military and medical skills requires effective initial training, and continued training is required to maintain proficiency. While most procedures involved with FWB transfusion, such as initiating an IV, are baseline skills for combat medics and medical providers, regular training must be conducted to maintain confidence in equipment and personnel. To ensure optimal blood matching and avoid unnecessary hemolytic reactions for training purposes, autologous transfusions (self-to-self) are used for FWB transfusion training. This process involves drawing blood from one location of the body (such as the left antecubital fossa) and “donating” it into another location (such as the right antecubital fossa).

Training Risks and Mitigation

All training, including FWB transfusion, involves risks that should be mitigated to the fullest extent. Despite the use of autologous transfusions, risks remain. As the medical subject matter expert in their unit, the Army PA should understand and acknowledge all risks while making every effort to effectively mitigate them. The Army PA should conduct a formal risk assessment with approval of the accepted risk by the unit commander.

The most common side effect with blood donation is the onset of a vasovagal reaction (VVR).[20] In a recent military study by Donham et al, VVR occurred in less than 0.5% of participants.[20] As with most regular donor protocols, VVR can be mitigated by ensuring participants eat and drink regularly prior to donation and lie flat on a stable surface during the donation event. If a reaction occurs, the donor’s legs should be lifted above the level of their heart to optimize venous return.

A study of over 3,400 US military autologous transfusions found that besides VVR, ocular blood exposure and a minor allergic reaction (urticaria) occurred only twice and once, respectively.[20] There were no reports of anaphylaxis or major hemolytic transfusion reactions.[20]

Clinical Indication for Fresh Whole Blood Transfusion

Once population screening and equipment acquisition is complete, the Army PA is fully prepared to execute the FWB transfusion when encountering a casualty meeting the clinical indication. The clinical signs of hemorrhagic shock (decreased mentation, pulse > 120 beats per minute, absent or weak radial pulse, systolic blood pressure < 90 mm Hg), along with a mechanism of injury suggesting significant blood loss (eg, limb amputation, penetrating chest or abdominal injury) are the indications for initiation of the DCR protocol[17]: hemostasis through tourniquet use in junctional and peripheral penetrating wounds, administration of TXA within 3 hours of injury, and early blood product resuscitation.[14]

Fresh Whole Blood Tips for Success

The following are tips for success for the Army PA regarding fresh whole blood.

1. The PA must review and understand the FWB CPG produced by the JTS.[19]
2. The PA must conduct unit screening for LTOWB and TTDs 3 to 6 months prior to deployment through the ASPB or local MTF. The roster should be verified through the TMDS blood module.
3. The PA must procure necessary equipment from installation supply channels or through vendor purchase 3 to 6 months prior to deployment to perform FWB and store FWB or cold stored whole blood in austere environments as the mission conditions dictate (eg, FWB kits, Golden Minute Container or Golden Hour Medic Thermal Blood Transfer Container).
4. The PA must rehearse protocols routinely with dedicated medical staff in collective unit training exercises and in the deployed MTF. Training should include:
   a. identification of FWB transfusion indications in notion casualties;
   b. notification of prescreened population and reporting to an MTF;
   c. screening of donor and recipient with EldonCards (if needed; this may be omitted if prescreened for LTOWB and documented in TMDS);
   d. autologous (self-to-self) FWB transfusions; and
   e. proper documentation on Standard Form 518.
5. The PA must execute FWB transfusion as part of the DCR protocol when clinically indicated in an actual casualty.

Resuscitative Endovascular Balloon Occlusion of the Aorta

Almost 90% of all deaths in combat occur in the prehospital setting.[5] Of these deaths, the leading cause of potentially survivable death in combat is NCTH.[5] Army PAs may help reduce these deaths through the use of REBOA, first described by Lieutenant Colonel Carl W. Hughes during the Korean War. Hughes placed a balloon tipped catheter into two combat casualties,[21] and although he was unsuccessful in saving their lives, he surmised that early implementation would have better outcomes.[21] In recent years, the REBOA procedure has gained popularity as a means to gain distal hemorrhage control while increasing blood pressure and central aortic pressure until hemorrhage control can be achieved. REBOA consists of inserting a flexible catheter with a balloon tip through the common femoral artery into the aorta. Other than cessation of blood flow distal to the balloon, early use is believed to preserve cerebral perfusion and coronary filling in patients with life-threatening hypotension and hypovolemia secondary to hemorrhage.[22] The use of REBOA is not a definitive treatment, but rather a temporizing measure that may allow more time for a critically wounded casualty to receive surgical care.

Considerations for Use

REBOA insertion requires appropriate training to ensure successful implementation and use in the prehospital setting, and there is still considerable concern about the benefit and safety of prehospital REBOA placement. A statement released by the American College of Surgeons Committee on Trauma, the American College of Emergency Physicians, the National Association of Emergency Medical Services Physicians, and the National Association of Emergency Medical Technicians considered the use of REBOA in the prehospital setting inappropriate, but did not make recommendations regarding the military use of REBOA.[23] Military providers must consider who is best prepared and at what level of care this procedure should be implemented. As of 2019, Role 2 is the first level of care in which REBOA is being performed, with or without a forward surgical team (FST). Role 2 has patient resuscitation capability, accessibility to various blood products (stored or via a walking blood bank), and the ability to surgically stabilize patients when collocated with an FST element. However, with the availability of training designed for the non-surgeons and providers without critical care training, improved tools including POC ultrasound and the ER-REBOA (Prytime Medical), and changing protocols, it is feasible to use REBOA at a Role 1 facility and even at the point of injury. REBOA use and implementation are currently addressed in greater detail by the JTS Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) for Hemorrhagic Shock CPG.[24]

Anatomy

The REBOA balloon is inflated at specific areas of the aorta to achieve desired hemorrhage control based on injury location. The aorta is divided into three zones[25]:

Zone I begins at the commencement of the left subclavian artery and extends to the celiac trunk.
Zone II begins at the celiac trunk and extends to the lowest renal artery.
Zone III begins at the lowest renal artery and ends at the bifurcation.

To impede bleeding resulting from abdominal injuries, REBOA should be placed into zone I; when trying to prevent bleeding resulting from pelvic trauma, the balloon should be inserted into zone III (however, insertion into zone III is not recommended in the prehospital setting). Zone II is the paravisceral aorta and generally accepted as a no-go zone.

Indications

REBOA offers a less invasive alternative than emergent resuscitative thoracotomy (ERT) for controlling NCTH in patients at risk for imminent cardiovascular collapse.[26] Patients with abdominal, pelvic, or junctional lower extremity bleeding are likely to benefit if hemorrhagic shock is recognized early. Precise indications for REBOA are not well studied; however, the REBOA CPG from the JTS recommends use for patients with[24]:

- blunt trauma with no major chest bleeding (negative chest radiograph, ultrasound, or bilateral chest tubes);
- a positive abdominal e-FAST exam;
- penetrating trauma to the abdomen or pelvis;
- pelvic fracture; or
- massive proximal lower extremity hemorrhage with signs of impending cardiovascular compromise (Figure 29-2).

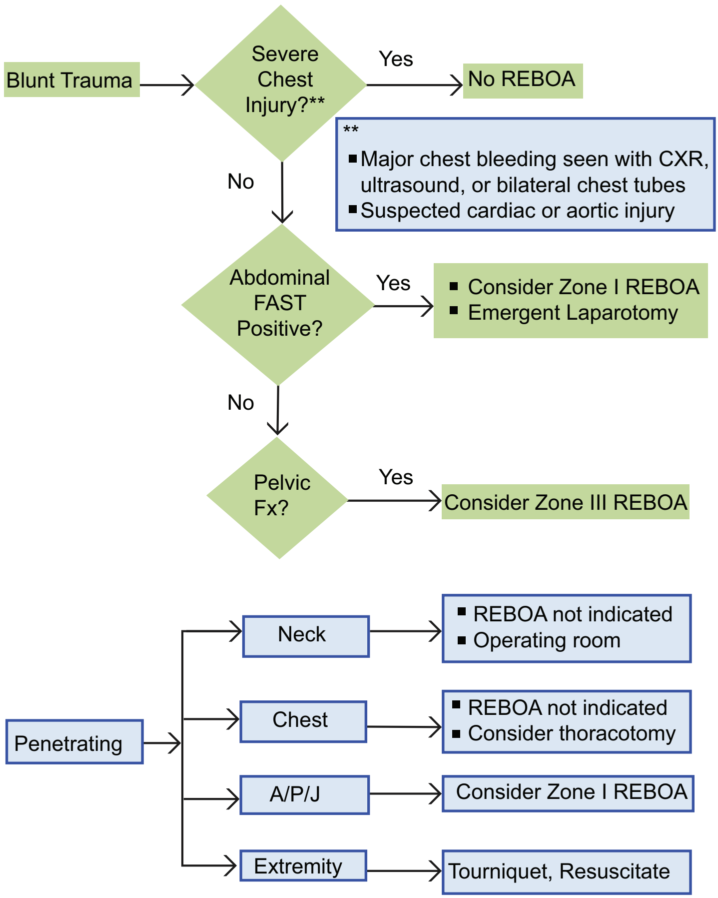

Figure 29-2. REBOA algorithm proposed by the Joint Trauma System.
A/P/J: abdominal/pelvic/junctional
CXR: chest x-ray
Fx: fracture

A more simplified approach is provided by the Committee on TCCC's ARC guidelines, which recommend use on patients with[27]:

- an injury pattern that suggests abdominopelvic non-compressible hemorrhage;

- systolic blood pressure < 90 mmHg; and
- an unsatisfactory response to the first unit of whole blood.

REBOA should not be used without proper resuscitation. The use of REBOA is still a controversial procedure and without a clear benefit for prehospital use.[28] However, combat death is a compelling motivator to implement programs and procedures that may have an unclear benefit, and REBOA may provide the temporary measure that allows adequate time to deliver severely wounded patients to a surgical capability.

Contraindications

Avoid REBOA in patients with thoracic trauma or hemorrhage.[26] These injuries should be ruled out using chest x-ray, thoracic ultrasound, or bilateral simple or tube thoracostomy. Careful planning should be done before the use of REBOA to ensure the availability of surgical resources for more definitive management.

There may be short-term and long-term sequelae to areas of the body not receiving blood flow during REBOA balloon inflation. Complications from REBOA include mesenteric ischemia and ischemia of the lower extremities; also, deployment of REBOA in thoracic aortic injury could increase hemorrhage and make the injury worse.[29] However, when compared to the more invasive emergent resuscitative thoracotomy (ERT) with aortic cross-clamping, the REBOA may be a safer and more feasible option for the Role 1 provider. ERT has its own set of complications and sequelae in addition to those outlined for REBOA; however, a detailed description of ERT is beyond the scope of a PA's practice.

Equipment and Placement

The majority of the equipment required to perform REBOA safely in the prehospital environment is available through the military logistical system. Obtaining an ultrasound may be more difficult, and PAs should purchase a handheld ultrasound device, either with unit funds or on their own. Handheld ultrasound devices are beneficial not only for use in the ARC setting, but also as a tool in the clinic.

The ER-REBOA device consists of a curled distal tip (P-tip [Prytime Medical]) and a compliant occlusion balloon. The catheter contains two lumens that run the length of the catheter and connect to extension lines with stopcocks. The balloon lumen is used to inflate and deflate the balloon. The arterial line lumen is used to monitor blood pressure. A peel-away sheath is pre-loaded on the catheter shaft to ease insertion of the catheter's P-tip into an introducer sheath hemostasis valve. The JTS Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) for Hemorrhagic Shock CPG, listed in the Resources section of this chapter, outlines a six-step process for successful REBOA employment.[24] It also lists standard equipment needed for REBOA placement.

Initial Training

The Basic Endovascular Skills for Trauma (BEST) course at the University of Maryland's R. Adams Cowley Shock Trauma Center was the first to offer training in the use of REBOA. This training was initially for surgeons and critical care fellowship-trained emergency medicine physicians. In 2015, a physician, a PA, and a Special Operations Combat Medic (SOCM) not trained in critical care attended the BEST course as a pilot project to evaluate the possibility of performing the procedure in the prehospital setting.[30] When the ER-REBOA catheter became FDA approved, the ability to train PAs and enlisted medical personnel became more feasible. This device decreased the number of steps required to access the common femoral artery and place a REBOA catheter. Currently, the Army and the American College of Surgeons both have REBOA training programs. Additionally, the Resuscitation Adjuncts: Prehospital Transfusion & REBOA (RAPToR) course (https://www.raptocourse.com/) is specifically designed for prehospital implementation of REBOA. The 2-day course provides REBOA and FWB training in the context of ARC. The RAPToR course is sponsored by Combat Medical and Prytime Medical, and is recognized by the CoTCCC as a training option.

Sustainment Training

The military tends to offer initial training that meets standards, but often fails to offer suitable sustainment training in a quality manner. Many medical officers assigned to maneuver units have difficulties maintaining currency in various skills because of many factors, including finding time for appropriate health care coverage for their units and time to attend courses. While it is not critical for Army PAs to maintain the skill required to perform REBOA during a training cycle, it is important to attend a training course at least 60 days prior to deployment. There are several options that could allow the Army PA to successfully employ the skills required for REBOA. The most useful is training with the perfused cadaver model.[31] (Cadavers can be used for training multiple skills beyond REBOA. The use of cadavers also eliminates hospital intrusion.)

Live tissue training (LTT) is another option for sustainment training. However, any LTT requires approval from an Institutional Animal Care and Use Committee (some units have an animal use committee within their major command; others may have to check with their local MTF). The swine is the patient model of choice for REBOA sustainment training. Recently, Borger van der Burg et al described a method that allows for multiple attempts at gaining access using a swine model and placing a silicone tube next to the common femoral artery.[32]

Other sustainment options include working with the local MTF to perform arterial access, which can be as simple as ultrasound-guided radial artery access. Other options include establishing memoranda of agreement with civilian hospitals that currently use REBOA or conducting sustainment training with the Simulation Trainer for Arterial Access and REBOA (STAAR) (Prytime Medical).

Advanced Resuscitative Care/Advanced Resuscitative Care Teams

FWB transfusion and REBOA comprise the evolving concept of ARC. ARC is a momentous update to TCCC that may provide further opportunity for PAs to play a key role in reducing battlefield fatalities from exsanguination. Although TCCC has saved numerous lives since its inception in 1996, it arguably did not address the most lethal of battlefield injuries—NCTH. In an evaluation of over 4,596 battlefield fatalities from 2001 to 2011, Eastridge et al found that 87.3% of casualties die before reaching a surgeon.[5] Of these fatalities, 67% were due to NCTH (Figure 29-3).[5] This landmark study reinforced the need for a modality to address the potentially preventable deaths caused by NCTH in the prehospital setting. ARC is a concept within TCCC that specifically addresses the need to control NCTH in prehospital

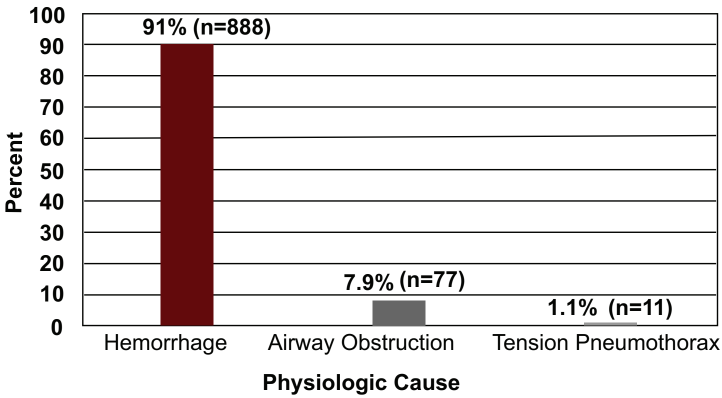

Figure 29-3. Data demonstrating non-compressible torso hemorrhage as the leading cause of death on the battlefield.
Reproduced with permission from: Eastridge BJ, Mabry RL, Seguin P, et al. Death on the battlefield (2001–2011): Implications for the future of combat casualty care. *J Trauma*. 2012;73(6 Suppl 5):S431–S437. https://journals.lww.com/jtrauma/pages/default.aspx

and Role 1 settings. ARC interventions include early and aggressive DCR with whole blood transfusions and use of the REBOA (see Figure 29-3).

Advanced Resuscitative Care Team

ARC is not meant to be performed by lone combat medical personnel, regardless of their skill level. Rather, ARC is specifically designed to be executed by an identified, well-trained, and properly equipped team. Ideally, the ARC team is composed of three or four members. The team who performs REBOA should have obtained initial training at a recognized REBOA training course and maintained their skill through an accepted means (cadaver, LTT, or STAAR).[27]

However, the official composition of teams performing ARC is yet to be determined. In the meantime, the team leader should delegate the multiple required tasks. The ARC team executes nine specific tasks: (1) ensure an adequate airway, (2) electronically monitor vital signs,

(3) establish IV or intraosseous access, (4) prepare and infuse blood products, (5) insert e-FAST and bilateral chest tubes, (6) establish common femoral artery access, (7) prepare the REBOA site, (8) perform the REBOA procedure, and (9) record the events that occur during resuscitation.[27]

As the primary medical trainer and the medical officer with the most continuity for the unit, the Army PA should lead the ARC team. PAs should seek out the appropriate training and be ready to execute this advanced resuscitative measure at the Role 1 or at the point of injury.

Training the Advanced Resuscitative Care Team

Because the ARC team is required to perform multiple tasks in a rapid and proficient manner, it is critical that the team is competent in the above listed skill sets, with particular emphasis on performing the REBOA procedure. Ideally, the ARC team would establish a baseline competency at a training course, then continue to sustain skill sets through ongoing experience with trauma patients, simulation training, or perfused cadaver-based training. At this time, there are multiple venues that can provide training in ARC: the Air Force Center for the Sustainment of Trauma and Readiness Skills (C-STARS) program, the Army Trauma Training Course, and military and civilian trauma training centers (with local training agreements).[27] As discussed above, the Army and the American College of Surgeons both have REBOA training programs. ARC was recently approved by the CoTCCC as a new component of TCCC. "TCCC Skill Sets by Responder Level,"[33] published in April 2019 by JTS and CoTCCC, includes the specific skill set that should be performed by TCCC ARC teams.[33] Although resources for ARC training are available, the CoTCCC is developing a specific ARC curriculum going forward.[34]

Unfortunately, not all casualty situations will be resolved with TCCC, DCR, and ARC due to constraints in medical evacuation or mission requirements. Therefore, Army PAs should be aware of and able to execute the principles of PFC.

Prolonged Field Care

In 2008, then Secretary of Defense Robert Gates issued a mandate that all military medical evacuation to a surgeon must occur in less than

60 minutes.[35] Although this has led to the lowest mortality rate of any conflict, providers cannot rely on 1-hour evacuations in current and future operations, and providers must plan for care over hours and even days. It should be noted, however, that findings by both Kotwal and Howard found it was not just rapid evacuation that decreased mortality, but also the ability to provide faster advanced care to the casualty.[35,36]

PFC is defined as "field medical care, applied beyond 'doctrinal planning time-lines' by a SOCM (Special Operations Combat Medic) or higher, in order to decrease patient mortality and morbidity. It utilizes limited resources and is sustained until the patient arrives at an appropriate level of care."[37] PFC was developed and became a focus of interest over the last decade in special operations and conventional forces due to the changes in deployed operations into more austere prehospital environments (Figure 29-4). PFC is an ongoing process that starts once the patient has been stabilized after initial presentation, whether in a trauma or a medical setting. It encompasses the best practices of TCCC, DCR, and continuous, assertive nursing care, and is broken down into 10 core principles. These principles have corresponding CPGs to explain and universalize medical practice (provided at www.prolongedfieldcare.org, with links to numerous articles and position papers covering the development, training, and implementation of PFC[38,39]). The JTS PFC CPGs, listed in the Resources section of this chapter, provide current recommendations on analgesia sedation management, burn management, crush syndrome, DCR, documentation, nursing care, ocular injuries, traumatic brain injury, and wound management.

Ten Core Principles of Prolonged Field Care

1. Trending vitals and documentation.
2. Resuscitation using blood products.
3. Ventilation and oxygenation.
4. Airway control.
5. Pain control.
6. Continued monitoring for potential complications.
7. Aggressive nursing care.
8. Surgical procedures (ARC).
9. Telemedicine.
10. Documentation and evacuation.[38]

Figure 29-4. Captain Megan Smith, PA-C, with medics and soldiers at Mosul Dam, Iraq, May 2019. The unit conducted base defense drills incorporating a mass casualty exercise including evacuation of casualties from the perimeter to the Role 1. The focus was working as a team on a trauma bed with minimal medics and a single PA. The closest aeromedical evacuation asset was 1.5 hours away. The training was focused on prolonged field care and advancing 68W skills to increase medical capabilities.
Photograph courtesy of Staff Sergeant Ronald Monsen.

Training

PFC encompasses a wide spectrum of medical skills, and units may be challenged to prepare and train for situations requiring PFC skills. Situations requiring PFC can happen during stateside training events, in combat, in humanitarian deployments, and even on vacation, so it is necessary to be as prepared as possible. Limited time and resources may be obstacles, but there is no substitute for hands-on training in all components of PFC. The first things to consider are what objectives need to be accomplished to acquire a good working knowledge of PFC components. The training should be well thought out and structured to ensure all members of the team are proficient in the smallest of tasks prior to a culminating event. A short-term train-up will not sufficiently prepare a medical team to be prepared for managing a real-world PFC scenario.

Role of the Physician Assistant in Prolonged Field Care

Army PAs have a high probability of being assigned to an austere environment with limited medical resources, where they are the senior medical provider with a small team of medics. Part of a battalion PA's job is to train the medics assigned to them. Training medics to work as team is as important as training them to be competent in all medical tasks in the scope of practice. The medic team is the PA's best asset in PFC situations. PAs must therefore understand how to optimally care for a casualty if placed in a PFC scenario, and they must also understand the limitations of PFC. PAs should maintain their skills by attending medical courses that advance their capabilities; however, employing life-saving techniques on patients will always surpass simulations. The PA should be proactive in this approach by utilizing local civilian trauma centers, most of which have medical training agreements in place with MTFs that are established by MTF commanders.

Conclusion

Eliminating potentially preventable deaths on the battlefield will always be a dynamic process. As forward medical capabilities improve, the leading cause of death on the battlefield will change. However, the role of the Army PA will remain constant—implementing current medical capabilities to treat combat casualties on the front lines of the battlefield. With the implementation of FWB transfusion, REBOA, ARC, and PFC on the battlefield, the Army PA must remain educated and knowledgeable about the JTS CPGs for each of these disciplines. It is the responsibility of the Army PA to train the medical team through rehearsals that implement novel capabilities on the battlefield—well before the combat deployment. Employment of these principles will continue to reduce potentially preventable deaths on the battlefield.

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Additional Sources

- The CoTCCC's official website is https://www.deployedmedicine.com, and the mobile phone app is Deployed Medicine. These TCCC resources offer updates, background and supporting evidence, videos, JTS podcast information, and more.
- JTS CPGs: for TCCC, DCR, FWB, and REBOA are found at the links below.
  - TCCC Guidelines for Medical Personnel: https:/jts.amedd.army.mil/assets/docs/cpgs/Prehospital_En_Route_CPGs/Tactical_Combat_Casualty_Care_Guidelines_01_Aug_2019.pdf
  - Damage Control Resuscitation (CPG ID: 18): https://jts.amedd.army.mil/assets/docs/cpgs/JTS_Clinical_Practice_Guidelines_(CPGs)/Damage_Control_Resuscitation_12_Jul_2019_ID18.pdf
  - Whole Blood Transfusion (CPG ID: 21): https://jts.amedd.army.mil/assets/docs/cpgs/JTS_Clinical_Practice_Guidelines_(CPGs)/Whole_Blood_Transfusion_15_May_2018_ID21.pdf
  - Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) for Hemorrhagic Shock (CPG ID: 38): https://jts.amedd.army.mil/assets/docs/cpgs/JTS_Clinical_Practice_Guidelines_(CPGs)/REBOA_%20Hemorrhagic%20Shock_06_Jul_2017_ID38.pdf
- JTS CPGs for the numerous PFC subcategories are found under the "Prehospital/En Route CPGs" header at https://jts.amedd.army.mil/index.cfm/PI_CPGs/cpgs
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