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CONCEPTS

Trauma

A framework for the design and implementation of Stop the Bleed and public access trauma equipment programs

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Abstract

Traumatic injuries remain the leading cause of death for those under the age of 44 years old. Nearly a third of those who die from trauma do so from bleeding. Reducing death from severe bleeding requires training in the recognition and treatment of life-threatening bleeding, as well as programs to ensure immediate access to bleeding control resources. The Stop the Bleed (STB) initiative seeks to educate and empower people to be immediate responders and provide control of life-threatening bleeding until emergency medical services arrive. Well-planned and implemented STB programs will help ensure program effectiveness, minimize variability, and provide long-term sustainment. Comprehensive STB programs foster consistency, promote access to bleeding control education, contain a framework to guide the acquisition and placement of equipment, and promote the use of these resources at the time of a bleeding emergency. We leveraged the expertise and experience of the Stop the Bleed Education Consortium to create a resource document to help inform and guide STB program developers and implementers on the key areas for consideration when crafting strategy. These areas include (1) equipment selection, (2) logistics and kit placement, (3) educational program accessibility and implementation, and (4) program oversight, facilitation, and administration.

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1 | INTRODUCTION

Traumatic injuries remain the leading cause of death for people under the age of 44 years old.[1] Injuries from motor vehicle crashes, workplace mishaps, and a multitude of other events can result in severe bleeding.[2] Uncontrolled hemorrhage represents the single biggest cause of preventable death in trauma, responsible for up to 40% of trauma mortality; 33%–56% of these deaths occur in the prehospital period.[3,4] Immediate postinjury care requires training in the recognition and treatment of life-threatening bleeding, as well as access to bleeding control equipment. The Stop the Bleed (STB) initiative empowers laypersons to perform control of life-threatening bleeding and seeks to expand access to bleeding control equipment.[5–8] Since its introduction in 2015, over 1,500,000 people have been trained in STB. Bleeding control equipment has been placed in airports, stadiums, businesses, schools, and other locations.[9] A proliferation of STB programs has begun to emerge. These programs vary greatly in content, scope, and deployment strategy.[10,11]

In 2016, the Stop the Bleed Education Consortium (SBEC), based out of the Uniformed Services University, convened experts from government, academia, and non-profit organizations to help develop STB educational programming, innovation, and scaling.[12] SBEC members have collaborated on multiple scholarly and educational activities related to studying topics directly related to further enhancing STB education and program implementation. A comprehensive bleeding control program should include considerations of equipment selection; logistics and kit placement; educational program accessibility and implementation; and program oversight, facilitation, and administration (Table 1). Please note that the numbering of the following lists does not necessarily reflect a weighted priority.

2 | BACKGROUND

Military experience demonstrated that immediate control of prehospital bleeding can decrease morbidity and mortality.[13–15] After the mass shooting at Sandy Hook Elementary School in 2012, the American College of Surgeons convened a group to address the issue of providing immediate life-saving care.[1,4,16] Known as the Hartford Consensus, these best-practice recommendations called to educate and equip the public with techniques of appropriate control of life-threatening bleeding. Soon thereafter, the National Security Council expanded the concept into a national initiative called STB.[4,5] Tourniquets are now recommended as the initial first aid management step for people with life-threatening extremity hemorrhage.[17] Those efforts have also yielded improvements in emergency medical services (EMS) and first responder clinical care protocols.[18–20] Despite these improvements, EMS response times average 7 min from a 911 call to scene arrival, with median times increasing to 14 min in rural areas.[21] During this time frame, uncontrolled life-threatening hemorrhage can cause a patient's condition to significantly worsen or possibly prove fatal.[22,23]

A growing body of literature has shown the safety and impact of prehospital tourniquets.[24,25] Smith et al found that prehospital tourniquets were safely used to control bleeding in major extremity penetrating trauma without increased risk of major complications and were also associated with increased systolic blood pressure on arrival to the emergency department, decreased blood product use, and decreased incidence of limb-related complications.[26] Bonk et al reviewed autopsy records and estimated 235 isolated extremity injury-related deaths could be prevented and an additional estimated 4354 concurrent extremity and central injury-related deaths could potentially receive enhanced care with early tourniquet placement.[27] Goolsby et al found this number to be up to 480 isolated extremity deaths prevented in a similar type of analysis.[28] Teixiera et al found that civilian prehospital tourniquet application was independently associated with a 6-fold mortality reduction in patients with peripheral vascular injuries.

3 | EQUIPMENT SELECTION

Program considerations should address the minimal contents and quantities for bleeding control kits.

A. **Bleeding control kits**. Bleeding control kits may be referred to as Individual First Aid Kits (IFAKs), STB Kits, Bleeding Control Kits, Trauma Kits, etc. Kits are available that contain varying equipment, quantities of supply, and configuration. Equipment should be acquired from reputable medical vendors, as incidents of defective, counterfeit, equipment have been reported.[29] Individual kit costs often start at around $100, and increase based on the quantities of bleeding control supplies contained, with larger kits costing between $800–$1200. Bleeding control programs should include standardized kits that include the following:

1. **Wound management supplies**. Gauze dressings, including hemostatic gauze, when possible, should be included. Dressings can be placed over the wound while providing manual pressure or packed directly into bleeding wounds. Hemostatic dressings contain compounds which promote the clotting of blood, and facilitate timely control of bleeding.[30–33] Although they work more effectively, hemostatic dressings are more costly and have an expiration date. We recommend hemostatic gauze be included in public access kits, unless precluded by funding or other implementation barriers, in which case standard gauze should be included. Other types of non-gauze hemostatic dressings, such as rapidly expandable miniature sponges, are also effective. Compression-type pressure dressings may also be included as adjunctive treatments to allow for pressure to be maintained.
2. **Tourniquet**. Many types of tourniquets (TQs) are available and marketed to the public, although limited information/research exists on the ease of use for laypersons. As of the writing of this manuscript, there is no standardized evaluation process before introduction to the public. Variable efficacy of tourniquets has

TABLE 1 Public access bleeding control program implementation considerations quick reference

Bleeding control kit contents
Gauze (hemostatic gauze is preferred)
Pressure dressings
Commercial tourniquet (CoTCCC approved TQ is recommended)
Latex-free medical gloves
Just-in-time instructions (from reputable source)
Trauma shears
Bleeding control kit packaging
Packaging is clearly labeled
Obtain free DOD license for use of Stop the Bleed logo
Packages are easy to open
Cabinet mounting systems are compliant with local code requirements
Optional additional equipment
Medical tape
Permanent marker
Vented chest seal
Hypothermia blanket
Nasal airway
Kit placement considerations
Conduct a hazards vulnerability assessment to determine kit placement
For areas of large gatherings, consider being able to care for up to 20 victims
Consider co-locating kits with automated external defibrillators
Areas where traumatic injuries are likely to occur
Clearly labeled signage
Identification of kit locations in a database
Public safety individual kits
Standardization/parity of equipment (type of tourniquet, etc)
Consider streamlined supply/resupply processes
Educational programs
Selection of bleeding control education program curriculum
Identify the group(s) responsible for public bleeding control education in the community
Courses should teach content consistent with SBEC guidelines that ideally include hands on components
Consider training collaborations with local EMS, trauma centers and service organizations
Ensure consistency between training programs and the contents of local kits
Program oversight and administration
Identify a lead agency for bleeding control program coordination
Ensure compliance with local/state regulatory requirements, including possible need for medical direction
Designate the individual(s) responsible for routine equipment checks and resupply
Be familiar with the state's Good Samaritan laws as they relate to bleeding control
Funding opportunities (both public and private) should be sought for program initiation and sustainment
Bleeding control kit use, and program impact should be monitored and periodically reviewed

[a]Quantities may vary by program.

Abbreviations: CoTCCC, Committee for Tactical Combat Casualty Care; DOD, Department of Defense; EMS, emergency medical services; SBEC, Stop the Bleed Education Consortium; TQ, tourniquet.

been demonstrated.[34] We recommend using the US Military's Committee for Tactical Combat Casualty Care's (CoTCCC) report on tourniquet testing to inform TQ selection.[35] In general, the most consistently effective tourniquets are commercially manufactured. Currently, the most well-studied tourniquets include a windlass-rod mechanism to provide and maintain the pressure necessary for effective bleeding control.[36] Most windlass TQs cost between $20–$30 each. However, the CoTCCC also recommends other tourniquet designs as effective for bleeding control.[20]

B. **Support equipment** will help enable and ensure safe and successful equipment use.

1. **Protective gloves**: Multiple pairs of latex-free medical gloves will allow for multiple rescuers and for the changing of soiled gloves.
2. **Just-in-Time instructions**: Studies have demonstrated improved success of tourniquet application by laypeople when using Just-in-Time (JIT) instructions.[37–39] However, there is variability in the quality of JIT instructions as well as research studies designed to test them.[40] JIT instructions from credible first aid education entities, and preferably those that have demonstrated effectiveness, should be used. JIT instructions can help mitigate the effects of loss of skills due to knowledge decay and help more broadly scale messaging to the public. In addition, the incorporation of quick-reference codes on the JIT instructions can provide access to more detailed information. Examples of JIT bleeding control instructions can be found on the Uniformed Services University[41] and American College of Surgeons[42] STB websites.
3. **Scissors**: Also known as "trauma shears" can help cut away clothing to reveal the source of life-threatening bleeding.
4. **Storage and housing of equipment**: Many types of holders, bags, and containers and cabinets are available. Individual kits contain equipment and supplies for one victim, whereas larger cabinets placed strategically can contain equipment for multiple patients. Storage systems should be clearly labeled, if possible, with the STB wording and mark (this requires licensure by the US Department of Defense).[43] If contents are stored in vacuum sealed packages, the packages should be easy to open. Such cabinets should be installed in easily accessible places and comply with building code requirements and American Disabilities Act.

Additional potentially life-sustaining trauma equipment. Medical tape and a permanent ink marker can also be included. In addition, it *may* be reasonable to consider adding additional equipment to make a "comprehensive trauma kit" that can address several other time-critical traumatic injuries beyond severe bleeding. This includes a vented chest seal, hypothermia blanket, and a nasal airway. Appropriate use of the additional equipment requires additional training and added expense. However, this additional equipment is often nominal in cost ($15–$20) and can be beneficial, particularly for use by off-duty medically trained personnel who, if on scene, can provide time-critical interventions before EMS arrival.

4 | LOGISTICS AND KIT PLACEMENT

STB programs should address the appropriate placement of kits, as well as designation of the responsible authority for kit maintenance and equipment resupply and replacement.

A. **Public access kits, placement, numbers, and equipment quantities**.

1. There has been relatively little scientific guidance on appropriate kit placement and minimal quantities of kits. The most robust of such analysis to date concluded that for sites with large numbers of persons, it is reasonable to have the capability of immediately treating a minimum of 20 bleeding victims.[44] Practically, we suggest this to be 20 tourniquets, 40 gauze rolls and pressure dressings, as well as support equipment (gloves, etc).
2. Place bleeding control kits in a variety of locations, both public and private, that may most benefit from the bleeding control kits. Similar to automated external defibrillators (AED) placement for treatment of sudden cardiac arrest, many programs place bleeding control kits adjacent to AEDs in public venues like airports, convention centers, malls, etc.[1,17] It is also reasonable to place equipment in areas (industrial areas, machine shops, etc) where traumatic injuries are possible or likely.[45,46]
3. Emergency planners can assist with hazard vulnerability assessments (a risk and threat assessment) that include the number of people that could occupy potential venues and the most likely location of injured casualties. This will help inform decisions about optimal kit placement within a structure. For example, a large high school, with multiple areas for a mass gathering (including an auditorium, gymnasium, and cafeteria), might benefit from kits at a central location or the preplacement of kits at a determined distancing between these high-occupancy areas. With regard to schools and, specifically young children, certain windlass tourniquets have been shown to be effective on children as young as 2 years of age with a minimal limb circumference of at least 13 cm.[46] There is no lower age/size cutoff for hemostatic gauze or pressure dressings.
4. Kit placement should also include clear signage for easy identification. The location of kits should be included in emergency response plans. Similar to the placement of AEDs, the locations of public accessible kits should be submitted to an online database for inclusion in mapping apps and in public safety Emergency Communications Centers databases.

B. **Public safety individually issued kits**. Many public safety (law enforcement, fire service, EMS) agencies provide individual kits to their personnel. Those kits typically contain equipment to treat a single patient.

1. If such kits are already in place in the community, it is reasonable to attempt to harmonize the equipment and contents (for example, tourniquet types) between existing public safety individually issued kits and public access kits.

2. Opportunity may exist to build upon existing supply chain processes used for public safety kits for supporting public access programs. This allows for improved training and interoperability of equipment by multiple users.

5 | EDUCATIONAL EFFORTS

Including educational and training programs will help increase the number of people trained in the control of life-threatening bleeding.

Educational efforts. Several bleeding control training curricula and educational programs exist. [20,47,48] Consistent with SBEC guidelines, at minimum, courses should teach the identification of life-threatening bleeding and the bleeding control techniques. Practical, hands-on practice of the equipment and techniques are highly encouraged.[49,51,52]

1. Consider designating an educational and training program lead agency or organization. Examples of organizations that have taken the lead for training in their communities include EMS agencies, local trauma centers, non-profits, faith-based organizations, and other service organizations.
2. Bleeding control education should be included as part of other existing training programs: first aid courses, cardiopulmonary resuscitation (CPR) courses, life-saving courses, etc. High school age students have successfully demonstrated being able to learn bleeding control techniques.[53–54]
3. Specific populations should also be targeted for bleeding control education: public safety personnel, security personnel at large event venues, industrial and construction workers, anyone taught CPR, and high school students.
4. Due to the variety of commercial tourniquets available, we recommend that a given community's training program include familiarization with the type of equipment contained in that community's bleeding control kits. Equipment provided and purchased should align with educational programs and vice versa.[55,56]

6 | PROGRAM OVERSIGHT, FACILITATION, AND ADMINISTRATION

Ensure that issues related to program oversight, facilitation and sustainment, and evaluation of program effectiveness are addressed to ensure program success and sustainment:

A. **Program oversight**. A lead organization/agency should be identified as coordinating entity for a community's bleeding control program. As appropriate and stipulated by local or state regulations, system-wide or community bleeding control programs may need to include the designation of a physician medical director. Medical directors are typically responsible for reviewing, approving, and overseeing medical programs. Certain types of equipment (such as hemostatic gauze) may require purchase under a physician's license. Additional state and local rules and regulations (such as state EMS agency involvement) should also be considered.
B. **Legislation**. The American College of Surgeons offers model legislation for bleeding control programs.[57] Examples of states with legislative actions related to bleeding control programs include Arkansas, California, Georgia, Indiana, Massachusetts, North Carolina, South Carolina, and Texas.[58,59]
C. **Maintenance requirements**. Routine checks of equipment contents and integrity, as well as systems of accountability, asset tracking and resupply mechanisms should be included in program design. Although the shelf life of most supplies and equipment in these kits is undated, hemostatic dressings have shelf lives that require tracking for expiration date and replacement. Further, kits should be routinely checked on a regular, established, basis to monitor for unrecognized use, tampering, and degradation due to environmental exposure. After use of a kit, the entire kit contents should be decontaminated (as necessary), inventoried, and resupplied.
D. **Liability and Good Samaritan considerations**. As with other types of life-saving response (eg, CPR, naloxone administration), Good Samaritan protection should extend for bleeding control events, as are afforded for CPR and life-saving first aid measures. Bleeding control programs should be familiar with the applicable Good Samaritan laws in their state, as in some cases, current laws may include bleeding control.[60] Texas, Indiana, and Massachusetts have included liability protections in their enacted bleeding control legislation.[59,61,62]
E. **Funding and program sustainment**. Equipment costs will vary based upon program scope and scale. For example, the placement of bleeding control kits on the campus of Johns Hopkins University cost approximately $9500 in initial equipment.[63] A very large, multilayered program implementation in western and central Pennsylvania included kits for over 1000 public school buildings as well as tourniquets for 8000 law enforcement officers, which was made possible with multiple funding sources totaling over $1.4 million.[64] Funding opportunities should be sought to establish and expand training initiatives, equipment acquisition, and program sustainment. State and local governments, as well as professional organizations, emergency preparedness, EMS, and trauma systems are all potential funding sources. Partnerships with both private entities, large event venues, philanthropic sources, faith-based groups, and civic organizations can also be explored.
F. **Measurement of program impact**. Information on bleeding control kit use should be monitored and periodically reviewed by the program leadership to help evaluate program effectiveness, and guide further program evolution. Bystander bleeding control interventions should be incorporated into trauma registries and injury databases similar to how bystander CPR efforts are incorporated into the Cardiac Arrest Registry to Enhance Survival.[65]

7 | SUMMARY

Uncontrolled bleeding is a major cause of preventable death in trauma. Well-designed and implemented bleeding control programs

improve the likelihood of appropriate care being delivered to victims of life-threatenening bleeding by allowing immediate responders to promptly aid. Comprehensive public access bleeding control programs will help ensure consistency and uniformity in program implementation, improve access to bleeding control education, serve to guide the acquisition and placement of equipment, and promote the use of these resources at time of a bleeding emergency. Future opportunities exist to study the longitudinal impact of public bleeding control programs on a multitude of topics including program implementation, bleeding control knowledge, skill degradation, program effects on community readiness, patient outcomes, and the incorporation of bystander bleeding control efforts into prehospital and trauma data registries.

CONFLICT OF INTEREST

Matthew J. Levy is the non-compensated chairperson of the non-profit Stop the Bleed Coalition. Craig A. Goolsby has a patent pending for "tourniquet and method of use." The remaining authors have no conflicts of interest relevant to this article to disclose.

DISCLAIMER

This article is the opinions of the author and does not reflect the official policy or position of the Uniformed Services University, Defense Department, or US Government.

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