Surgery 165 (2019) 795–801

Contents lists available at ScienceDirect

Surgery

journal homepage: www.elsevier.com/locate/surg

Building community resilience: A scalable model for hemorrhage-control training at a mass gathering site, using the RE-AIM framework ☆

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ARTICLE INFO

Article history:
Accepted 1 October 2018
Available online 10 November 2018

ABSTRACT

Background: In a decade, the US military reduced deaths from uncontrolled bleeding on the battlefield by 67%. This success, coupled with an increased incidence of mass shootings in the US, has led to multiple initiatives intent on translating hemorrhage-control readiness to the civilian sector. However, the best method to achieve widespread population-level hemorrhage-control readiness for civilians has not yet been elucidated. This study evaluates the implementation of American College of Surgeons Bleeding Control training at a National Football League stadium as a prospective model for general mass gathering site implementation.

Methods: The American College of Surgeons' Bleeding Control Basic layperson hemorrhage-control training was implemented at Gillette Stadium in Massachusetts. The five domains are as follows: reach (demographics of study participants), effectiveness (correct tourniquet application after intervention), adoption (investigator, leadership, and participant efforts for sustainability of intervention), implementation (course details), and maintenance (correct tourniquet application at retention testing at 3 to 9 months).

Results: A total of 562 employees were included in the study. Of those included employees, 58.7% reported having taken first-aid training and 17.3% reported having taken hemorrhage-control training. There was an increased mean likelihood to help (4.39 vs 4.09, $P < .01$) and comfort level to control hemorrhage (4.26 vs 3.60, $P < .01$) after training compared with before training, on a Likert scale (1–5). The stadium operations team located hemorrhage control kits with automatic external defibrillators, integrated layperson immediate-response awareness into its Web site, and developed a public safety announcement. The training, performed by physicians, nurses, and emergency medical technicians, consisted of a 30-minute lecture and a 30-minute hands-on skills-training course, with a class size of 24. The total number of sessions was 24.

Conclusion: Achieving initial hemorrhage-control readiness and maintenance at a mass gathering site through American College of Surgeons Bleeding Control training is feasible but requires significant commitment from training staff, site leadership, and financial resources.

Background

The incidence of mass shootings in the United States has risen during the past decade. At the same time, multiple complex urban-terror events resulting in mass casualty incidents (MCIs) involving both penetrating (guns, knives, explosives) and blunt trauma (motor vehicle) have occurred across Europe and the United States.[1,2] Mass gathering sites, such as stadiums, concert venues, transportation hubs, schools, and shopping malls, are targets because of the concentration of people within a confined area.[3,4] Examples of

☆ Partially funded by the Gillian Reny Stepping Strong Center for Trauma Innovation and Gillette Stadium, Foxborough MA.

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https://doi.org/10.1016/j.surg.2018.10.001
0039-6060/

MCIs include the 2013 Boston Marathon bombings, the 2015 Paris attacks on a nightclub, the 2016 Brussels attacks at an airport and train station, the 2017 Manchester, UK, arena attack, and the 2017 Las Vegas mass shooting incident. MCIs are loosely defined as events that overwhelm the local resources to respond and are associated with delays in arrival of first responders.[3] Mass gathering sites already require large operational teams to coordinate and provide for the influx of people during scheduled events. Most operational teams undergo job-specific training, but there is no industry standard for recognition and initial treatment of bleeding by nonmedical personnel.

During 2005–2006, the US military implemented widespread hemorrhage-control training and provided tourniquets to all deployed soldiers.[5] After this intervention, the mortality rate from uncontrolled extremity hemorrhage fell from 23.3 to 3.5 deaths per year—an 85% reduction in mortality.[6] A landmark study by Kragh et al[7] led to an estimated 2,000-plus lives saved by expeditious use of tourniquets in the field from 2006 to 2009.[7] The military's success in this area has resulted in multiple national initiatives aimed at training the lay public and public safety professionals (fire, emergency medical services, and law enforcement) in hemorrhage control.[8–10] These initiatives have continued to be embraced as civilian trauma injuries increasingly resemble battlefield injuries; however, the optimal method to reach large numbers and optimally train laypeople has not been elucidated.[11] The reach, effectiveness, adoption, implementation, and maintenance (RE-AIM) framework has been utilized as a methodology in more than 100 publications to improve the sustainable adoption and implementation of effective, generalizable, evidence-based public health or medical interventions.

In this context, we sought to implement layperson hemorrhage-control training for the operational staff of a major National Football League (NFL) stadium as an a priori nested study within an efficacy trial for hemorrhage-control readiness interventions. The objective of this study was to evaluate the establishment of a bleeding-control program at a stadium using the RE-AIM framework to serve as a model for future stadium implementation programs.

Methods

This study was part of a randomized efficacy trial testing various hemorrhage-control readiness interventions for laypeople. The umbrella study was registered on clinicaltrials.gov (NCT03479112). The trial compared the efficacy of in-person hemorrhage-control training—the American College of Surgeons Bleeding Control training (ACS B-CON)—and audio and visual point-of-care interventions with no intervention in achieving correct tourniquet application in laypeople. Four study arms were created: in-person training, audio-guided point of care, visual flashcard point of care, and control (no intervention). After participants in each arm received their respective intervention, they were tested on the application of a tourniquet to a mannequin during a simulated mass-casualty scenario. Afterward, each arm received the in-person hemorrhage-control training. These study arms were only created for the trial and were not evaluated differently in the implementation study. Participants were administered pretraining and post-training surveys in addition to undergoing retention testing 3–9 months after initial testing. Partners Healthcare (Boston, MA) institutional review board approval was obtained for this study (protocol#: 2016P002631). Informed consent was obtained from all participants.

The RE-AIM framework was utilized to evaluate implementation. This framework provides a systematic and standardized approach to designing and evaluating the impact of an intervention.[12] By adopting this standardized tool, investigators can gauge the real-world applicability of their interventions and identify the factors required for successful adoption and dissemination of the intervention. This approach has been extensively used in the literature to evaluate public health interventions.[13–15] We evaluated our implementation using the five RE-AIM domains: reach, efficacy, adoption, implementation and maintenance (Table 1).

Reach

Reach is defined as the representativeness of the study participants to the actual target population.[12] Representativeness ensures that the findings from this implementation exercise can be extrapolated to the target population. For this study, we approached the management of Gillette Stadium (Foxborough, MA), which seats more than 66,000 people and is the largest stadium in New England, for permission to train their operational staff in hemorrhage control and immediate response to trauma. Brigham and Women's Hospital (Boston, MA) has provided medical direction for Gillette Stadium since 2002 and had previously developed relationships with key stakeholders, including stadium operations, fire services, emergency medical services, and law enforcement. The stadium includes personnel who work for security, parking, food and beverage operations, stadium operations, and other similar employers within the stadium. Factors evaluated were participant demographics (age, sex, level of education), prior first-aid training, and prior hemorrhage-control training.

Efficacy and effectiveness

Efficacy is defined as the effect of the intervention(s) on important outcomes. This domain gauges how well the intervention achieves the desired results. For this study, participants' ability to correctly apply a tourniquet in a simulated mass-casualty scenario before and after the hemorrhage-control training was the outcome measure for efficacy of this intervention. In addition, participants' self-perceived likelihood of helping in an MCI and their comfort level in achieving bleeding control before and after the training were compared on a 5-point Likert scale.

Adoption

The adoption domain of the RE-AIM framework deals with the wider acceptance by the investigators, participants, and the greater community to sustain the intervention. The objective of this aspect of evaluation is to determine the sustainability and propagation of the intervention in the desired setting. In the case of this study, adoption was measured by the steps taken by the investigators, stadium leaders, and study participants to ensure the sustainability of hemorrhage-control readiness in the stadium and other similar venues.

Implementation

Implementation encompasses the protocol's design and the logistics of implementing it. This aspect of the evaluation reveals some of the challenges faced during the implementation of the intervention. It also provides insight for future planning and execution of similar programs. For this domain, we describe the curriculum selection for this implementation, the logistics of the course (class size, location, and timing), instructor details, and cost associated with implementation.

Maintenance

Maintenance relates to the integration of the intervention into the fabric of the organization/individual on which it was implemented. This domain scales the extent of impact the intervention

Table 1
Assessment of RE-AIM framework indicators.

Indicators	Measures
Reach	Participant demographics: Age, sex, educational level Prior first-aid training Prior hemorrhage-control training
Effectiveness	Comparison of proportion of correct tourniquet application by participants in a simulated emergency scenario, before and after the training Comparison of pretraining and post-training willingness to try to control hemorrhage in a mass casualty situation Comparison of pretraining and post-training comfort level in hemorrhage control in a mass casualty situation
Adoption	Initiatives by implementation team Initiatives by stadium leadership Perception of participants regarding hemorrhage-control training dissemination
Implementation	Course selection Class size, location, and timing Instructor details Remunerations
Maintenance	Plans for knowledge and skill retention evaluation of participants Ongoing engagement with stadium leadership

Table 2
Reach: Characteristics of participants.

Characteristics		*n* (%)
Age (mean, standard deviation)		46.6 years, ±15.9 years
Sex	Male	337 (59.9%)
	Female	219 (38.9%)
Educational level	Did not complete high school	13 (2.3%)
	High school	107 (19.0%)
	Some college	234 (41.6%)
	Bachelor's or higher	207 (36.9%)
Prior first-aid training		330 (58.7%)
Prior hemorrhage-control training		97 (17.3%)

maintains after a given period. For this study, we describe our measurement of the maintenance of hemorrhage-control readiness in study participants after 3 to 9 months of the intervention, as well as the initiatives by the implementation team to ensure sustained readiness at the stadium.

Statistical analysis

Descriptive statistics were used to characterize participants' demographics. A very limited amount (0.3%) of responses were missing and were assumed to be *missing at random*. No comparisons were made between any arms. The effect of B-CON training on participants' self-reported likelihood to provide aid in an MCI and participants' self-reported comfort level controlling hemorrhage were analyzed using the Wilcoxon signed-rank test. All the analyses were conducted at 5% level of significance using STATA version 14.0 (StatCorp LLC, College Station, TX).

Results

Reach

A total of 562 stadium operational personnel were trained. These personnel included all staff that have significant interaction with guests during events, including security, parking ushers, food and beverage, and stadium operations. The average age of the participants was 46.6 years. A majority of the participants were male (59.9%; Table 2). Most of the participants (78%) reported some college (41.6%) or a completed bachelor's degree or higher (36.9%). Most of the participants reported having received first-aid training (58.7%), and only 17.3% reported any form of hemorrhage-control training. The most common responses for hemorrhage-control training were military training (14, 14.4%) and emergency medical technician (EMT) training (11, 11.3%). A total of 31 (31.9%) of the participants specifically mentioned having received tourniquet training.

Efficacy and effectiveness

Because the implementation study was nested within the Public Access and Tourniquet Training Study (PATTS trial), we evaluated correct tourniquet application before and after the training. Only 16.4% were able to correctly apply tourniquet before the training, and 87.7% correctly applied tourniquets immediately after the training.

Moreover, participants' mean likelihood to provide immediate hemorrhage-control response in case of an MCI increased from 4.1 to 4.3, on a Likert scale of 1 to 5. Participants' confidence of using hemorrhage-control skills in a real-world scenario also improved from 3.6 to 4.3 (Table 3).

Adoption

The adoption of this this intervention is described at three different levels: the investigator level, stadium leadership level, and the participant level (Table 4). All three of these levels undertook initiatives that ensured the sustainability of the intervention.

On the investigator level, regional collaborations with local hospitals and emergency medical services (EMSs) ensured that there was a pool of instructors willing to teach the hemorrhage-control course. On the national level, the investigators are collaborating with other sports venues and mass transit stations to implement hemorrhage-control training. Further outreach efforts included teaching staff at other mass gathering sites, including multiple schools, shopping malls, healthcare facilities, and convention centers. Finally, this implementation effort was accompanied by research efforts such as the PATTS trial and multiple surveys administered to the participants at various times to generate evidence for successful implementation strategies.

The stadium leadership contributed to the adoption process in three different ways. First, they located hemorrhage control kits with all automatic external defibrillators in the stadium and provided on-duty employees with individualized first-aid kits (IFAKs) to ensure easy access to hemorrhage-control equipment in case of need. They also produced a 30-second public safety announcement (PSA) that informs the viewers about the importance of immediate response in case of bleeding and provides resources for further information (Appendix 1). This PSA is played at each football

Table 3
Effectiveness: Self-assessment traits of participants before and after the training.

Self-reported trait mean (standard deviation)	Pretraining*	Post-training*	*P* value
Willingness to perform hemorrhage control in a mass casualty scenario	4.1 (1.2)	4.4 (1.3)	< .01
Confidence in performing hemorrhage control in a mass casualty scenario	3.6 (1.2)	4.3 (1.2)	< .01

* Outcomes were measured on a Likert scale of 1 to 5. The Wilcoxon signed-rank test was used to determine statistical significance (*P* value).

Table 4
Adoption: Initiatives by implementation team, stadium leadership, and participants.

Level	Initiatives	Explanation
Implementation Team	Regional collaboration	Collaborations forged with: • Massachusetts Medical Society • Regional emergency medical service providers • Multiple hospitals These collaborations helped in the provision of instructors and evaluators for the implementation, building a regional consensus on the need for hemorrhage control readiness for public venue employees, as well as replicating similar models at other mass gathering venues.
	National collaboration	• Negotiations with multiple other sports and mass transit venues for implementation of adoption of B-CON readiness for their employees.
	Outreach	Outreach efforts of the team resulted in implementation of B-CON in smaller, yet equally susceptible, public venues, including staff at: • Schools • Hospitals (including security, administrators, and clinicians) • Shopping malls (security staff)
	Research	• The implementation of B-CON training at the stadium was accompanied by randomized trial to determine the most effective method to achieve hemorrhage-control readiness. • Multiple surveys administered to the stadium employees at different time points to determine the pre-implementation and postimplementation readiness and impact of B-CON training.
Stadium Leadership	Access to tourniquets	• Bleeding control kits collocated with AEDs in the stadium • All on-duty employees provided individualized first-aid kits (IFAKs) on event days
	Awareness campaign	• Public safety announcement (PSA) played on the jumbotron before start of event • Stadium website and mobile application have information on initial first aid for bleeding and a link to "bleedingcontrol.org'
	Establishing a training base	• Stadium leadership planning to establish a center of excellence for B-CON and disaster management training for the NFL stadiums.
Participants	Perception of usefulness	• On a Likert scale of 1 to 5, with 1 being not useful at all and 5 being very useful, employees ranked B-CON training 4.9 (0.4)* • 85.9 % employees believed that B-CON training should be part of skills required for public-venue employees
	Dissemination of knowledge	• 90.4 % participants reported discussing hemorrhage control and tourniquets with at least 1 person, within 3–6 month of the training

* Mean (standard deviation).*B-CON*, bleeding control.

game and will be played at future events. Further efforts for awareness included integration of hemorrhage-control training resources on the stadium's Web site and mobile application. Stadium leadership was committed to establish Gillette Stadium as one of the first "Stop the Bleed" stadiums in the world and aid other sports venues in improving medical preparedness capabilities. Previously Gillette Stadium has sponsored several tabletop and functional exercises to simulate MCIs with stakeholders from across the public and private sector.

Participants had a high perception of this training's usefulness (mean: 4.9) on a Likert scale of 1 to 5. In addition, 85.9% of participants believed that this training should be part of stadium personnel's employment training. Participants also helped disseminate information regarding hemorrhage control by laypeople. Of participants, 90.4% reported discussing this training with at least 1 other person.

Implementation

The implementation of the hemorrhage-control training took place in the time span of 3 months. This section describes the curriculum selection, class details, instructor profile and remunerations associated with this study, and is summarized in Table 5.

The curriculum selection was paramount for this implementation because no universally accepted standard exists. The key factors we sought in the curriculum to be implemented were wide acceptance, ease of instruction, and standardized approach to reduce variability. The ACS B-CON was identified as one course encompassing all these characteristics.[16] The concept of layperson empowerment to perform bleeding control has been endorsed by a host of national trauma and emergency medicine societies and the Obama White House.[17] This course consists of a 30-minute lecture-style knowledge class that is taught on a standardized presentation made by ACS and of 30 minutes of skills training on mannequins under the supervision of instructors. The knowledge section of the class consists of methods to identify life-threatening bleeding, methods of achieving hemorrhage control, introduction to different types of tourniquets, and protocol for immediate responders in an MCI to follow. The skills training includes use of direct pressure, wound packing, and use of tourniquet for hemorrhage control. The recommended ratio of participants to instructors is 8:1.

The class size was capped at 24 participants. Each training day consisted of 1 to 3 classes (average: 2). Classes were scheduled

Table 5
Implementation: Course description and logistic details of implementation.

	Details
Course	The American College of Surgeons (ACS) Stop the Bleed course for laypersons was selected for implementation because of endorsements from the national trauma and emergency medicine organizations and the office of the vice president. The course has a recommended instructor-to-student ratio of 1:8 and consists of the following two half-hour sessions: • Knowledge session (lecture style presentation of basics of identifying life-threatening bleeding and responding appropriately with pressure, packing of wound or use of tourniquet. Standard PowerPoint presentation made by the ACS was used). • Skills session (an interactive session with the participants for practicing compression, wound packing, and tourniquet use on mannequins under the supervision of an instructor).
Class	The class size was capped at 24 participants per class. Each training day consisted of 1 to 2 classes. Total number of classes was 24 during a period of 3 months Participants filled out a pretraining questionnaire before the class and a post-training questionnaire after the class.
Instructors	All instructors were qualified medical professionals (attending physicians, emergency medicine and surgery residents and physicians, nurses, emergency medical technicians) and had undergone the Stop the Bleed instructor course before instruction. Each class had 3-4 instructors.
Remuneration	Stadium employees received this training as part of their employment and were compensated by the stadium at their regular compensation rate. Instructors who participated in the study were compensated through the study fund at $100/day.

around game days in the stadium, before or after the game, to ensure ease of access to participants and minimum disruption of work. Participants were asked to fill out a pretraining and post-training survey. The participants were trained in a total of 24 classes over a period of 3 months.

All instructors in this implementation were trained medical professionals, including physicians, surgeons, nurses, and EMTs. The instructors volunteered from various departments of Brigham and Women's Hospital (BWH), Boston, MA; South Shore Hospital, South Weymouth, MA; Brigham and Women's Faulkner Hospital, Boston, MA; Boston Med Flight, Bedford, MA; and Fallon Ambulance, Quincy, MA. All instructors received the ACS B-CON instructor course by the trauma program manager at BWH. Each class had 3–4 instructors.

The instructors were compensated through the study fund at $100/day. The participants of this training received compensation as part of their employment and were compensated at their hourly rate by the stadium administration.

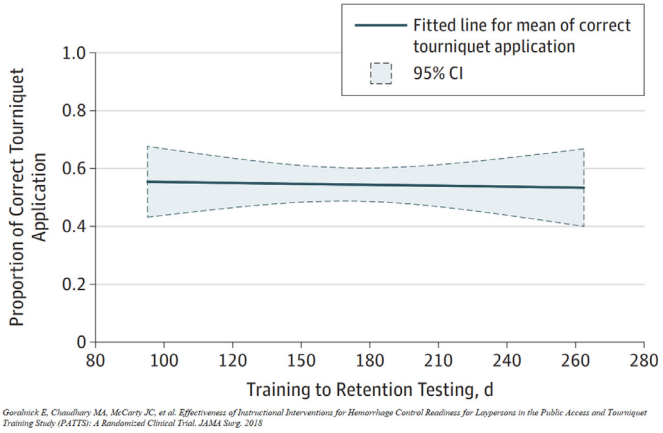

Fig. 1. Proportion of correct tourniquet application during retention testing 3 to 9 months after the intervention.

Maintenance

To measure the maintenance of the hemorrhage-control training at the stadium, we planned a study to evaluate the retention of skills of participants 3 to 9 months after training. The participants were tested on their ability to correctly apply a tourniquet in a simulated mass-casualty scenario, similar to the initial testing. The analysis plan for this study included testing for demographic predictors of retention of hemorrhage-control skills. This follow-up assessment was completed in 2017 and 303 study participants were evaluated. We found that 55% of participants were able to successfully complete tourniquet application at retention testing.[18] In addition, it was found that after the initial decay in tourniquet application skills, up to 3 months after the intervention, no significant further skill decay was noted (Fig. 1).[18] This analysis also showed that intervention in younger participants was significantly associated with higher likelihood of skill retention, as compared with older participants.[18]

Discussion

Our objective was to examine and evaluate a mass gathering site hemorrhage-control training model using the RE-AIM framework that could serve as a roadmap for national and international scalability. The effectiveness of the training to empower participants was demonstrated by their significant increase in self-reported willingness to help in an MCI and their comfort level in controlling bleeding after completing the B-CON course. The reach of the course extends beyond the individual participants to those who attended games during the airing of the PSA.

A roadmap exists for a model of layperson empowerment to intervene and provide medical care—cardiopulmonary resuscitation and AEDs. Implementation of cardiopulmonary resuscitation and AED training of personnel at public venues, including stadiums and schools, has been documented for more than 30 years, with the intent of improving success for the resuscitation of spectators undergoing sudden cardiac events.[19] However, no clear US standard exists in sporting arenas regarding implementation and training of venue employees. Most recommendations are based on or consensus statements from professional medical organizations and to date there has been no survey to understand actual implementation of organizational recommendations in these venues.[19–21]

The "Stop the Bleed" campaign similarly champions layperson and public safety professional empowerment to recognize life-threatening bleeding and intervene by calling for assistance and providing compression in the form of direct pressure, wound packing, and direct-pressure or tourniquet application. As this

campaign evolves, public venues, such as sports stadiums, may serve as opportunities to amplify the campaign by a multipronged approach to include training stadium staff, training public safety professionals, and educating and creating awareness of spectators and athletes/performers. In a recent commentary, Bulger et al[22] have suggested that we may support a herd immunity by training a portion of the public who will aid untrained others to perform critical tasks to, in combination, effectively provide hemorrhage control.

Our longstanding medical direction was the most critical factor in the success of our implementation.[23] Our personnel relationships aided not only in creating a sustainable strategy to conduct training but also in a variety of logistical challenges as they arose during the implementation period. Stadiums and other similarly large gathering sites like concert venues are inherently susceptible to becoming sites of an MCI, whether that be a domestic terror attack like the 2017 Las Vegas shooting or a natural disaster. After we approached management and explained the potential risks inherent in being a large mass gathering site and the benefit from training their employees, they were enthusiastic to participate and partner with the initiative. Obtaining support from the organization from the beginning was key because the process requires significant resource allocation by the organization in the form of employees' training time. A benefit of starting with an organization like Gillette Stadium is that it has the necessary resources to allocate to implementation without significant impact on its operations. Once the stadium has trained the majority of its current employees, it is able to transition the implementation model to one of incorporating it into new employee training to streamline the process.

Our pilot program with Gillette Stadium has led to further outreach to other public venues that have expressed interest in having their employees trained. Implementing training of employees at Gillette Stadium provides the tangible benefit that, in the event of a trauma, the employees have the knowledge and skills to potentially save lives, not only within the confines of the stadium, but within their communities. Subsequently, we have performed some training with other communities based on referrals from the initial study participants. This has a two-fold benefit: advertising to further the reach and public awareness of the "Stop the Bleed" Campaign and benefiting the stadium as an additional marketing tool it can use to garner business. Gillette Stadium began playing PSAs describing its employees' training during home NFL games on October 29, 2017. Immediately after this, multiple other entities began expressing interest in having their stadium personnel trained.

Implementation and delivery of the program has been consistent across training sessions by nature of its design. B-CON necessitates currently that trainers have experience in health care delivery (physicians, nurses, EMTs).[24] This creates consistency but does have higher costs associated. Healthcare professionals are difficult to schedule for training, given their busy routines, and come at a very high monetary cost. They also serve as a rate limiting factor (bottle neck) for wide spread implementation beacuse of their limited numbers. Another option is creating a "train the trainer" model for the stadium to reduce the cost of further training, but this method would require validation and quality control. The ACS purports the B-CON as a "train the trainer" program, and all course participants receive a trainer certificate. We plan to develop further studies to validate this training model to mitigate the administrative costs and difficulties associated with professional healthcare trainers. In discussion with management, we decided that the employees to train in the initial stages were the stadium operational team because that group covers the widest range of areas within the stadium and stadium grounds.

The most important outcome for this initiative is decreasing preventable deaths in the event of trauma. Fortunately, this outcome is relatively rare within the confines of mass gathering sites, thus surrogate end points for effectiveness are used. We demonstrate that employees reported feeling empowered to act and being more comfortable controlling hemorrhage after the training. Studies in layperson response in the event of cardiac arrest show that the characteristics of volunteers with a greater likelihood to help include having completed emergency response training.[25] Another study of 307 police officers, taxi drivers, and community leaders in Uganda demonstrated that, when surveyed 6 months after a 1-day training session in first aid, 74% had used hemorrhage-control skills to care for someone else within their community.[26] The investment of Gillette Stadium in placing multiple bleeding-control kits throughout the stadium in high-traffic areas is a crucial component to accompany the employee training. The kits consist of tourniquets, hemostatic gauze scissors, and gloves. The only component in the kit that has a limited shelf life is the hemostatic gauze and has to be replaced every 5 years. Our course provides tangible skills employees can use if presented with a bleeding victim. Furthermore, these skills are applicable beyond the workplace to any scenario with a bleeding victim. Maintenance of preparedness after initial training is a key component of any initiative. Both the off season and scheduled events during the football season afforded a preexisting schedule to easily facilitate both initial and retention testing.

We encountered some difficulties in our initiative and there are some limitations to its current form. The requirement of trainers to be trained health care professionals increases costs and may create scheduling challenges. This could be addressed by the train-the-trainer model, if validated, or by having a centralized training location rather than performing the training onsite. Just-in-time and Web-based options have also demonstrated promise for educating the public and may be a future option for training both staff and the general public at mass gathering sites.[27–29] The costs of the bleeding-control kits also entails a high initial investment, and some components of the kit have a finite, although long, shelf life.[18,27]

Achieving effective hemorrhage-control readiness within a 3-month period at a mass gathering site through ACS B-CON training is feasible, but it requires significant commitment from the training staff, site leadership, and financial resources. The November 2017 shooting in Las Vegas at an outdoor concert that lead to 58 deaths highlights the importance of bleeding-control readiness at public venues. This description of a sustainable bleeding-control program using a RE-AIM framework affords a roadmap for stadium implementation. Each of these interventions are aimed not only at stadium readiness, but as a method to inform, educate, and empower the broader public about their role to improve our national trauma care chain of survival aimed at reduction of preventable deaths.

Acknowledgment

Craig Goolsby has a patent pending for tourniquet and methods of use. The views expressed in this article are the authors' opinions and do not represent the official policy of the Uniformed Services University, Defense Department, or US Government.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.surg.2018.10.001.

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