The American Journal of Surgery 217 (2019) 368–372

Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.americanjournalofsurgery.com

Stop the Bleed Training empowers learners to act to prevent unnecessary hemorrhagic death

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ARTICLE INFO

Article history:
Received 18 May 2018
Received in revised form
25 July 2018
Accepted 18 September 2018

Keywords:
Hemorrhage
Tourniquet
Education
Preventable
Trauma

ABSTRACT

Background: Uncontrolled bleeding is a leading cause of preventable death from trauma. With the rise in mass casualty events, training of laypersons can be life-saving. “Stop the Bleed” is a campaign to teach the public techniques of bleeding control. We believe that training in these techniques will increase participants' willingness and preparedness to intervene and increase knowledge of trauma/hemorrhage control.

Methods: We created a “Stop the Bleed” training program. School nurses, medical students, researchers, and community members participated in the program. Pre- and post-training questionnaires assessed participants' willingness/preparedness to intervene in a casualty event and knowledge of trauma/hemorrhage control.

Results: There was a significant change in attitudes after receiving training ($p < 0.05$). There was also an improvement in knowledge regarding bleeding control techniques.

Conclusions: “Stop the Bleed” training empowers participants with the confidence and knowledge to aid others in preventable hemorrhagic death.

Introduction

Trauma is a major cause of death for all ages and the most common injuries leading to death are traumatic brain injury and uncontrolled hemorrhage.[1,2] It is estimated that 57% of civilian deaths from hemorrhage could have been prevented with adequate hemorrhage control.[3–6] Life-threatening bleeding can cause death within minutes, and arrival of pre-hospital personnel may be delayed due to distance or safety concerns.[7,8] Meanwhile non-medical bystanders are first on scene, but usually do not act out of inexperience and fear of causing harm.

Inspired by an increasing incidence of mass shooting events in recent years and the military experiences in Iraq and Afghanistan, the Hartford Consensus Joint Committee was formed and set a goal to create a national policy to enhance survival in mass casualty events. The Hartford group along with the American College of Surgeons created the “Stop the Bleed” campaign to teach techniques of bleeding control to laypeople who may be bystanders to life-threatening bleeding.[9,10] Bleeding control (BCon) training is aimed at teaching non-medical civilians the essential techniques of tourniquet placement and wound packing, with the concept that these bystander responders (the ones first on scene) have the opportunity to intervene before hemorrhagic death, potentially saving a life.[11]

Although the creation of this training campaign was inspired by active shooter events, it is important to recognize that these skills can be utilized in multiple scenarios, not just mass casualties.[9] Routine every day injuries account for many more bleeding patients than the highly publicized mass casualty events, and patients involved in industrial or farming accidents, motor vehicle collisions, and any penetrating wounds can suffer from fatal

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https://doi.org/10.1016/j.amjsurg.2018.09.025
0002-9610/

exsanguination.[12]

A public opinion survey by the Hartford Consensus group revealed that 51% of those surveyed would be very likely to assist in severe bleed scenarios (e.g., shooting victims, car crash victims).[13] However, many surveyed also expressed significant concern about risks of self harm (contracting disease, personal safety) or of further injuring the victim by causing pain, worsening the existing injury, or contributing to bad outcomes such as limb loss or death. Nevertheless, recent evidence shows that laypeople can be trained to effectively assist victims prior to the arrival of pre-hospital personnel.[14,15] We hypothesize that training in BCon techniques and improving baseline knowledge of hemorrhage and bleeding control techniques would increase participants' willingness and preparedness to intervene in an emergency.

Methods

We created a "Stop the Bleed" training program at the McGovern Medical School at UT Health and reached out to surrounding communities and local schools. This certified training course includes three components: (I) a didactic lecture, (II) interactive discussion of BCon methods, and (III) hands-on training with certified instructors on tourniquet placement technique and hemorrhage control with wound packing. We also created a pre- and post-training questionnaire to evaluate participants' baseline knowledge of trauma and hemorrhage, to assess their attitudes towards intervention, and to follow changes in their knowledge to assess effectiveness of teaching (Table 1). Specifically, multiple-choice questions 1 and 2 examined baseline knowledge, Likert style questions 3 and 4 looked at the attitudes towards willingness and preparedness to intervene, and questions 5 through 7 were used to assess the effectiveness of BCon instruction at changing baseline misinformation. Reliability of the questionnaire, specifically the Likert questions, was assessed via Cronbach's alpha. The pre- and post-training questionnaires demonstrated an alpha of 0.38 and 0.72, respectively. The low alpha value for the pre-training questionnaire may be attributed to the two items selected for reliability analysis.

Participants received "Stop the Bleed" training by American College of Surgeons (ACS) certified instructors. Identical pre- and post-training questionnaires were administered to the participants, which included local school nurses (SN), third-year medical students (MS3), an interdisciplinary group (ID) consisting of researchers and other health profession students, and members of the community (CM) during the 2018 National Stop the Bleed Day.

The "Stop the Bleed" training was a part of the lecture series for third-year medical students during their surgery clerkship. A random identifier was used to preserve both anonymity and allow for data matching. These identifiers were assigned by random distribution using a standard deck of 52 playing cards. Participants were also given the option to opt out of the study by checking a box at the bottom of the questionnaire. Anonymity was used to ensure that medical student clerkship evaluations and grades were not affected by their answers during this activity. Statistical significance between pre-vs. post-training data was analyzed using T-test and Wilcoxon-signed ranked test, with significance defined as $p < 0.05$. Exclusion criteria included incomplete surveys, lack of anonymous identifier, and those who chose to opt-out of data analysis.

Results

BCon instructors taught thirteen "Stop the Bleed" sessions over 6 months during the 2017–2018 academic year, which were all included in this study. In total, 604 individuals received potentially life-saving training. After exclusion (19 incomplete surveys, 30 without identifiers) 555 responses were included in the study. Analysis of the data was divided according to the professional background of the participants (SN = 287, MS3 = 123, ID = 68, CM = 77) (see Table 2).

There was a statistically significant shift between feelings of both *willingness* and *preparedness* as determined by the Wilcoxon-signed rank test. Following training, participants felt more willing and more prepared to assist in caring for a stranger who was

Table 2
Stratified pre- and post-questionnaire responses from the Likert survey.

Question	Pre/Post	Group	*Likert Scale (No. of respondents) n = 478*				
			SD	D	N	A	SA
Willingness	Pre	SN	0	4	18	101	164
	Post		0	0	3	32	252
	Pre	MS3	1	0	8	44	70
	Post		0	0	1	18	104
	Pre	ID	0	1	7	15	45
	Post		0	0	1	10	57
	Pre	CM	0	0	3	24	50
	Post		0	0	1	5	71
Preparedness	Pre	SN	0	11	46	157	73
	Post		0	0	1	35	251
	Pre	MS3	10	53	37	19	4
	Post		0	0	2	43	78
	Pre	ID	3	16	26	17	6
	Post		0	0	1	18	49
	Pre	CM	5	13	22	21	16
	Post		0	0	1	15	61

SN = school nurses, MS3 = third-year medical students, ID = interdisciplinary group, CM = community members. SD = strongly disagree, D = disagree, N = neutral, A = agree, SA = strongly agree.

Table 1
Pre-/Post- BCon training questions.

#	Question	Possible responses
1	The most likely cause of death for someone aged 18–45 years is:	Heart disease, Cancer, Trauma*, Infection
2	The most common cause of preventable death in trauma patients is:	Bleeding*, Brain injury, Sepsis, Organ failure
3	If I were involved in a mass casualty today, I would be WILLING to help strangers who are bleeding	SD, D, N, A, SA
4	If I were involved in a mass casualty today, I would be PREPARED to help strangers who are bleeding	SD, D, N, A, SA
5	Cardiopulmonary resuscitation (CPR) is usually effective for a hemorrhagic patient in whom you cannot palpate a pulse	True, False*
6	When commercial gauze is not available, wound packing with improvised dressings (clothing) is often effective in initial control of external bleeding.	True*, False
7	When a commercial tourniquet is not available, an improvised belt tourniquet is just as effective in controlling bleeding from extremity wounds.	True, False*

Questions 1–2 are multiple choice. Questions 3–4 are Likert scale: Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A) and Strongly Agree (SA). Questions 5–7 are True/False. Correct answers marked with *.

bleeding (Fig. 1A and B). Before BCon training the overall willingness to help a bleeding stranger, assessed by checking either "agree" or "strongly agree", was 92%. There were no differences in willingness to help between groups: 92% of school nurses, 93% of medical students, 88% of the interdisciplinary group, and 96% of community members. At baseline, there were however significant group differences in preparedness to help. While 80% of school nurses felt prepared, only 19% of medical students, 34% of the interdisciplinary group, and 48% of the community members responded positively ($p < 0.05$). After the "Stop the Bleed" intervention, every participant group had increased confidence in both categories of willingness [SN 99%, MS3 99%, ID 99%, CM 99%] and prepareness [SN 100%, MS3 98%, ID 99%, CM 99%] to greater than 98%, and the differences in preparedness between the groups observed before training were negated.

We also reviewed the percentage of "correct" responses on the questionnaire as to knowledge of trauma and bleeding control (Table 1, Q1-2, Q5-7). There were a total of five questions: two multiple-choice style questions focusing on foundational knowledge and three true/false questions evaluating key points taught in the course. Thus, participants could have scored a 0, 20, 40, 60, 80, or 100% on this portion. None of the participants scored a 0%. Overall score frequencies are shown in Fig. 2. Most participants correctly answered three or four out of the five questions with baseline knowledge. However, after training, the majority (63%) answer all 5 questions correctly. If we consider >60% to be "passing", among the SN group, 63% passed before BCon training. In the MS3, ID, and CM groups, 73%, 66%, and 48% of participants, respectively, passed. After BCon training the percentage of participants who passed increased to 89%, 100%, 85%, and 86% among SN, MS3, ID, and CM respectively.

In order to give real time analysis and feedback to our instructors, we specifically analyzed questions 5–7 on the questionnaire after each BCon session, with the goal that feedback on the percentage of correct answers could be utilized to improve the quality of teaching in future sessions. In a prior data set consisting of two groups of unpaired but consented MS3 participants, these three questions were identified to be commonly incorrect at baseline. For example, question 5 was answered correctly by 70%, question 6 was 78%, and question 7 was the lowest at 11%. When the survey was repeated after training Group 1 improved minimally to 73% for question 5, adequately to 97% for question 6, but question 7 saw correct answers in only 43% of responders. This was interpreted as inadequate teaching for this group, and the feedback

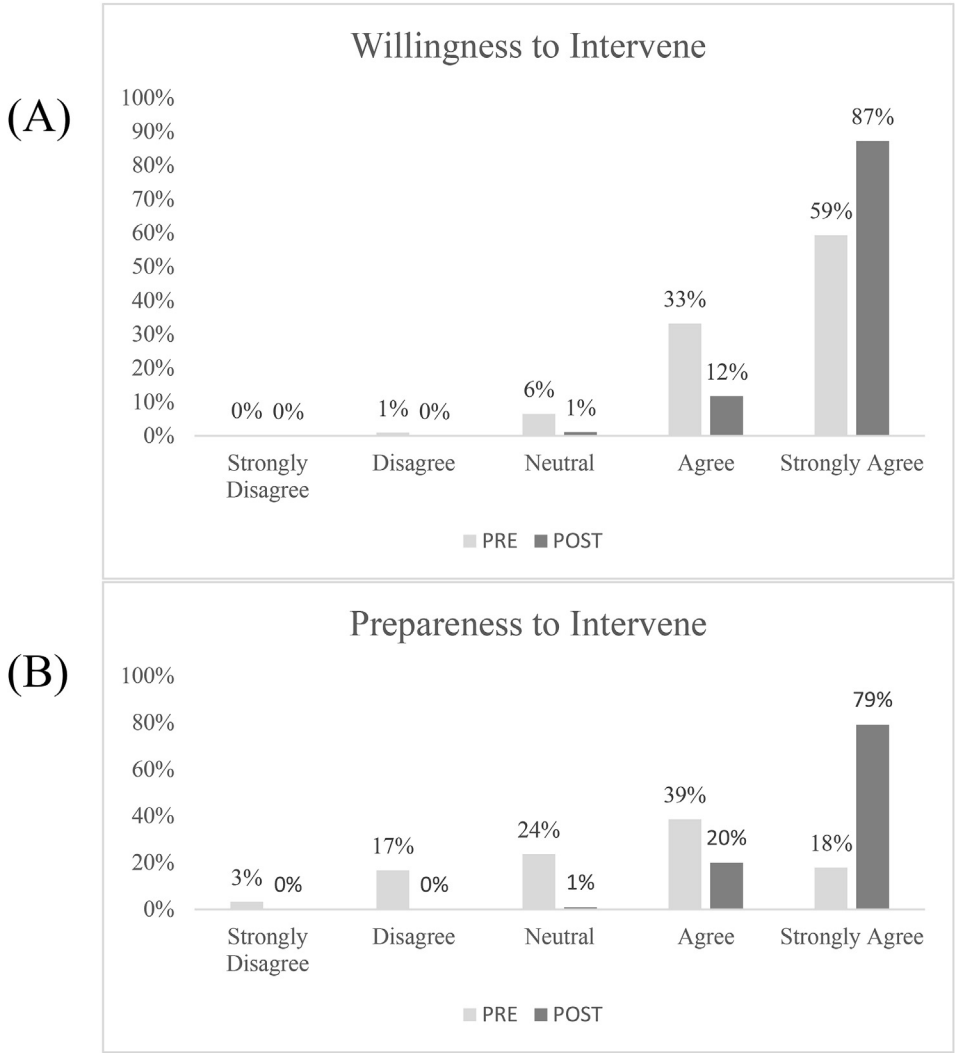

Fig. 1. Participant attitudes. Change in participant attitudes pre- and post- BCon training, (**A**) willingness vs. (**B**) preparedness. (SD = strongly disagree, D = disagree, N = neutral, A = agree, SA = strongly agree).

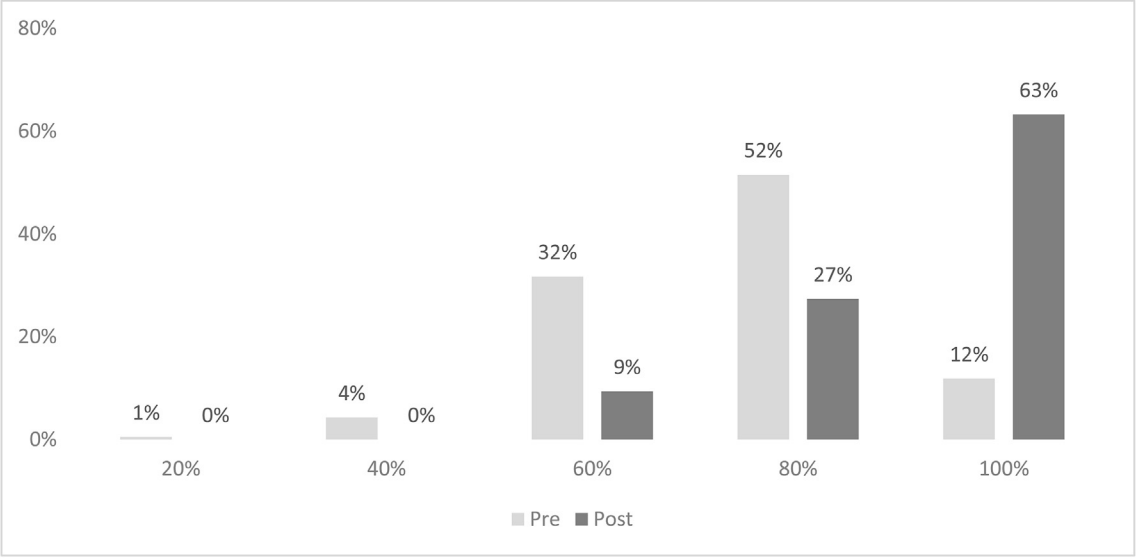

Fig. 2. Participant knowledge. Change in percentage correct (of 5 questions) pre- and post- BCon training.

given to instructors. When the same instructors taught BCon to Group 2, the correct answers training for all 3 questions was 100% (Table 3).

Discussion

Between 2000 and 2013, there was an average of 11.4 annual active shooter incidents per year.[16] In the years 2014 and 2015, the incidence increased to 20 annually, with more than 200 casualties.[17,18] However, deaths from penetrating trauma are more likely to occur outside of these events, accounting for the vast majority of homicide deaths each year. Moreover, penetrating trauma accounts for less than 15% of traumatic deaths annually, with motor vehicle crashes, falls, and industrial/occupational events being more common causes of death.[19] With death from hemorrhage occurring in a large and varied number of settings, it is critical to address bystander response in a public campaign similar to that utilized to reduce death from cardiac arrest. Overcoming barriers to action and improving baseline knowledge of layperson bystanders with in-person workshops increases the chance that someone could act to stop life-threatening bleeding.[15]

Our study demonstrates that "Stop the Bleed" training is successful in increasing both participant confidence and knowledge on effective BCon techniques. The willingness to help was 92% in contrast to the 51% noted in the opinion survey of the general population conducted by the Hartford Consensus Group. In fact, the group of community members our study showed 96% *willingness* at baseline. A selective bias could explain this vast difference between the Hartford data vs. our data of the laypeople. For their study, the Hartford group conducted phone interviews and looked at the response rate of first aid-naïve respondents. Our data comes from community members with diverse backgrounds already motivated to participate in National Stop the Bleed Day. Furthermore, since most participants of our study are healthcare professionals or trainees (i.e., medical students) dedicated to serving others, it is not surprising that they had a high baseline before training for being at least *willing* to help in a mass casualty incident. Jacobs et al., show that, in an active shooter event, many healthcare professionals believe that they have a special duty to provide public assistance, which our subjects also endorsed with the majority answering with an "agree" or "strongly agree" on *willingness* to intervene at baseline.[20] And even though the participants' baseline *willingness* was high, there was still a statistically significant right shift on the post-training to "strongly agree", which is similar to other recent studies on the effect of BCon training.[21]

Despite this *willingness* to intervene, participants' baseline feeling of *preparedness* was not as strong. Feelings of *preparedness* to intervene largely correlated with the level of experience of the participant, as seen with the nursing group feeling more prepared to help before BCon training than were either the medical students or the interdisciplinary group. In the community, there was an even more dramatic distribution of attitudes towards pre-intervention *preparedness*. Despite this initial difference in the varying attitudes, there was an overall positive shift in the attitude of all the groups towards feeling more prepared after training. This illustrates that "Stop the Bleed" training empowers participants to act in situations involving bleeding. This perceived increase in *preparedness* is likely responsible for the observed post-training *willingness* to intervene.

Similar to the observed change in attitude, there was also a positive shift in the knowledge related to methods to stop life-threatening bleeding, i.e.: wound packing and tourniquet use. Participants' baseline knowledge of hemorrhage control appeared to follow similar distributions, regardless of their backgrounds. This result is understandable, as tourniquets and use of hemostatic agents while common in the military, are just beginning to be introduced to the civilian population and thus are not currently prevalent.[22] At baseline, participant knowledge of techniques to control bleeding roughly followed a normal distribution (Fig. 2). Our study demonstrates that BCon training improved this

Table 3
Non-paired data reflecting teaching feedback.

% Correct	Group 1		Group 2	
	Baseline	Post-teaching	Baseline	Post-teaching
Q5	70%	73%	85%	100%
Q6	78%	97%	70%	100%
Q7	11%	43%	17%	100%

Prior data set of 76 non-paired participants. Group 1 (n = 37). Group 2 (n = 39). Correct answers to questions 5–7 on survey. Feedback on percentage of correct answers given to instructors between sessions.

knowledge deficit, arming participants with appropriate information on how and when tourniquets and hemostatic gauze could be used to stop bleeding.

We additionally utilized the participants' answers to the true/false questions on the survey as a feedback mechanism. Specifically, we followed the percentage of correct responses on the post-survey and provided this information to our BCon instructors. Teaching was then adjusted so that subsequent sessions received emphasis on the key information points that had low correct scores from prior sessions. Interestingly, we noticed on the pre-survey that majority of participants believed that an improvised tourniquet made from a belt was just as effective as a commercial tourniquet. This is most likely due to misinformation, existing biases, and inadequate portrayals in pop culture/media. Therefore, this became one of the measures of for teaching efficacy as the courses continued.

Our training and research first started as part of a lecture series within our medical school surgical clerkship curriculum. As our teaching efforts have extended outside of the hospital and medical school, we have continued to collect data on participants before and after BCon training. This study is primarily limited by long-term follow-up of these trainees and assessment of the training in real world bleeding situations. By the end of the 2017–2018 academic year, “Stop the Bleed” training will be fully integrated and standardized into our medical school curriculum. We continue to work with our Trauma Prevention Coordinators and city wide Stop the Bleed collaborators to expand our combined teaching efforts throughout the non-medical community and continue to collect the same survey data from all participants.

Conclusion

We found BCon training to be an effective tool to build confidence in participant's willingness and preparedness to respond to a stranger with severe bleeding. We also noted that baseline knowledge of the use of tourniquets and hemostatic agents is limited, but training increases this knowledge and hopefully minimized barriers to intervention.

Author contributions

RL analyzed data, provided Stop the Bleed Training, prepared the manuscript.

MS analyzed data, performed statistical analysis, reviewed and edited the manuscript.

JH, BC, JBH, CW participated in study design, and reviewed and edited the manuscript.

SA participated in study design, provided Stop the Bleed Training, reviewed and edited the manuscript.

Disclosure

The authors report no proprietary or commercial interest in any product mentioned or concept discussed in this article.

Funding

This project was supported with funds from Center for Translational Injury Research (CeTIR).

Acknowledgements

Sarah Beth Abbott for facilitating all teaching sessions in and outside of the university, teaching hands on portions of the classes and scheduling additional instructors. George Tarver and Brett Dodwell for regularly providing BCon instruction.

References

1. Oyeniyi BT, Fox EE, Scerbo M, Tomasek JS, Wade CE, Holcomb JB. Trends in 1029 trauma deaths at a level 1 trauma center. *Injury*. 2017;48(1):5–12. https://doi.org/10.1016/j.injury.2016.10.037.
2. Rhee P, Joseph B, Pandit V, et al. Increasing trauma deaths in the United States. *Ann Surg*. 2014;260(1):13–21.
3. Dorlac WC, DeBakey ME, Holcomb JB, et al. Mortality from isolated civilian penetrating extremity injury. *J Trauma*. 2005;59:217–222.
4. Scerbo MH, Holcomb JB, Taub E, et al. The trauma center is too late: major limb trauma without a pre-hospital tourniquet has increased death from hemorrhagic shock. *J Trauma Acute Care Surg*. 2017;83(6):1165–1172.
5. Teixeira PGR, Brown CVR, Emigh B, et al. Texas tourniquet study group. *J Am Coll Surg*. 2018;226(5):769–776.
6. Scerbo MH, Mumm JP, Gates K, et al. Safety and appropriateness of tourniquets in 105 civilians. *Prehosp Emerg Care*. 2016;20(6):712–722.
7. Mell HK, Mumma SN, Hiestand B, Carr BG, Holland T, Stropyra J. Emergency medical services response times in rural, suburban, and urban areas. *JAMA Surg*. 2017;152(10):983–984.
8. Schnek E, Witjetunge G, Mann NC, Lerner EB, Longthorne A, Dawson D. Epidemiology of mass causality incidents in the United States. *Prehosp Emerg Care*. 2014;18(3):408–416.
9. Jacobs LM. The Hartford Consensus IV: a call for increased national resilience. *Bull Am Coll Surg*. 2016;101:17–24.
10. Stewart RM, Jenkins DH, Winchell RJ, Rotondo MF. ACS Committee on Trauma pledges to make zero preventable deaths a reality. *Bull Am Coll Surg*. 2016;101(10):23–28.
11. Pons PT, Jerome J, McMullen J, Manson J, Robinson J, Chapleau W. The Hartford Consensus on active shooters: implementing the continuum of prehospital trauma response. *J Emerg Med*. 2016;49(6):878–885.
12. Holcomb JB, Butler FK, Rhee P. Hemorrhage control devices: tourniquets and hemostatic dressings. *Bull Am Coll Surg*. 2015;100(1Supp):66–70.
13. Jacobs LM, Burns KJ, Langer G, Kiewiet de Jonge C. The Hartford Consensus: a national survey of the public regarding bleeding control. *J Am Coll Surg*. 2016;222:948–955.
14. Haider AH, Haut ER, Velmahos GC. Converting bystanders to immediate responders: we need to start in high school or before. *JAMA Surg*. 2017;152(10):909–910.
15. Goralnick E, Chaudhary MA, McCarty JC, et al. Effectiveness of instructional interventions for hemorrhage control readiness for laypersons in the public access and tourniquet training study (PATTS)A randomized clinical trial. *JAMA Surg*. 2018. https://doi.org/10.1001/jamasurg.2018.1099. Published online May 09.
16. Blair JP, Schweit KW. *A Study of Active Shooter Incidents, 2000-2013*. Texas State University and the Federal Bureau of Investigation, US Department of Justice; 2014.
17. Schweit KW. *Active Shooter Incidents in the United States in 2014 and 2015*. Washington D.C: Federal Bureau of Investigation, U.S. Department of Justice; 2016.
18. Biddinger PD, Baggish A, Harrington L, et al. Be prepared—the Boston Marathon and mass-casualty events. *N Engl J Med*. 2013;368(21):1958–1960.
19. Centers for Disease Control and Prevention. Accidents or unintentional injuries. https://www.cdc.gov/nchs/fastats/accidental-injury.htm; 2015. Accessed May 1, 2018.
20. Jacobs LM, Burns KJ. Tourniquet application training for individuals with and without a medical background in a hospital setting. *J Trauma Acute Care Surg*. 2015;72(2):442–445.
21. Ross EM, Redman TT, Mapp JG, et al. Stop the Bleed: the effect of hemorrhage control education on laypersons' willingness to respond during a traumatic medical emergency. *Prehospital Disaster Med*. 2018;33(2):127–132.
22. Bulger EM, Synder D, Schoelles K, et al. An evidence-based prehospital guideline for external hemorrhage control: american College of Surgeons committee on trauma. *Prehosp Emerg Care*. 2014;18(2):163–173. https://doi.org/10.3109/10903127.2014.896962.