Stop the Bleed: The Effect of Hemorrhage Control Education on Laypersons' Willingness to Respond During a Traumatic Medical Emergency

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Keywords: hemorrhage control training; stop the bleed; tourniquet training

Abstract

Background: The "Stop the Bleed" campaign advocates for non-medical personnel to be trained in basic hemorrhage control. However, it is not clear what type of education or the duration of instruction needed to meet that requirement. The objective of this study was to determine the impact of a brief hemorrhage control educational curriculum on the willingness of laypersons to respond during a traumatic emergency.

Methods: This "Stop the Bleed" education initiative was conducted by the University of Texas Health San Antonio Office of the Medical Director (San Antonio, Texas USA) between September 2016 and March 2017. Individuals with formal medical certification were excluded from this analysis. Trainers used a pre-event questionnaire to assess participants knowledge and attitudes about tourniquets and responding to traumatic emergencies. Each training course included an individual evaluation of tourniquet placement, 20 minutes of didactic instruction on hemorrhage control techniques, and hands-on instruction with tourniquet application on both adult and child mannequins. The primary outcome in this study was the willingness to use a tourniquet in response to a traumatic medical emergency.

Results: Of 236 participants, 218 met the eligibility criteria. When initially asked if they would use a tourniquet in real life, 64.2% (140/218) responded "Yes." Following training, 95.6% (194/203) of participants responded that they would use a tourniquet in real life. When participants were asked about their comfort level with using a tourniquet in real life, there was a statistically significant improvement between their initial response and their response post training (2.5 versus 4.0, based on 5-point Likert scale; $P < .001$).

Conclusion: In this hemorrhage control education study, it was found that a short educational intervention can improve laypersons' self-efficacy and reported willingness to use a tourniquet in an emergency. Identified barriers to act should be addressed when designing future hemorrhage control public health education campaigns. Community education should continue to be a priority of the "Stop the Bleed" campaign.

Ross EM, Redman TT, Mapp JG, Brown DJ, Tanaka K, Cooley CW, Kharod CU, Wampler DA. Stop the bleed: the effect of hemorrhage control education on laypersons' willingness to respond during a traumatic medical emergency. *Prehosp Disaster Med*. 2018;33(2):127-132.

Introduction

In October of 2015, the White House (Washington, DC USA) launched its "Stop the Bleed" initiative to address the concerns for the disturbing number of mass shooting incidents plaguing the United States.[1] The Federal Bureau of Investigation (FBI; Washington, DC USA), in cooperation with Texas State University (San Marcos, Texas USA), published a report in 2013 on the study of active shooter events in the United States demonstrating a concerning rise

Abbreviations:
CAT: Combat Action Tourniquet
CPR: cardiopulmonary resuscitation
RMT: Ratcheting Medical Tourniquet
SWAT-T: Stretch Wrap and Tuck Tourniquet

Received: May 1, 2017
Revised: July 23, 2017
Accepted: August 3, 2017

Online publication: February 19, 2018

doi:10.1017/S1049023X18000055

from the years 2000 to 2013.[2] The report clearly illustrated the increasing threat to the public and prompted a meeting of medical experts within the trauma community; the resulting Harford Consensus called for new protective and response measures within the community to respond to this rising threat.[3]

These studies suggest that active shooter incidents generally end prior to the arrival of any police or medical first responders. Additionally, the majority of these crime scenes are not deemed to be safe for medical responder entry until long after the violence has occurred. This phenomenon delays victims from receiving medical attention. This conceivably has contributed to loss of life that may have been saved by expedient medical care. The Hartford Consensus concluded that it is unreasonable to believe medical first responders can arrive in a timely enough fashion to respond. Therefore, bystanders need to be capable of rendering emergency first aid in order to save lives.

Bystander first aid has the potential to save lives in numerous situations. Ashour, et al identified that appropriate bystander actions at the scene of motor vehicle collisions would have resulted in 4.5% increased survival based on deaths from preventable causes.[4] According to the Fatal Injury Reports from the Centers for Disease Control's (CDC; Atlanta, Georgia USA) Web-based Injury Statistics Query and Reporting System (WISQARS), the death rate for motor vehicle collisions in the United States in 2014 was 10.58 per 100,000 (33,736 individuals).[5] Bystander action in these scenarios may translate into over 1,500 lives saved annually in the United States alone.

This study examines laypersons' ability and willingness to respond to medical emergencies and the perceived barriers to action. It also examines the impact of a brief educational intervention on hemorrhage control with the goal to identify sources for improved community education and public messaging to increase laypersons' sense of self-efficacy and improve the capacity within the community to respond to traumatic emergencies.

Methods

Design, Setting, and Participants

The University of Texas Health Science Center San Antonio Institutional Review Board (San Antonio, Texas USA) approved this study and was found to meet criteria for Non-Regulated Research, as a community outreach project (Protocol Number: HSC20160321N).

Investigators recruited participants through the University of Texas San Antonio student interest groups, the Southwest Regional Trauma Advisory Council (San Antonio, Texas USA) community education committee, and through personal connections within the San Antonio community. There were 236 participants who voluntarily applied for the class at multiple venues within Bexar County and Frio County, Texas. Venues included a community health fair, two elementary schools, community group meetings, the University of Texas at San Antonio student interest groups, San Antonio Airport Personnel public safety training, and a local musicians group rehearsal session.

Data collection occurred from September 2016 to March 2017. Individuals with a medical certification were excluded from analysis (Figure 1).

Volunteers completed a pre-event questionnaire (Appendix 1; available online only). Data regarding subject comfort levels, knowledge, and attitudes about tourniquets were collected with the pre-study questionnaire. Each training course included individual evaluation of tourniquet placement followed by 20 minutes of didactic instruction on hemorrhage recognition and control techniques (Appendix 2; available online only). The focus was on recognition of serious hemorrhage, the importance of direct pressure, and indications and techniques for tourniquet placement. Each session included time for hands-on instruction and practice of tourniquet application on both adult and child size mannequins. Following the completion of the event, all volunteers were asked to complete a post-event questionnaire with similar questions and the same knowledge assessment as in the pre-event questionnaire.

Figure 1. Participants in the Study.

Questionnaire

A simple questionnaire was used to capture participant demographics, medical experience and training, history of military service, self-assessed confidence with tourniquet placement and perceived safety, willingness to respond to a medical emergency involving hemorrhage, and perceived barriers to action. It also included a brief knowledge assessment on tourniquets. The questionnaire was completed prior to the start of the course and again at the completion.

Individual Assessment of Tourniquet Placement

Trainers asked all participants to place a tourniquet on a mannequin before beginning the course. Each participant was randomized, using online randomization generator, into one of 12 possible study arms. They included tourniquet type (Combat Action Tourniquet [CAT; North American Rescue, LLC; Greer, South Carolina USA], Ratcheting Medical Tourniquet [RMT; M2 Inc.; Winooski, Vermont USA], or Stretch Wrap and Tuck Tourniquet [SWAT-T; TEMS Solutions, LLC; Salida, Colorado USA]); mannequin type (adult or child); and location (upper extremity or lower extremity). Each participant was asked to place a tourniquet on the bleeding extremity to which they were randomly assigned. They were provided the

https://doi.org/10.1017/S1049023X18000055 Published online by Cambridge University Press

following scenario: "This person has an injury that has continued to bleed despite direct pressure on the wound. It has been determined they need a tourniquet. A tourniquet has been pulled from the public access bleeding control kit, and someone hands it to you. Please place the tourniquet so that it will stop the bleeding. Please let me know when you believe your placement is complete." The instructor would then hand the participant their designated tourniquet and start a timer. The timer would be stopped once the participant reported being done placing the tourniquet. The tourniquet placement would then be assessed for correct position, placement technique, and adequate tightness. Each mannequin was marked with a simple piece of moulage to identify the bleeding area. Correct position included any location on the injured limb proximal to the wound. Correct placement technique was observed if the participant used the device in a reasonable manner as compared to manufacturer provided instruction. Adequate tightness was present if the researcher was unable to slide a finger under the tourniquet. No instructions were provided to the participant, and no feedback was provided until after the exercise was complete. Following the exercise, the instructor would provide feedback on the correct placement and technique.

Statistical Analysis

Microsoft Excel (Microsoft Corp.; Redmond, Washington USA) was used to manage the data and SAS JMP (SAS Institute Inc.; Cary, North Carolina USA) for statistical analyses. Descriptive statistics were produced for analysis of demographics, and chi-square (or Fisher's exact) tests and t-tests were conducted to determine differences between the groups. Patient self-efficacy ratings were compared prior to and following the educational intervention using non-parametric Wilcoxon Signed-Rank paired test for location. The McNemar-Bowker test of symmetry was used for comparing opinions about tourniquet safety and willingness to use in real life prior to and following the educational intervention. Baseline and post-educational intervention knowledge questionnaire scores were compared using paired t-tests. Statistical significance was defined as $P < .05$, and 95% confidence intervals were obtained, when appropriate.

Results

The Questionnaire

Of 236 participants, 218 met the eligibility criteria (Figure 2). The participants were 68.1% female (147/216), with most reporting having completed some college or were currently attending college. Most participants were Hispanic (44.5%), under age 21 (29.8%), and reported earning < $25,000 per year (42.5%; Table 1).

When initially asked if they felt tourniquets were safe, 72.5% (158/215) said "Yes," and 2.3% (5/218) felt they were unsafe. Following training, 97.5% (199/204) felt tourniquets were safe, and only 0.5% (1/202) felt they were unsafe. Of those who initially felt tourniquets were unsafe, all felt they were safe following training. The one individual who felt tourniquets were unsafe following training previously reported feeling that they were unsure about the safety.

When initially asked if they would use a tourniquet in real life, 64.2% (140/218) responded "Yes." Following training, 95.6% (194/203) of participants responded that they would use a tourniquet in real life. Of the participants who initially responded "No" (2.8%; 6/218), all responded "Yes" following training. Before training, men were statistically more likely to respond "Yes" to using tourniquets than women (80.9% versus 57.1%; $P = .003$), but that difference resolved following training.

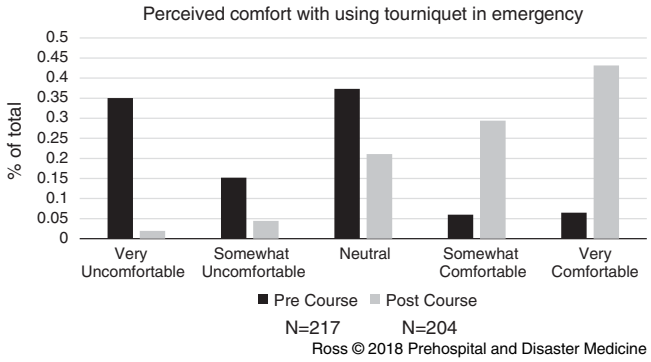

Figure 2. Perceived Comfort of Tourniquet Use.

Participant Demographics	
Age N = 217	
Mean Years (95% CI)	33.9 (32-36)
Sex (M) N = 216	
Male	31.9% (69)
Female	68.1% (147)
Race N = 218	
Asian	4.1% (9)
Black	17.9% (39)
Hispanic	44.5% (97)
White	33.5% (73)
Education N = 217	
College	30.0% (65)
Grade School	2.8% (6)
High School	10.1% (22)
Post Grad	8.3% (18)
Some College	48.8% (106)
Income N = 212	
<$25,000	42.5% (90)
$25,000-$49,999	22.2% (47)
$50,000-$100,000	25.9% (55)
>100,000	9.4% (20)

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Table 1. Participant Demographics

Prior to the training, participant overall comfort level with responding to an emergency was 3/5 (2-3 median IQR). Following training, the comfort level in applying a tourniquet was 4/5 (3-5 median IQR; Table 2). There was a statistically significant difference between men and women's post-training comfort with applying a tourniquet (4.35 versus 3.97; $P = .004$). When participants were asked about their comfort level with using a tourniquet in real life, there was a

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	No. (% participants)		
Survey Item	**Pre-Course**	**Post-Course**	**P Value**
Opinion on the safety of TQ	N = 218	N = 204	
Safe	158 (72.5%)	199 (97.5%)	<.001
Unsafe	5 (2.3%)	1 (0.5%)	
Unsure	55 (25.2%)	4 (2.0%)	
Opinion on the willingness to use a TQ in real life	N = 218	N = 203	
Yes	140 (64.2%)	194 (95.6%)	<.001
No	6 (2.8%)	1 (0.5%)	
Unsure	72 (33%)	8 (3.9%)	
Comfort level with using TQ in real life	N = 217	N = 204	
Median (IQR)	2.5 (1-3)	4 (3-5)	<.001
Comfort level with responding to medical emergencies	N = 214		
Median (IQR)	3 (2-3)		
Comfort level in applying a TQ		N = 204	
Median (IQR)		4 (3-5)	
Tourniquet general knowledge assessment	N = 217	N = 204	
Correct T/F Answers (95% CI)	4.1/5 (4.0-4.2)	4.7/5 (4.7-4.8)	<.001
Tourniquet placement knowledge	N = 209	N = 197	
Correctly Identified Images (95% CI)	3.1/4 (2.9-3.3)	3.6/4 (3.4-3.7)	<.001

Table 2. Participant Questionnaire and Knowledge Assessment
Abbreviation: TQ, tourniquet.

statistically significant difference between their initial response and their post-training response (2.5 versus 4.0; P < .001; Figure 2).

Barriers to responding during an emergency with tourniquets included:

1. Do not feel adequately trained to help (63.3%), more common in women than men (69.4% versus 50.7%; P = .008), and more common in those making <$25,000 (75.6%; P = .005);
2. Fear of making a mistake (45.4%), more common in women than men (55.8% versus 23.2%; P < .001);
3. Fear of causing more harm than good (42.2%), more common in women than men (46.9% versus 31.9%; P = .037), and more common amongst Asian participants (66.7%) and least common amongst Hispanic participants (33.0%);
4. Someone else would be more qualified to help (28.4%);
5. Fear of being sued (16.5%);
6. Fear of contracting a blood-related illness from the victim (12.4%);
7. Do not like blood (9.2%), more common in college grads (21.5%; P < .001), those making >$100,000 (25.0%; P = .001), and those ages 31-40 (25.0%; P = .006); and
8. Fear of being judged by others (5.0%), more common in those earning >$100,000 (20.0%; P = .012; Table 3).

Participants had a statistically significant improvement in basic tourniquet knowledge with an initial score of 4.1/5 increasing to 4.7/5 (P < .001) post training. There was also a statistically significant improvement in knowledge on where to place tourniquets with participants correctly identifying 3.1/4 correct placements at baseline and 3.6/4 (P < .001) following training.

Tourniquet Placements

The overall success rate for tourniquet placement was 17.7%. The rates of successful tourniquet application for the RMT, SWAT-T, and CAT were 23.5%, 11.3%, and 18.6%, respectively (P = .162). Participants with reported military service were statistically more likely to be successful (57.1%; P = .005). No other differences were noted based on demographics or reported prior tourniquet training. There were no statistically significant differences based on the extremity applied or mannequin type (adult versus child; Table 4).

Discussion

This study is one of the first to examine barriers to act for traumatic medical emergencies. It is also the first to document the outcomes from a "Stop the Bleed" campaign-focused educational program. The study found that most laypersons are not comfortable responding to a traumatic medical emergency.

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	No. (% participants)
Barriers to Action among Participants	N = 218
Do not feel adequately trained to help	138 (63.3%)
Fear of making a mistake	99 (45.4%)
Fear of causing more harm than good	92 (42.2%)
Other would be more qualified to help	62 (28.4%)
Fear of being sued	36 (16.5%)
Fear of contracting a blood-related illness from the victim	27 (12.4%)
Do not like blood	20 (9.2%)
Fear of being judged by others	11 (5.0%)

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Table 3. Participant Identified Barriers to Act

Tourniquet Placement Success		
	Total No. (%)	**P Value**
Combined (N = 209)	37 (17.7%)	
Tourniquet Type		.162
CAT (N = 70)	13 (18.6%)	
RMT (N = 68)	16 (23.5%)	
SWAT-T (N = 71)	8 (11.3%)	
Mannequin		.733
Adult (N = 102)	19 (18.6%)	
Child (N = 107)	18 (16.8%)	
Extremity		.965
Upper (N = 108)	19 (17.6%)	
Lower (N = 101)	18 (17.8%)	

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Table 4. Successful Tourniquet Placements
Abbreviations: CAT, Combat Action Tourniquet; RMT, Ratcheting Medical Tourniquet; SWAT-T, Stretch Wrap and Tuck Tourniquet.

Multiple barriers to act were identified, with the most common being feeling inadequately trained. Other significant barriers included fear of making a mistake and fear of causing more harm than good. The participants demonstrated a 30.0% increase in their willingness to use a tourniquet in real life following a short educational intervention. Additionally, of those participants who believed tourniquets were harmful before the class, all reported they thought they were safe following the class.

There were some significant demographic differences among the barriers to acting. Women were more likely to report fear of making a mistake, fear of causing more harm than good, and feeling inadequately trained to help. Women were also less likely to feel comfortable responding to a medical emergency and less likely to use a tourniquet in real life. Finally, women were less likely to be comfortable with their ability to apply a tourniquet, even after training. The actual ability of women to successfully place a tourniquet was no different than the men. Multiple previous studies evaluating bystander response and helping behavior have demonstrated significant gender differences.[6-8]

One unexpected finding was that those earning $25,000-$50,000 were much more likely to act than those earning >$100,000. Previous bystander response data for out-of-hospital cardiac arrest has found that lower socioeconomic status is associated with lower rates of bystander response.[9-11] The >$100,000 group did report higher rates of not liking blood and fear of being judged by others as barriers to action. These findings may account for the observed difference.

Other studies have shown educational interventions can significantly improve willingness to respond in an emergency. A 2009 study by Hamasu, et al looking at college students' willingness to perform cardiopulmonary resuscitation (CPR) showed that initially, individuals cited "knowledge of how to work an automated external defibrillator (AED) device" as a major limiting factor. In this study, training improved perceived willingness to respond from 13.0% prior to Basic Life Support training to 77.0% following training.[12] This study had similar findings with inadequate knowledge/training as the major limiting factor and noted significant improvement in perceived comfort following training.

The only major ethnic difference identified in this study was individuals that identified as Asian were far more likely to report fear of causing more harm than good. Additionally, those who identified as Hispanic were the least likely to report this as a barrier. This finding is consistent with prior findings by Shibata, et al when looking at a Japanese population.[13]

This study demonstrates that short educational interventions are adequate to improve laypersons' sense of self-efficacy and reported willingness to act. The longer commercial courses that are currently available are not necessary to achieve the public health goal of improved layperson preparedness and willingness to act.[1] This study also revealed an unacceptably high rate of failure of commercially available tourniquet application in the hands of untrained laypersons. Based on this study, and previous studies looking at layperson use of tourniquets,[14,15] it may be necessary to re-evaluate how commercially available tourniquets are manufactured and packaged in order to improve a tourniquet's usability by the lay public before the widespread dissemination of tourniquets will have a significant public health effect.

Future prospective studies are needed to assess the duration of the brief educational intervention impact. Military studies looking at recent recruits have demonstrated rapid skill degradation on tourniquet placement as soon as one week after the initial training.[16] Incorporating hemorrhage control training into public schools as part of a larger health education program may enable retention of these skills. A similar concept has already been implemented for CPR in some areas of the United States.[17] At least one county in Texas has adopted this approach to hemorrhage control training by including this instruction with every American Heart Association (AHA; Dallas, Texas USA) Basic Life Support and CPR course they teach.[18]

Limitations

This study has limitations. First, this study was part of a larger study specifically looking at different commercial tourniquets and

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the ability for laypersons to apply them in the absence of training. Although this study found no statistically significant differences between the different type of tourniquet used, the extremity, or type of mannequin with regards to successful tourniquet placement, differences existed in the tourniquet application assessments based on the participant's randomization.

Second, this study was focused on adults. Several high school and middle school students attend the classes, but they were excluded from the testing. A significant body of research has shown that teaching younger students may have a much larger impact than adults on community preparedness.[19,20] Future efforts should explore hemorrhage control education in teenagers as well.

Third, this study was a convenience sample from the community that volunteered to attend a class on controlling hemorrhage. The study found that overall less than 10.0% found blood as a barrier to act and only 12.4% were concerned about contracting a blood-related infection from the victim. Previous studies looking at bystander CPR and barriers to action found that around 16.0% of individuals voiced concerns over transmission of infection.[12,21] Additionally, these volunteers may be more enthusiastic about tourniquet use and more likely to respond to an emergency. This convenience sample may not have been an adequate representative sample of the entire community.

Finally, this study tested individuals in multiple different environments and venues. The various testing sites may have influenced the success of the participants and impact of the educational intervention. Every effort was made to ensure the educational content was standardized, but due to the multiple venues, the material was presented by large laminated slides, large screen projectors, and even handheld tablet computers.

Conclusion

In this hemorrhage control education study, it was found that a short educational intervention can improve laypersons' self-efficacy and reported willingness to use a tourniquet in an emergency. Identified barriers to act should be addressed when designing future hemorrhage control public health education campaigns. Community education should continue to be a priority of the "Stop the Bleed" campaign.

Acknowledgements

The authors would like to thank the San Antonio Fire Department, the Office of the Medical Director for the San Antonio Fire Department, and all the "Stop the Bleed" trainers for their contribution to this community outreach effort. They would also like to thank the Centre for Emergency Health Sciences (Spring Branch, Texas USA) and Scotty Bolleter for sharing his educational materials and expertise in the development of this project.

Supplementary Material

To view supplementary material for this article, please visit https://doi.org/10.1017/S1049023X18000055

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