Tourniquet application training for individuals with and without a medical background in a hospital setting

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The injuries to the children and adults killed at Sandy Hook Elementary School in Newtown, Connecticut, were immediately lethal.[1] However, that tragedy prompted the American College of Surgeons, an organization with a focus on prehospital and trauma care, to call for the creation of a committee to make recommendations regarding ways to increase survival from active shooter situations. The Joint Committee to Create a National Policy to Enhance Survivability from Mass Casualty Shooting Events was formed in 2013. After the Boston Marathon bombings, the committee expanded its focus to include all mass-casualty events. The recommendations of the committee became known as the Hartford Consensus, named for the city where the meetings took place and the fact that the group was able to reach consensus on what needs to be done to increase survival.

As shown at the Boston Marathon bombings, military-type injuries are now seen in the civilian sector. Injuries from blasts and high-velocity assault weapons can produce extremity injuries that can lead to exsanguination and death if not quickly controlled. The overarching principle of the Hartford Consensus is that in these events, no one should die of uncontrolled bleeding.[2,3] This means that extracavitary bleeding should be controlled at the scene with direct pressure, a hemostatic dressing, or a tourniquet, and those with intracavitary bleeding should be rapidly transported to a medical center for hemorrhage control.

As called for by the Hartford Consensus and as demonstrated at the Boston Marathon bombings, civilian, non medical bystanders can and will act as first responders. Those bystanders willing to assist the injured should have tourniquets accessible and the skill to control extracavitary hemorrhage. Based on the recommendations of the Hartford Consensus, officials at Hartford Hospital deemed it necessary to be prepared to respond to events that could result in life-threatening extremity hemorrhage. The purpose of this article is to describe a process that was used at Hartford Hospital to train individuals with and without a medical background to apply a tourniquet. Our objectives were as follows: (1) to assess training by evaluation of return demonstrations performed by all trainees; (2) compare trainees' confidence scores regarding tourniquet application from pretraining to posttraining period; and (3) compare confidence scores for medical versus nonmedical personnel.

METHODS

This educational project was reviewed by the Human Protection Program at Hartford Hospital and deemed that it did not meet the federal definition of research.

To prepare for a possible intentional event that could result in life-threatening extracavitary hemorrhage, bleeding control bags were placed in the main lobbies and the cafeteria of the hospital, and training in tourniquet application was offered to hospital personnel. The bleeding control bags are located next to publicly available automated external defibrillators. Each bag contains tourniquets and hemostatic dressings to treat approximately 14 extremity injuries. Funding for the equipment was provided by the Hartford Hospital Women's Auxiliary, which received a presentation on the need for publicly available tourniquets and a demonstration on the application of a combat style tourniquet.

During the spring of 2014, various groups throughout the hospital were offered the tourniquet application training on a voluntary basis. This included the board of directors, executive team members consisting of vice president–level staff, the LIFE STAR air-medical crew, management forum representatives consisting of managers, physicians, registered nurses, public safety officers, and other available staff. The public safety officers were especially targeted for training to comply with the Hartford Consensus recommendation that law enforcement personnel accept bleeding control as one of their core responsibilities.[2,3]

The training consisted of either a live demonstration of the application of a combat style tourniquet and return demonstration by the learners or a video demonstration and return demonstration. Initially, the live demonstrations were used for small groups of approximately 15 to 20 individuals. A 3-minute custom video was created to teach larger groups and on a more frequent basis. Both the live and video formats were a presentation by a trauma surgeon who explained and demonstrated the correct steps to apply a combat style tourniquet after first advising that personal safety should always be a priority. The trainees then practiced tourniquet application, and their skill was verified by the trauma surgeon or an emergency medical service provider who had been previously trained and verified as competent in tourniquet application. With the demonstration, time for questions and answers, and return demonstration, the entire training took approximately 15 minutes.

Upon completion of the training, it was expected that the trainees would be able to (1) state the indications for a

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tourniquet as extremity bleeding unable to be controlled with direct pressure; (2) describe the three steps of applying a tourniquet as placement, tightening, and securing; (3) identify that when a tourniquet is applied, it is important to note cessation of bleeding and elimination of the distal pulse; (4) state that the purpose of the pen in the bleeding control kit is to indicate on the victim the presence of a tourniquet and the time of application; and (5) correctly demonstrate application of a tourniquet. In addition to the objectives mentioned here, the return demonstration required the trainee to (*a*) correctly place the tourniquet 2 to 3 inches above the wound (hypothetical) over clothing or padding and (*b*) tighten the tourniquet and secure the windlass until the bleeding stops and the distal pulse is eliminated (hypothetical).[4–6] A fellow learner acted as a victim with a hypothetical injury for which the tourniquet was placed.

Before and immediately after the training, participants were asked to rate their level of confidence for five aspects of tourniquet application on a 5-point Likert-type scale, with 1 indicating "very little confidence" and 5 indicating "quite a lot of confidence." The five items requested confidence ratings for meeting the learning Objectives 1 through 5 as stated earlier. Participants were not required to indicate their names on the rating scales.

The pretraining and posttraining confidence scores for each question were examined descriptively with frequencies, percentages, and means for the entire group and for participants classed as medical (physicians and registered nurses) or nonmedical personnel (all other trainees). In addition, confidence scores were also examined for those participants who received the live presentation versus those who viewed the video presentation. The Wilcoxon signed-rank test was conducted to compare confidence scores for each item from pretesting to posttesting period. Mann-Whitney U-tests were used to compare differences in confidence scores between groups for each item. SPSS version 14 (Chicago, IL) was used for data analysis. A p value of 0.05 or less indicated statistical significance. A Bonferroni correction was made for multiple testing.

RESULTS

More than 200 staff members at Hartford Hospital received training in tourniquet application. Table 1 lists the various groups that were trained. Greater than 75% of these individuals, although employed in health care, were nonmedical personnel.

TABLE 1. Professional and Organizational Groups Trained at Hartford Hospital in Tourniquet Application

Board of directors, n =15
Women's Auxiliary, n =30
Administrators (other than physicians and registered nurses), n =72
Physicians, n =19
Registered nurses, n =34
Public safety officers, n =71
Others, n =30

The Board of directors and members of the Women's Auxiliary did not complete the pretests and posttests of confidence. Eight individuals did not identify their group membership.

TABLE 2. Mean Scores for the Confidence Items Pre to Post-training for all Learners

Item	Pretraining	Posttraining
1. State the indications for a tourniquet.	3.27 (1.56)	4.70 (0.69)
2. Describe the three steps of applying a tourniquet.	2.56 (1.51)	4.66 (0.72)
3. Identify what is important to note when a tourniquet is applied.	2.89 (1.62)	4.75 (0.63)
4. State the purpose of the pen in the bleeding control kit.	2.66 (1.70)	4.82 (0.62)
5. Correctly apply a tourniquet.	2.80 (1.58)	4.71 (0.66)

For each item, the number of respondents was 229 or 230. SDs of the means are in parentheses. Increases on all items are significant at $p = 0.000$ based on Wilcoxon signed-rank tests with a Bonferroni correction.

Regarding actual skill, successful return demonstration by all trainees confirmed their ability to apply a combat style tourniquet when assessed for correct placement, tightening of the tourniquet, securing of the windlass, and verbalizing the assessment of the cessation of bleeding and elimination of the distal pulse (hypothetical).

Inspection of the confidence scores for all groups of learners indicated that the mean scores on each of the post-training evaluation items were greater than 4.50, indicating high perceived confidence. For each item, greater than 93% of the respondents rated their confidence as 4.0 or greater after the training. Learners' scores on each item increased significantly from pretesting to posttraining period ($p = 0.000$). Table 2 presents the pretraining and posttraining mean scores on confidence for each item for all groups combined.

Examination of the confidence scores for the medical personnel revealed that for each posttraining item, greater than 98% selected a 4.0 or a 5.0. Of the nonmedical personnel, greater than 90% selected a 4.0 or 5.0 for the all posttraining items. When the posttraining confidence scores were compared

TABLE 3. Mean Scores for the Confidence Items After the Training for Medical and Nonmedical Personnel

Item	Medical Personnel, n = 53	Nonmedical Personnel, n = 169 (170 for Items 3 and 4)
1. State the indications for a tourniquet.*	4.94 (0.23)	4.63 (0.77)
2. Describe the three steps of applying a tourniquet.	4.89 (0.32)	4.58 (0.80)
3. Identify what is important to note when a tourniquet is applied.	4.94 (0.23)	4.70 (0.70)
4. State the purpose of the pen in the bleeding control kit.	4.96 (0.19)	4.77 (0.71)
5. Correctly apply a tourniquet.	4.87 (0.39)	4.65 (0.73)

*Scores of medical personnel were significantly higher than the nonmedical personnel at $p = 0.002$ based on Mann-Whitney U-test with a Bonferroni correction.
SDs of the means are in parentheses.

TABLE 4. Mean Scores for Confidence Items After the Training for Those Who Received a Live Demonstration and Those Who Viewed a Video Demonstration of Tourniquet Application

Item	Live Demonstration, n = 138	Video Demonstration, n = 91 (92 for Items 3 and 4)
1. State the indications for a tourniquet.	4.67 (0.76)	4.75 (0.57)
2. Describe the three steps of applying a tourniquet.	4.69 (0.73)	4.60 (0.70)
3. Identify what is important to note when a tourniquet is applied.	4.71 (0.74)	4.82 (0.42)
4. State the purpose of the pen in the bleeding control kit.	4.76 (0.76)	4.89 (0.31)
5. Correctly apply a tourniquet.*	4.80 (0.62)	4.58 (0.72)

*Scores of those receiving the live demonstration were significantly higher than those who viewed a video demonstration at $p = 0.003$ based on Mann-Whitney U-test with a Bonferroni correction.

SDs of the means are in parentheses.

for the medical versus the nonmedical personnel, the medical group scored significantly higher on the first item regarding stating the indications for a tourniquet ($p = 0.002$). Table 3 presents the mean confidence scores after training for each item for the medical and the nonmedical personnel. When trainees were compared as to whether they received a live presentation or a video demonstration, those receiving a live presentation rated their confidence for correctly applying a tourniquet (Item 5) significantly higher than those who received a video demonstration ($p = 0.003$). Table 4 presents the mean confidence scores for those who received the live demonstration and those who viewed the video demonstration.

DISCUSSION

A recent 12-year review of gunshot wounds at an urban Level I trauma center has demonstrated an escalating pattern of the extent and severity of injury from gun violence.[7] During the last 5 years, there has been a growing number of mass killings in the United States.[8] Events such as the Boston Marathon bombings and the school stabbings in a high school outside Pittsburgh indicate that hemorrhage can result from these other forms of violence.[9,10] As noted by the American College of Surgeons' Committee on Trauma (COT), external hemorrhage is recognized as a major source of potentially preventable death.[11] An expert panel convened by the COT has recommended the use of tourniquets in the civilian prehospital environment.[11]

The benefits of tourniquets in the military through the Tactical Combat Casualty Care (TCCC) initiative provided evidence used by the COT to support its recommendation.[11] One study of 4,596 US combat fatalities from 2001 to 2011 documented that the death rate from peripheral-extremity hemorrhage decreased from 23.3 deaths per year when tourniquets were not used to 3.5 deaths per year when tourniquets were fully implemented.[12] Another study from the military showed that tourniquet use before the onset of shock is strongly related to survival.[13] In addition, the military has shown that the morbidity risk associated with tourniquet use is low and the benefit clearly outweighs the risk; one study found no loss of limb associated with tourniquets in 232 patients.[14]

The project reported here lends support (1) that tourniquet application training can be accomplished in a brief education session; (2) that medical and nonmedical individuals can successfully provide an accurate return demonstration of tourniquet application; and (3) that individuals with medical and nonmedical backgrounds can become confident in tourniquet application. Although there were significant differences between the medical and nonmedical personnel for posttraining confidence for stating the indications for a tourniquet, the mean scores for both groups were greater than 4.50, indicating high confidence. Similarly, the trainees who received a live demonstration had higher posttraining confidence scores for correctly applying a tourniquet than those who viewed a video demonstration. The mean score for that item for the video group was greater than 4.50, indicating high confidence. In both instances, the differences, although significant, are small and can be considered unimportant.

A qualitative assessment of the training indicated that most learners seemed ready and willing to learn, even those without a medical background. It seems that they recognized the importance of the acquisition of this skill and achieved a sense of satisfaction as their confidence and ability to apply a tourniquet were realized. Verbal reports by the public safety officers indicated acceptance of this skill into their role as their moniker implies, that is, public safety. Since the training reported here, other groups have asked to be trained, and this will be forthcoming.

With the ever increasing incidents of shootings, stabbings, and mass-casualty events, it is time to teach hemorrhage control techniques and tourniquet application to individuals working in places frequented by the public as well as to any interested citizen. In particular, school personnel should be targeted for hemorrhage control and tourniquet application training. Since the Sandy Hook Elementary School shootings of December 14, 2012, through June 10, 2014, there have been 74 school shootings in the United States.[15]

Although the TCCC guidelines for military tactical care are comprehensive, it seems that the models already in place by TCCC to teach military personnel tourniquet application can be formally modified to teach civilian, nonprofessional audiences tourniquet application. Modification of the TCCC guidelines for use by professional civilian first responders has been completed by the Committee for Tactical Emergency Casualty Care.[16] The National Association of Emergency Medical Technicians offers a course consistent with the principles of Tactical Emergency Casualty Care to civilian law enforcement and other professional first responders.[17] These programs could be adapted to focus on bleeding control training for civilian bystanders.

The promotion and delivery of training can perhaps be accomplished in a manner similar to how the American Heart Association and the American Red Cross promote cardiopulmonary resuscitation (CPR) to the public. However, unlike CPR training, individuals will need to be taught to first consider

their personal safety. As recommended by the Hartford Consensus, the concept of "run, hide, fight" must be taught.[3] However, it is recognized that bystanders may wish to render assistance or that they may be sheltered in place with injured individuals during which time they can provide care.

To promote widespread adoption of bystander tourniquet application training and to avoid barriers such as those that have occurred with bystander CPR training, the approach should be driven by principles supported by implementation science as promoted by the National Institutes of Health and the Agency for Healthcare Research and Quality.[18–20] Implementation is "the use of strategies to adopt and integrate evidence-based health interventions and change practice patterns within specific settings."[21] More specifically, implementation science attempts to understand barriers and facilitators that affect successful adoption of a program.[22] Research has demonstrated that when programs are carefully implemented with consideration of contextual factors and when significant obstacles to implementation are avoided, better outcomes result.[23] Interested organizations and stakeholders should be surveyed regarding potential barriers and facilitators to the training and adoption of bystander tourniquet application. A national body should be designated to implement the training and endorse bystander hemorrhage control and tourniquet application. Creative efforts will be needed to secure funding for tourniquet application training and the placement of tourniquets in convenient and accessible locations.

Leadership at all levels of government and the private sector needs to be aware that survival from intentional mass-casualty events can be increased if citizen bystanders know what to do and have the proper equipment to control bleeding. Although the Hartford Consensus has made several recommendations to increase survival from intentional mass-casualty incidents, this article has focused on what can be done at a local level to teach civilian bystander tourniquet application. We believe that training of civilians in tourniquet application and accessibility of tourniquets should become widespread.

DISCLOSURE

The authors declare no conflicts of interest.

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