Effective Hospital-Wide Education in Hemorrhage Control

James R Hegvik, MD, Sarah K Spilman, MA, Sherry D Olson, RN, BSN, Carrie A Gilchrist, RN, BSN, Richard A Sidwell, MD, FACS

BACKGROUND: Uncontrolled hemorrhage is the leading cause of potentially preventable traumatic death. Bleeding victims must receive immediate medical attention to save lives, and the first opportunity to control bleeding after trauma often comes from bystanders. Educating the general public is important for improving outcomes for hemorrhaging victims, and it is imperative for all people, including those with no clinical training, to have the knowledge to respond until trained medical specialists arrive.

STUDY DESIGN: An 8-minute educational module was deployed to all hospital employees and included information on the location and contents of hemorrhage control bags in the hospital and how to use the materials in the bags to respond to uncontrolled hemorrhage. A pre-post questionnaire was administered with the module to evaluate effectiveness. McNemar tests were used to compare the responses and evaluate effectiveness of the education.

RESULTS: Eighty-four percent of eligible employees (n = 4,845) completed the module and all items on the questionnaires. Three-quarters of respondents provided direct or ancillary care to patients, and one-quarter worked in nonclinical roles. On average, 57% of questions were answered correctly in the pre-questionnaire and 98% were answered correctly in the post-questionnaire. The module was effective for all employees regardless of clinical training.

CONCLUSIONS: There is currently no succinct hemorrhage control education available that can be deployed across a large workplace environment. Results demonstrate that the brief learning module was effective in educating all employees in the basics of hemorrhage control. The module could be deployed in clinical and nonclinical settings. (J Am Coll Surg 2017;–:1–6. © 2017 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

Uncontrolled hemorrhage is responsible for 30% to 40% of all traumatic deaths and is the leading cause of preventable traumatic death.4,5 Previous understanding of how to handle a hemorrhaging patient at the scene of injury was for bystanders to notify help and await emergency medical services arrival.5–7 It is now known that maximizing victim survival requires a different kind of response. The first person to the scene needs to be equipped with the knowledge and tools to assist a hemorrhaging victim, as there often is not time to wait for emergency personnel to arrive.8

To maximize chances of saving lives, many national organizations, including the American College of Surgeons Committee on Trauma, have worked to highlight the importance of rapid response to hemorrhaging patients.4,6,9,10 Efforts have focused on applying battlefield knowledge to the civilian setting so that prehospital and hospital personnel are prepared for mass casualty events.2,6,11,12 The first person to the scene of any trauma, however, is likely to be a bystander, who may likely have no first aid or clinical training.13 Experts recognize that bystanders need to be the first care providers at the scene, therefore, the general public should possess basic knowledge for recognizing and controlling hemorrhage until emergency medical services or medical personnel arrive.4,6,11,14,15 In a nationally representative survey of the general public, Jacobs and colleagues12 found that the majority of respondents support training the public...
in hemorrhage control techniques and indicated that they would be willing to aid a bleeding victim. However, they also express that they would be concerned about providing such assistance due to concern for their personal safety and fear of doing more harm than good.

Despite tremendous efforts at the national level, there is still a lack of organized and widespread education for teaching hemorrhage control techniques to individuals with little or no medical training.4,9,12 Bleeding Control for the Injured teaches basic hemorrhage control skills to people who have little medical experience with hemorrhage control,7 but the course requires on-site participation. The majority of respondents (55%) had direct patient care responsibilities, 20% provided ancillary care service, and 25% were nonclinical. The questionnaires were developed collaboratively by the study team. Before starting the module, each participant completed a 10-question pretest that included 7 questions to assess knowledge of hemorrhage control techniques and response procedures, as well as 3 questions to assess clinical training and hospital role. The participants then answered the same questions after completing the module, with pre- and post-test items worded identically to evaluate the effectiveness of the training. The questions and responses are listed in eDocument 1. Pre and post data were linked by employee identification number, and respondents were excluded from analyses if they did not answer every question in the pre- and post-tests (n = 307 [5.3%]). Permission was granted by the hospital’s IRB to access the questionnaire data retrospectively, therefore, the requirement of informed consent was waived by the IRB.

Study variables
There were 7 multiple-choice questions about the BCBs and hemorrhage control techniques (see eDocument 1). Each item was coded dichotomously for a correct or incorrect answer, and comparisons assessed improvement in study responses after completing the module. In addition, the respondents indicated their role at the hospital (direct patient care, ancillary care, or nonclinical), if they had any first aid training or training in the control of severe bleeding, and their highest level of education.

Statistical procedures
All analyses were performed with IBM SPSS Basic Statistics for Windows, version 20.0 (IBM Corp). Categorical data were reported as count and percentage. The McNemar test of 2 binary outcomes was used to test whether respondents demonstrated increased knowledge after completing the learning module. All statistical tests were evaluated based on a 0.05 significance level.

RESULTS
A total of 4,845 employees completed the education module and answered all questions on the pre- and post-tests, which represents an 84% response rate. The majority of respondents (55%) had direct patient care responsibilities, 20% provided ancillary care service, and

METHODS
Study design
This study tested the effectiveness of a hemorrhage control education module using a pre-post study design. In May 2016, the trauma services department at an adult Level I trauma center launched an educational module to train all employees across a city-wide health system in hemorrhage control techniques. The health system includes 4 hospitals in the metropolitan area, with a total of 5,800 full-time employees. All hospital employees were required to complete the training as part of their annual educational requirements. Employees received an email invitation from hospital leadership, and the computer module and electronic surveys were automatically deployed to their employee accounts. All data were collected prospectively from May 2016 through August 2016.

The impetus for the study was the acquisition and positioning of 27 bleeding control bags (BCB) across 4 hospital locations in late 2015 (QuikClot Bleeding Control Bag; Z-Medica). The Emergency Preparedness Committee was then faced with the difficulty of educating all staff on the location and use of the BCBs. To address this issue, an 8-minute education module was designed by trauma services personnel to introduce the location, contents, and use of the BCBs. The module also taught how to apply direct pressure to compress bleeding and how to use the Stretch, Wrap, and Tuck (SWAT) tourniquet. The module format included short videos, interactive screens, and opportunities for participants to engage in the content electronically (eAppendix 1).

The questionnaires were developed collaboratively by the study team. Before starting the module, each participant completed a 10-question pretest that included 7 questions to assess knowledge of hemorrhage control techniques and response procedures, as well as 3 questions to assess clinical training and hospital role. The participants then answered the same questions after completing the module, with pre- and post-test items worded identically to evaluate the effectiveness of the training. The questions and responses are listed in eDocument 1. Pre and post data were linked by employee identification number, and respondents were excluded from analyses if they did not answer every question in the pre- and post-tests (n = 307 [5.3%]). Permission was granted by the hospital’s IRB to access the questionnaire data retrospectively, therefore, the requirement of informed consent was waived by the IRB.
25% were in nonclinical roles. Nearly 30% of respondents had no first aid training, and 17% of respondents held a high school degree or lower.

As shown in Table 1, respondents answered more questions correctly after completing the educational module. On the pretest, 57% of all questions were answered correctly; this rate rose to 98% accuracy in the post-test. In the pretest, more than three-quarters of respondents correctly identified the first person to attempt to stop bleeding and the first step when approaching an injured person. However, pretest data also revealed that less than half of respondents knew the location of the BCBs, the items in the bags, and the proper technique to control bleeding before they completed the module. The greatest improvement was noted on the technique of the SWAT tourniquet stretch, which increased from 22% in the pretest to 97% in the post-test.

Baseline knowledge was positively correlated with advanced training in bleeding control ($r = 0.14; p < 0.001$) and having a bachelor’s degree or higher ($r = 0.07; p < 0.001$). As expected, baseline knowledge was negatively correlated with having a nonclinical role at the hospital ($r = -0.08; p < 0.001$) and having no first aid training ($r = -0.12; p < 0.001$). Knowledge in the post-test, however, was not significantly associated with role in the hospital or first aid training.

**DISCUSSION**

Although there is more attention on efforts to educate the public in hemorrhage control techniques, there is not yet a succinct, efficient, and feasible way to educate a large group of people. The objective of this study was to assess whether an electronic educational module about hemorrhage control could be satisfactorily deployed to a workforce. Results suggest that we were able to successfully and efficiently provide basic knowledge of hemorrhage control to more than 4,800 hospital employees. Notably, the module was equally effective for clinical and nonclinical staff.

Bystanders have a significant role to play in trauma response, whether they are the first person at the scene of a single-victim car crash or an uninjured person at the site of a mass casualty event. The goal is to minimize delay between injury and initial treatment to control hemorrhage. We believe that with a short interactive computer module, the general public can be educated about the importance of hemorrhage control and, more importantly, how to locate and use bleeding control equipment to treat someone with uncontrolled hemorrhage.

Offering hemorrhage control education to hospital employees is an important first step to building community preparedness and resiliency. The research effort tested the efficacy of the module, but educating healthcare employees also contributes to the local community by educating a substantial segment of the population. According to the Bureau of Labor Statistics, approximately 13% of the workforce is employed in the healthcare sector, making it one of the top industry sectors in the country. Educating employees in this segment improves the overall chances that a bystander will have the appropriate knowledge to intervene in an emergency situation.

This effort serves as the launching point for many hospital- and community-wide efforts. First, the module remains active and is deployed to newly hired employees. It also will be an annual education requirement. We plan to review pretest data when employees complete the module after 12 months to assess retention. Second, we are looking for ways to incorporate hemorrhage control skills as an adjunct to other hands-on training sessions at the hospital. Finally, this effort serves as the foundation for a community-wide effort to educate the citizens in our city. A new module is being produced to educate citizens on the basics of hemorrhage control and the ways they can respond to a bleeding victim.

We acknowledge that there are limitations to this study. First, it is unclear how much information the respondent

---

**Table 1. Percentage of Respondents with Correct Answers in the Pre- and Post-Tests (n = 4,845)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pretest</th>
<th>Post-test</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location of bleeding control bag</td>
<td>2,182</td>
<td>4,803</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Items in bleeding control bag</td>
<td>2,285</td>
<td>4,805</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>First person to attempt to stop bleeding</td>
<td>3,753</td>
<td>4,809</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>First step when approaching an injured person</td>
<td>4,381</td>
<td>4,701</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Proper technique to control bleeding by direct pressure</td>
<td>2,098</td>
<td>4,534</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Stretch, Wrap, and Tuck tourniquet stretch</td>
<td>1,043</td>
<td>4,681</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Stretch, Wrap, and Tuck technique and placement</td>
<td>3,466</td>
<td>4,783</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
retains after completing the module. Second, this module does not provide hands-on training and we cannot verify that individuals could use the BCBs to control hemorrhage.

CONCLUSIONS
It is imperative that the general public is knowledgeable in the basic tenets of hemorrhage control. Study results demonstrate that a brief electronic educational module could effectively educate employees in a large workplace on the basics of hemorrhage control.

Author Contributions
Study conception and design: Hegvik, Spilman, Olson, Gilchrist, Sidwell
Acquisition of data: Hegvik, Spilman, Olson, Gilchrist, Sidwell
Analysis and interpretation of data: Hegvik, Spilman, Sidwell
Drafting of manuscript: Hegvik, Spilman
Critical revision: Hegvik, Spilman, Olson, Gilchrist, Sidwell

Acknowledgment: The authors would like to thank Sue Riedemann for her assistance in deploying the online education module.

REFERENCES
eDocument 1. PRE-/POST-TEST QUESTIONS
(CORRECT ANSWER IS IN BOLD TYPE)

1. Where can you find a Bleeding Control Bag?
   A. Code carts
   B. Supply rooms
   C. Next to fire extinguishers
   D. Public areas, adjacent to automatic external defibrillators (AEDs)

2. Which of the following is not in a bleeding control bag?
   A. Shears
   B. Suture material
   C. Gauze
   D. Tourniquets

3. Who should be the first person to attempt to stop an injured person’s bleeding?
   A. The first person present, regardless of medical background, once the injury scene is safe
   B. Emergency medical services (EMS) provider, once the injury scene is safe
   C. EMS provider, once the victim has been evacuated from the injury scene
   D. The Medical Emergency Team or Code team in the hospital

4. What is the first step when approaching an injured, bleeding person?
   A. Hold the victim’s head and neck still
   B. Protect yourself—make sure the scene is safe
   C. Cut away clothing to expose the area that is bleeding
   D. Place the victim in a “rescue” position

5. To control bleeding by direct pressure, you should:
   A. Compress a “pressure point” above the area that is bleeding
   B. Wrap gauze around the bleeding wound
   C. Pack gauze into the wound and firmly hold pressure at the site of bleeding
   D. Apply pressure 2 inches above and 2 inches below the area that is bleeding

6. The Stretch Wrap and Tuck (SWAT) tourniquet should be stretched tightly until:
   A. The “circles” flatten into straight lines
   B. The “ovals” turn into “circles”
   C. The “SWAT” lettering reaches the square boxes
   D. The victim begins to experience pain from the tightness

7. Correct use of a SWAT tourniquet includes which of the following:
   A. Place approximately 2 inches above the bleeding wound
   B. Cover the joint (elbow, knee) if that is where the bleeding is located
   C. Wrap one time tightly around the extremity to stop the bleeding
   D. Loosen the tourniquet if it is causing pain for the victim
Effective Hospital-Wide Education in Hemorrhage Control
James R Hegvik, MD, Sarah K Spilman, MA, Sherry D Olson, RN, BSN,
Carrie A Gilchrist, RN, BSN, Richard A Sidwell, MD, FACS
Uncontrolled hemorrhage is the leading cause of potentially preventable traumatic death. Currently,
there is no way to efficiently educate large groups in hemorrhage control techniques. Results demon-
strate that an 8-minute module deployed electronically was effective in educating employees in the
basics of hemorrhage control.