A Randomized Controlled Trial With Retention Testing to Determine the Most Effective Intervention for Hemorrhage Control Readiness for Laypersons: The PATTS Trial

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Study Protocol and Statistical Analysis

a. Study design:

a. Prospective, randomized, multi-arm, open-label trial with follow-up retention testing

b. Location:

a. Gillette Stadium, Foxborough, Massachusetts, USA.

c. Consent:

a. Participation in the study was voluntary and oral consent was obtained from all subjects. A fact sheet was provided to all participants.

d. Inclusion/Exclusion criteria:

a. Adult (18 years and above) volunteers with no prior hemorrhage control training or experience were included in the trial.
b. Anyone with previous formal hemorrhage control or tourniquet training was excluded from the trial analysis.

e. Randomization:

1. Eligible study subjects were randomized into the following arms using block randomization such that for every four participants, one was randomized to each of the four arms:
    - ***i. Control arm:*** Study subjects in this arm of trial received no intervention (no training or access to point-of-care prompts) to assess baseline competence in hemorrhage control.
    - ii. ***Experimental arm 1:*** Study subjects in this arm were given the American College of Surgeons Bleeding Control Basic (B-Con) in-person training course by qualified instructors. This curriculum was developed by a collaboration between American College of Surgeons and the Hartford Consensus.[9] The session included a multimedia presentation in a class format that included some background information about extremity hemorrhage and potential benefits of immediate first-response and hemorrhage control, steps to take in a mass casualty scenario and instructional videos on hemorrhage control modalities and their appropriate use. This was followed by hands on training in hemorrhage control, with 1:4, instructor to trainee ratio.
    - iii. ***Experimental arm 2:*** Study subjects in this arm received a commercially available audio bleeding control kit. The kit included diagram and visual aids to identify the correct severity of injury and determine the appropriate method of bleeding control. The kit also had buttons on it to play stepwise audio instructions on application of compression dressing, hemostatic packing and tourniquet application in two languages (English and Spanish). The audio kits were bought at market price and the name of the manufacturer was not mentioned in the manuscript to avoid conflict of interest.
    - iv. ***Experimental arm 3:*** Study participants in this arm of the trial received bleeding control flashcards that contain diagrams and figures to correctly identify the severity of injury and visual instructions on appropriate application of pressure dressing, hemostatic packing and tourniquet.

f. Sample size calculation:

- ***a.*** Sample Size calculation was done using Stata v14.1 with 80% power and an alpha level of 0.05. Trial arm paired-comparisons were taken as independent trials and sample size was calculated for each pair. The largest number was taken as the sample size for each arm. The smallest difference in application rate, and the arm used to determine sample size calculation, was between the control and flashcard arm.
  - ***i.*** Control group expected application rate 20% based on prior studies
  - ***ii.*** Flashcard Proportion expected application rate 44% based on prior studies
- ***b.*** Final sample size is 412 with 103 subjects in each arm. This is before exclusion of individuals with prior hemorrhage control training thus, to account for 20% of individuals to report prior training, over 125 individuals will be recruited to each arm.

g. Pre-study questionnaire:

- ***a.*** Study subjects were given a pre-trial questionnaire to gather information regarding age, gender, level of education, any prior first-aid training, and if they reported prior first-aid training, whether it included hemorrhage control training. Those individuals who reported prior hemorrhage control training were then asked an open ended question about what that training consisted of. The questionnaire also included questions to determine participants willingness to assist in an emergency and self-reported comfort level in acting as a first-responder in a mass causality scenario. Answers were presented on a Likert-type scale.

h. Post-trial questionnaire:

- ***a.*** After the hemorrhage control test, all participants were given a post-trial questionnaire which assessed their perception of usefulness of the training, willingness and self-reported comfort-level in providing first response in a mass causality scenario on a Likert-type scale.
- b. Questionnaires will also be re-administered at 3-9 month retention testing, which will assess participant perception of usefulness of the training, self-reported willingness and comfort-level in providing first response in a mass causality scenario on a Likert-type scale as well as other questions relating to emergency preparedness and hemorrhage control.

i. Protocol:

a. A reviewer will read aloud a simulated scenario describing an explosion in a public gathering. A bleeding mannequin with traumatic amputation of leg just above the knee will be present. The participant will then be directed to a nearby bleed-control box and asked to stop the bleeding. The bleed-control box will contain a combat application tourniquet (CAT). The reviewer will start timing after directing the subject to the bleed-control box.

Subjects in the control arm were directly subjected to the bleeding control test. Experimental arm 1 subjects will attend B-Con course taught by ACS trained instructors and then subjected to the test. Experimental arm 3 and 4 subjects received an audio guide and flash card in their bleed-control box respectively,

during the test. At retention testing, participants were not retrained nor had available point of care prompts.

The participants were timed until they feel that they had stopped the bleeding. Time for complete bleeding control and tourniquet application was recorded only for subject who appropriately control the hemorrhage within 7 minutes. Appropriateness of hemorrhage control was determined by correct placements of tourniquet and adequate pressure of the tourniquet as determined by attempting to forcefully slide a Kelly clamp under between the tourniquet and the extremity of the mannequin. For unsuccessful hemorrhage control, the reason for failure was recorded. No feedback was given to the participant during the test.

b. 20 reviewers were used for the purpose of this study. All the reviewers were physicians, nurses, and EMTs, trained in hemorrhage-control.

1. After testing of the two point of care prompt arms and the control arm, these individuals then underwent the ACS B-Con training from qualified instructors. This training was 45 to 60 minutes long, consisting of an audio-visual presentation with tourniquet application instructions followed by hand-on training under the supervision of an instructor, the same as the B-Con intervention arm.
2. ***Test for retention:***
    a. 3-9 months after the trial, we planned to test all study subjects with a simulated mass causality scenario for retention of knowledge and skills. This test will be the same as the initial test for competence at tourniquet placement in the trial and the same evaluation form will be used to evaluate the study subjects.

j. Donation of study material:

a. At the end of the retention study, the bleeding control boxes will be donated to the stadium, to be co-located with AEDs.

1) ***Statistical analysis:***

a) The primary outcome in our study was the correct application of tourniquets. The main analyses in the randomized study were the pairwise comparisons of the proportion of correct tourniquet application in each of the three intervention arms to the control arm.

b) In the initial testing phase, the proportion of participants who correctly applied a tourniquet in the three intervention arms were compared to control using three pairwise two-sided Fisher's Exact Test of the three interventions to control in an intent-to-treat analysis (as randomized).

c) To analyze retention, we performed two pairwise comparisons: 1) all participants tested at retention versus initial control to identify long-term efficacy (correct tourniquet application) compared to no training; 2) participants tested at retention versus initial testing in B-Con randomized arm to identify if there is a significant skill decay 3-9 month after training. Generalized estimating equations z-tests were used in these pairwise tests to account for the repeated measures on participants who were in both the initial and retention phases.

d) At retention testing, an a priori planned logistic regression analysis was performed to identify any demographic associations with correct tourniquet application between 3 and 9 months after B-Con training. It also assessed for different effects due to the original (randomized) arm in initial testing in case the combination of randomized arm and then

B-con training had differential effects on correct tourniquet application (although our a priori hypothesis was that there would be no difference). Age was divided into categorical variables creating three groups using previously defined age breaks: young adult [18-35 years old (yo)], middle aged adult (35-55 yo), and older adult (> 55 yo). This model assessed for an association between days since training to retention testing, allowing for a non-linear effect. We assessed for co-linearity, and interactions between variables [age and education, age and sex, age and prior training, sex and education, sex and prior training] and ran diagnostics on the model fit. We used Hosmer and Lemeshow's goodness-of-fit test to evaluate our model.

e) The Wilcoxon rank sum test was used to compare time to correct tourniquet application across arms (restricted to participants in each arm who correctly applied the tourniquet). Demographic variables for each intervention arm versus control and retention versus control were compared using Wilcoxon rank sum tests for continuous variables and two-sided Fisher Exact tests for categorical variables.

f) The data on empowerment will be analyzed using descriptive statistics. Likert type data will be analyzed using non-parametric tests (Wilcoxon sign rank, Kruskal-wallis test). Single group repeated measures analysis will be used to analyze the change in empowerment over time. The Likert type data will also further be analyzed by transforming it into dichotomous categorical data with those reporting being very likely or very comfortable being a positive response and anything less than that being recorded as a negative. The various empowerment parameters will be assessed for their relationship with skill efficacy (correct tourniquet application).