American Journal of Emergency Medicine xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

American Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/ajem

Does practice make perfect? Prospectively comparing effects of 2 amounts of practice on tourniquet use performance☆,☆☆,★

Erez N. Baruch, MD [a,*], Avi Benov, MD, MHA [a,b], Avi Shina, MD, MHA [a,c], Amy L. Berg, MD [a], Amir Shlaifer, MD, MHA [a,d], Elon Glassberg, MD, MHA [a], James K. Aden III, PhD [e], Tarif Bader, MD, MHA [a,f], John F. Kragh Jr, MD [e], Avraham Yitzhak, MD [a]

[a] Israel Defense Forces Medical Corps, Ramat Gan, Israel
[b] Department of Surgery "A," Meir Medical Center, Kfar Saba, Israel
[c] Talpiot Medical Leadership Program, Sheba Medical Center, Ramat Gan, Israel
[d] Orthopedic Division, Tel-Aviv Sourasky Medical Center, Tel Aviv, Israel
[e] Damage Control Resuscitation, US Army Institute of Surgical Research, JBSA Fort Sam, Houston, TX, 78234
[f] Department of Military Medicine, Hebrew University, Jerusalem, Israel

ARTICLE INFO

Article history:
Received 27 June 2016
Received in revised form 15 August 2016
Accepted 24 August 2016
Available online xxxx

ABSTRACT

Introduction: Although a lifesaving skill, currently, there is no consensus for the required amount of practice in tourniquet use. We compared the effect of 2 amounts of practice on performance of tourniquet use by nonmedical personnel.

Methods: Israeli military recruits without previous medical training underwent their standard tactical first aid course, and their initial performance in use of the Combat Application Tourniquet (CAT; Composite Resources, Rock Hill, SC) was assessed. The educational intervention was to allocate the participants into a monthly tourniquet practice program: either a single-application practice (SAP) group or a triple-application practice (TAP) group. Each group practiced according to its program. After 3 months, the participants' tourniquet use performance was reassessed. Assessments were conducted using the HapMed Leg Tourniquet Trainer (CHI Systems, Fort Washington, PA), a mannequin which measures time and pressure.

Results: A total of 151 participants dropped out, leaving 87 in the TAP group and 69 in the SAP group. On initial assessment, the TAP group and the SAP group performed similarly. Both groups improved their performance from the initial to the final assessment. The TAP group improved more than the SAP group in mean application time (faster by 18 vs 8 seconds, respectively; $P = .023$) and in reducing the proportion of participants who were unable to apply any pressure to the mannequin (less by 18% vs 8%, respectively; $P = .009$).

Conclusion: Three applications per monthly practice session were superior to one. This is the first prospective validation of a tourniquet practice program based on objective measurements.

1. Introduction

Trauma is the leading cause of death between the ages of 1 and 44 years [1]. One of the most common causes of preventable trauma death is limb injury [2-4] which may cause massive bleeding that might lead rapidly to exsanguination and death [5-7]. Thus, time required to control bleeding is of paramount importance even in civilian settings where hospitals are nearby the point of injury as at the Boston Marathon bombing [8-10]. Because military data from past conflicts have shown that prompt bystander use of tourniquets increases survivability [6,11], civilian organizations, such as the American Heart Association and the American College of Surgeons, have recommended that lay bystanders should be competent in tourniquet use to stop bleeding from limb wounds [12,13].

Tourniquet use is now taught to nonmedical personnel in armies [14], law enforcements organizations [15], and civilian workplaces [16] worldwide. Tourniquet practice programs can vary greatly, from instruction cards [17] through video demonstrations [18] to a multiday course [19]. However, a performance comparison of different practice programs was not reported. Moreover, the lack of consensus is not

☆ Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.
☆☆ Conflict of interest: The authors declare no conflicts of interest.
★ Meetings: This study was presented at the 2015 Military Health System Research Symposium conference.
* Corresponding author at: 13 Smilanski St, Rishon Le Zion 7525869, Israel. Tel.: +972 524257570.
E-mail addresses: erez_br@yahoo.com (E.N. Baruch), avi.benov@gmail.com (A. Benov), avishina@yahoo.com (A. Shina), amylaurenberg@hotmail.com (A.L. Berg), shlaifer.md@gmail.com (A. Shlaifer), elon.glassberg@gmail.com (E. Glassberg), james.k.aden2.civ@mail.mil (J.K. Aden), drtarifb@gmail.com (T. Bader), john.f.kragh.civ@mail.mil (J.F. Kragh), ayitzhak@gmail.com (A. Yitzhak).

http://dx.doi.org/10.1016/j.ajem.2016.08.048
0735-6757/

limited to the type of the practice program. Even the amount of tourniquet applications required in a practice session is unknown. No empiric comparisons of practice amounts were found in the medical literature, leaving the mainstay of any practice program undetermined. The aim of the present study is to compare performance in tourniquet use of nonmedical military recruits in a monthly tourniquet practice of either a single application or a triple application.

2. Methods

2.1. Materials

The Combat Application Tourniquet (CAT; Composite Resources, Rock Hill, SC) is the Israel Defense Forces' (IDF) standard issue tourniquet for controlling limb wound bleeding [20]. It is also the standard issue tourniquet in the US Armed Forces, according to the Committee of Tactical Combat Casualty Care [21,22]. The CAT is 38-mm-wide lightweight (~60 g) tourniquet. It uses a hook-and-loop fastener and a buckle to fit a wide range of limb sizes, combined with a windlass system. The windlass uses a free-moving internal band to provide circumferential pressure to the limb. Once tightened, it is then locked in place with a clip. All of the investigators in this study were competent with CAT use.

The HapMed Leg Tourniquet Trainer (CHI Systems, Fort Washington, PA) is a simulated right-thigh body segment (serial no. 0023) with an amputation injury just proximal to the knee. The medial hip-pelvic area had an embedded computer interface which includes a touchpad. Software (version 1.12) internal to the mannequin allowed the leg to stand alone and be operated by user input through finger touch on the pad. Transducers in the mannequin can sense pressure and measure time, thereby reflecting the trainee's success in bleeding control [23]. The mannequin's software allows the simulation of 7 built-in injury scenarios. These scenarios differ from one another by the pressure threshold required to control bleeding (as required by different limb sizes). All uses were conducted with a scenario requiring a pressure threshold of 200 mm Hg. The mannequin was laid on a stretcher which was placed on the ground and was operated in accordance with the manufacturer's instructions. There was no fluid or blood flowing out of the trainer; bleeding was simulated by red lights located in the wound area of the trainer. The number of lights illuminated represented the intensity of bleeding—all 26 lights on meant no control of bleeding, whereas no lights on meant bleeding had stopped. Intermediate control was indicated by a few lights twinkling on and off.

2.2. Study design

Because this prospective educational study was a voluntary mannequin-based study, the Institutional Review Board of the IDF Medical Corps determined that it was not human subject research. The general design of the study was a preassessment and postassessment of the effect of an educational intervention in nonmedical personnel, as illustrated in Fig. 1.

As part the standard combat training in the IDF, study participants underwent a 17-hour tactical field first aid course called the "Life Saver" course. The course curriculum includes practice in the following: tourniquet application, basic wound dressing application, basic casualty evacuation, simple airway maneuvers, and education regarding environmental injuries. During the course, as performed routinely in the IDF [24], participants have practiced in applying a tourniquet on a fellow recruit's limb (both arm and thigh) or on their own limb. Because a cessation of hemorrhage from a wound might be hard to identify while providing care at nighttime or under fire, participants were habituate to tight the tourniquet as much as they can in each application regardless of a visual feedback of a hemorrhage. Effectiveness of application was determined by the absence of a distal pulse, as palpated by the Life Saver instructor. Pulse palpitation was conducted only after the participant had completed his application. There was no use of mannequins in the course. All participants undertook written and practical examinations at the end of the course to possibly qualify as a "Life Saver." Instructors in the Life Saver course are military medics who have undergone 4 additional weeks of "Life Saver Instructor" training in the School of Military Medicine, IDF Medical Corps [24].

Seven to fourteen days after completion of the Life Saver course (no tourniquet applications or training took place during this interval), an initial assessment was conducted. The initial assessment established the baseline tourniquet use performance of the participants before the educational intervention. Before the initial assessment, one of the investigators briefed each of the participants individually. The briefing included an explanation of the study and the description of a scenario in which an amputated casualty (simulated by the mannequin) is lying behind cover, where no tactical threat is endangering the participant. Each participant was asked for a verbal consent to participate in the study. If he consented, the participant arrived at the assessment zone which was hidden to avoid cross-learning. To avoid any bias due to reasons which are not directly related to the participant ability to apply a CAT, the participant did not perform any rigorous physical activity before the assessment and did not carry any combat gear or weapon. The participant was placed approximately 0.5 m (1.5 ft) from the mannequin while holding a CAT in his hand. The participant was instructed to do his best at applying the tourniquet to the mannequin the instant the investigator ordered "Start!" (at which point the investigator activates the mannequin). The investigator stopped the simulation only when the participant stood up from the mannequin and called out "Done!". No form of communication was allowed between the participant and the investigator. All participants had one and only one initial assessment.

After initial assessment, the educational intervention was conducted. Participants were allocated into 2 groups which differed only by the number of tourniquet applications per monthly practice session. The single-application practice (SAP) group was to conduct a single tourniquet application during a monthly practice session. The triple-application practice (TAP) group was to conduct a triple tourniquet application during a monthly practice session. Allocation to the study groups was based on the routine IDF randomized placement process. At adolescence, Israeli males undergo rigorous medical, cognitive, and psychosocial evaluation in IDF recruitment centers to determine their capabilities and placement in the army as service is compulsory [25,26]. These pre-enlistment scores are collected prospectively. Recruits who have arrived to an infantry brigade training camp were randomized into different platoons based on their pre-enlistment scores, ensuring psychotechnical and socioeconomic homogeneity within and between platoons to avoid any ability bias. Thus, all platoons were similar in size, demographics, and capabilities. This process is conducted routinely in any IDF infantry brigade. As part of the educational intervention, these platoons were allocated to the study groups using a flip of a coin—4 platoons to the SAP group and 5 platoons to the TAP group. Meaning, study allocation was based on randomized platoons and not on randomized individuals.

Each of the intervention's practice sessions lasted several minutes per participant. All practice sessions were supervised by experienced military medics who were chosen by the brigade's commanders and had undergone an additional 3-hour training by the investigators to ensure competency in tourniquet use. This additional training was conducted with a ratio of 1 investigator to 3 medics. The training curriculum was divided into 2 parts: application technique and safety. The *application technique* part included the following: review of a proper tourniquet application technique, common pitfalls in tourniquet application [27], how to troubleshoot a failed application, and feedback techniques. The safety part included a review of the IDF Medical Corps CAT safety guidelines [20] and possible complications of tourniquet application. Practice without supervision of these experienced medics was strictly prohibited. During sessions, the tourniquet was used by the participant on a fellow participant's arm or thigh. Each participant was ordered to do his best at applying the tourniquet while the supervisor

Please cite this article as: Baruch EN, et al, Does practice make perfect? Prospectively comparing effects of 2 amounts of practice on tourniquet use performance, Am J Emerg Med (2016), http://dx.doi.org/10.1016/j.ajem.2016.08.048