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STOPPING HEMORRHAGES FROM THE LIMBS: RAISING EFFICIENCY THROUGH TRAINING ON UNFIXED HUMAN PREPARATIONS

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A – study design, **B** – data collection, **C** – statistical analysis, **D** – interpretation of data, **E** – manuscript preparation, **F** – literature review, **G** – sourcing of funding

ABSTRACT

Background: Hemorrhages from the limbs are one of the most frequent injuries endangering human life. Immediate help from witnesses and the emergency services is necessary in such cases. Developing the skill of stopping the bleeding manually requires adequate training. One of the modern methods for such training is the use of cadavers, which accurately imitate real patients.

Aim of the study: The aim of this research is to evaluate the effectiveness of learning to stop the bleeding manually on freshly frozen cadavers.

Material and methods: Thirty-one people who had already trained on medical phantoms took part in the study. The participants stopped the hemorrhage on the cadavers twice and the time taken was recorded. The second attempt was performed after a short briefing from a teacher. After the training, the participants assessed their satisfaction with the course on a scale of 1 to 5.

Results: On the first attempt, the average time of stopping the bleeding was 2.06 seconds (SD ± 1.61); the longest time was 10 seconds and the shortest was 0.7 seconds. On the second attempt, the average time was 1.52 seconds (SD ± 0.59); the longest time was 4.1 seconds and the shortest was 0.8 seconds. The average rating of course satisfaction among the respondents was 4.48 points (SD ± 0.88).

Conclusions: This research showed that training on cadavers increased the quickness of reaction while stopping a hemorrhaging. Moreover, it indicated that training on medical phantoms does not assure optimal ability to perform rescue procedures.

KEYWORDS: cadavers, bleeding, hemorrhage, paramedic, learning, education

Background

Medical emergency teams come across many different patient injuries, and the most common are hemorrhages from the limbs [1]. Hemorrhages pose a serious threat to human health and life, because inadequate or delayed medical aid can lead to hypovolemic shock and even death of the victim. The first and most basic procedure is applying manual local pressure to the place of hemorrhage, then putting on a pressure dressing and, if necessary, applying a tourniquet. In this case, quick help of both eyewitnesses as well as the emergency services is necessary. This condition requires the implementation of numerous medical interventions that can be performed, among others, by medical rescuers who

constitute the main composition of emergency medical teams [2]. However, all actions must be taken as soon as possible, and performed accurately and correctly, and this requires adequate training [3].

Unfortunately, paramedics' training varies depending on the availability and advancement of equipment in the form of training phantoms or other medical equipment. Learning during internships in medical emergency teams is not always possible. Conditions that prevail at the scene of the incident often make it impossible to conduct the same education for all paramedics due to the necessity of immediate execution of appropriate rescue procedures on the patient, and the lack of ability to practice them multiple times. In addition, it is often unrealistic for several people to repeat the medical procedures on one injured patient for training purposes.

Nowadays, more and more professional and advanced simulators reflecting the human body are available, but they are not able to replicate the structures of the human body. To ensure the best results, education should aim to create maximum realism. One contemporary teaching method is to provide training on cadavers, i.e. unfixed human preparations that faithfully replicate the structures of a real patient. They provide the opportunity to train on many medical procedures, including iniections of arterial and venous vessels, establishment of intraosseous approach, endotracheal intubation, cricothyroidotomy, defibrillation and rapid trauma examination. Available studies indicate a high level of satisfaction, and better mastery of the ability to perform various medical procedures, by training on human cadavers [4–7].

Aim of the study

The aim of the study is to evaluate the effectiveness of learning to manually stop limb hemorrhage on freshly frozen cadavers that have been thawed and appropriately prepared 24 hours prior to the start of the study.

Material and methods

Study group

The study was attended by 31 students who were studying Emergency Medical Services at the University of Natural Sciences and Humanities in Siedlce, Poland, who previously been trained in stopping hemorrhages at the simulation laboratory.

Materials

The research tools were cadavers, i.e. unfixed human preparations that came from the USA. These preparations were previously tested for the presence of HBV, HCV, HIV and syphilis and found to be negative, so they were safe for participants of the study. During transport, the preparations were frozen and the day before the examinations they were thawed in the dissecting room. They therefore preserved the natural appearance and structure of the tissues.

Methods

Before examination, the upper limb was appropriately prepared. The upper limb was amputated evenly at the level of the forearm. Radial and ulnar arteries were dissected. The vessels were rinsed with water to remove the remaining blood, so that the clots would not create embolic material that could affect the results of the study. Radial and ulnar arteries were ligated in such a way that they would not move during several dozen attempts to manually stop the hemorrhage. Additionally, to allow the simulated blood to flow through the limb, a drain was inserted into the subclavian artery through which the fluid was introduced.

The study was divided into two parts. The first was the manual stopping of the hemorrhage. The time of examination was measured from the beginning of the task until the bleeding was effectively stopped. Then, the study group took a short class, during which the operation on the cadavers was demonstrated. After that, a second attempt to stop the hemorrhage with time measurement was performed. The results were subjected to statistical analysis (Wilcoxon's test for related variables). At the end of the study, the participants were asked to assess their satisfaction of with the training on a scale of 1 to 5 (with 5 indicating high satisfaction).

Results

Characteristics of the study group

The study was conducted on 31 students in the field of emergency medical services, including 10 women (32.26%) and 21 men (67.74%). The average age of participants in the study was 21.58 years (SD ± 3.23). Before the examination, the students took part in classes on the manual stopping of hemorrhages.

The first attempt

In the dissecting room, on a stand with the upper limb preparation, the students attempted to manually stop of the hemorrhage. The average time to successfully stop the hemorrhage in this trial was 2.06 seconds (SD ± 1.61). The longest time was 10 seconds and the shortest was 0.7 seconds.

The second attempt

Before the second attempt, a short (20-minute) lecture was carried out, addressing the correct method of manually stopping the hemorrhage along with the site of pressure. Limb structures such as arteries, veins, and muscles were also discussed. Then a second attempt to stop the hemorrhage was made, giving an average time of 1.52 seconds (SD ± 0.59). In this trial, the longest time to stop the hemorrhage was 4.1 seconds while the shortest was 0.8 seconds.

Satisfaction rating

After finishing the measurements, 31 students were asked to assess their satisfaction with the study on a scale from 1 to 5 (with 5 indicating high satisfaction). The average satisfaction score was 4.48 points (SD ± 0.88).

Statistical analysis

A lack of normality of distribution was found in both measurements using the Shapiro–Wilk test ($p < 0.05$). For this reason, a statistical analysis for dependent variables (Wilcoxon test) was used, which demonstrated a statistically significant difference between the first and second attempts ($p = 0.02$).

Discussion

In many countries, medical emergency teams consist mainly of paramedics [8,9]. It depends on their skills and knowledge whether they will be able to implement the appropriate treatment for a patient who is in a state of sudden threat to health or life. One of the injuries that poses a serious threat to human life is hemorrhage [10]. A procedure for treating the victim in the event of an external hemorrhage from the limb is to apply manual pressure to the arteries as soon as possible, and then to put on a tourniquet [11]. However, medical staff need adequate training to be able to effectively stop the bleeding at the site of the incident.

At medical universities, students exercise mainly in simulation laboratories using training phantoms, which gives more and more opportunities to perform medical procedures such as placing intravenous, intraosseous or endotracheal intubation, and direct laryngoscopy. However, along with the advancement of the phantom, its purchase price has increased. An alternative way of learning is to conduct exercises on animal preparations [12]; however, this creates a lot of ethical controversies [13,14]. These days, human cadavers are the most desirable teaching tool. They are models of the natural human tissues, which allows training on many medical procedures. In the literature, there is evidence that supports the use of cadavers over phantoms because they reflect a higher level of realism in performing medical activities and lead to greater satisfaction for people taking part in classes [15–17].

This study attempted to evaluate the effectiveness of teaching the manual stopping of a hemorrhage from the amputated upper limb. For this purpose, a human limb preparation was used, which was amputated at the proximal end of the radial and ulnar bones. The technique of stopping the hemorrhage was based on manual pressure on the brachial artery.

Despite the students' preparations for the study by conducting classes in the simulation laboratory, the results were quite varied. Their average time was 2.06 seconds (SD ± 1.61) on the first attempt. Before the second attempt, the participants took part in a short lecture, during which the technique of performing pressure on the brachial artery was discussed and presented. This resulted in a reduction of the time to stop the hemorrhage, with an average time of 1.52 seconds (SD ± 0.59). Between the measurements, statistically significant differences were found (Wilcoxon test: $p = 0.02$). In addition, students were highly satisfied with participation in the study, with an average rating of 4.48 points (SD ± 0.88) on a scale of 1 to 5. The authors point to the need for further research on cadavers to determine the effectiveness of teaching other medical procedures. The acquired skills can improve the quality of help provided by medical personnel as well as by police and fire brigade [18].

Conclusions

This study shows that conducting training on the manual stopping of hemorrhages using cadavers reduces the time taken to stop the hemorrhage. It also shows that exercises on phantoms do not ensure the achievement of an optimal level of ability to perform medical procedures. Students who took part in the study declared a high level of satisfaction with the classes. In order to improve the quality of medical interventions, more opportunities to conduct exercises on cadavers should be established, which may be crucial in life-threatening situations.

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