doi: 10.18484/2305-0047.2020.6.688

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EFFICIENCY OF DIFFERENT METHODS OF TEMPORARY EXTERNAL HEMOSTASIS AT THE PRE-HOSPITAL STAGE OF EMERGENCY MEDICAL CARE

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Цель. Изучение эффективности различных способов временной остановки наружного кровотечения на догоспитальном этапе оказания помощи с учетом локализации ранений.

Материалы и методы. Изучено 86 случаев оказания догоспитальной помощи пострадавшим с наружными кровотечениями. Были собраны данные о пострадавших (возраст, пол), клиническом статусе (тип и локализация раны, вид кровотечения), объеме неотложной помощи (применяемые методы гемостаза, их эффективность, побочные эффекты, сложность использования), учитывалась длительность догоспитального периода.

Результаты. В ходе исследования установлено, что наиболее частой причиной наружных кровотечений является бытовая травма (45,35% наблюдений). Турникет был основным средством гемостаза. Контактные гемостатические средства применялись только в 2,32% случаев оказания догоспитальной помощи. В ряде случаев при остановке наружного кровотечения было последовательно использовано несколько гемостатических средств в связи с недостаточной их эффективностью. Авторы предлагают алгоритм временной остановки наружного кровотечения при оказании экстренной медицинской помощи на догоспитальном этапе.

Заключение. Основными принципами, которыми необходимо руководствоваться при выборе любого из методов остановки кровотечения, являются быстрота и надежность гемостаза на все время эвакуации и минимальное повреждающее действие на ткани.

Ключевые слова: экстренная медицинская помощь, догоспитальный этап, наружное кровотечение, методы гемостаза

Objective. To estimate the efficiency of different methods of temporary external hemostasis at the pre-hospital stage of emergency medical care, taking into account the localization of injuries.

Material and methods. The cases (n=86) of prehospital emergency medical care for patients with external bleeding were studied. The data on the victims (age, gender), clinical status (type and location of injuries, type of bleeding), the volume of emergency care, the hemostasis methods used to control bleeding, their efficiency, side effects, difficulty of use were collected, and the duration of the pre-hospital stage were also taken into account.

Results. The study found out that the most common cause of external bleeding is domestic accident (45.35%) of cases. By the nature of tissue damage, the cut wounds prevailed. Multiple or combined injuries occurred in 13.95% of cases. A tourniquet was the main method of hemostasis. Contact hemostatic agents were used only in 2.32% of cases at the pre-hospital stage. In some cases, when attempting to control the external bleeding, several hemostatic agents were sequentially used due to the lack of their efficacy. In 17.4% of cases, the victims with multiple or combined injuries received intravenous administration of the systemic hemostatic agents. In the complex of anti-shock measures in patients with severe trauma 77.91% of the prehospital patients underwent infusion therapy. Isotonic crystalloid solutions were used. A reliable increase in the duration of the prehospital stage of victims who underwent to a combination of hemostasis methods and intravenous infusion has been registered. The increase in the length of the prehospital stay occurs at the expense of the time required for creation of venous access and initiate infusion. The authors propose the algorithm for temporal control of external bleeding during emergency medical care at the pre-hospital stage.

Conclusion. The main principles that need to be guided in the choice of any methods for stopping of bleeding are the speed and reliability of hemostasis for entire time of evacuation and the minimum damaging effect on the tissues.

Keywords: emergency medical care, pre-hospital stage, external bleeding, tourniquet, contact hemostatic agent

Novosti Khirurgii. 2020 Nov-Dec; Vol 28 (6): 688-693
Efficiency of Different Methods of Temporary External Hemostasis at the Pre-Hospital Stage of Emergency Medical Care
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Научная новизна статьи
Впервые изучена эффективность различных способов временной остановки наружного кровотечения на

догоспитальном этапе оказания помощи с учетом локализации ранений. Установлено, что основными принципами, которыми необходимо руководствоваться в выборе любого из методов остановки кровотечения, являются быстрота и надежность гемостаза на все время эвакуации и минимальное повреждающее действие на ткани.

What this paper adds

The effectiveness of various methods for temporal external hemostasis at the pre-hospital stage of emergency medical treatment taking into account the localization of injuries was estimated. It has been established that the main principles that must be followed in choosing any of the methods for stopping the bleeding are the speed and reliability of hemostasis for the entire duration of evacuation and the minimal tissue damage.

Introduction

Bleeding is the leading cause of the potentially preventable death of victims at the pre-hospital stage. According to the studies from 53.7 to 80% of all people die each year as a result of injuries [1].

If the great artery is injured, the victim often dies in the very first minutes after the injury as a result of massive blood loss and the snowball development of circulatory and metabolic disorders.

The paramount task of emergency medical care is to achieve fast and reliable hemostasis. The arsenal of existing hemostatic agents is quite diversified.

The tourniquet, proposed by Friedrich Esmarch in 1873 and modified by Bernhard Langenbeck, is still used in Ukraine as an official device of external arterial bleeding control. Tourniquet Esmarch within the emergency medical equipment is obligatory for equipping vehicles.

Tourniquet is an effective device of arresting lifethreatening external haemorrhage. However, their use is a subject of much debate. The attitude towards the use of tourniquets remains ambiguous. Mention should be made of the ongoing debate between military and civilian practitioners, with the former advocating the use of tourniquets, while the latter, given the likelihood of potential complications from their use, for these reasons tourniquets are often discouraged to use in practice.

Different opinions are explained by the different nature of injuries, conditions of the pre-hospital stage and the physician qualification. The National Association of Emergency Medicine Services Physicians Physiology of the USA (NAEMSP) recommends the use of hemostatic tourniquet only in case of traumatic amputations [2].

Applying of a hemostatic tourniquet often leads to serious damage to the soft tissues and causes a number of significant metabolic disorders in the organism that determine the results of treatment of a victim in general.

According to the researchers in 22-49% of cases the application of a hemostatic tourniquet is not performed according to the indications or performed incorrectly, and in 5.5-30% it leads to development of complications [3].

Among the potential complications of using a tourniquet, it is necessary to mention a compartment syndrome with severe and persistent damage to nerves and tendons, rhabdomyolysis, reperfusion tissue injury [4].

Recently, a large arsenal of hemostatic tourniquets has been developed and is widely used: CAT – Combat Application Tourniquet (USA), SOFTT – Special Operations Forces Tactical Tourniquet (USA), MAT – Mechanical Advantage Tourniquet (Canada), EMT – Emergency Military Tourniquet (Canada) and many others having a number of advantages, such as compactness and ease to use, possibility of appropriate compression, less severe tissue damage. However, not all injuries are available for applying a tourniquet. The cases of bleeding in adjacent anatomical sites are especially difficult because of impossibility of applying a tourniquet in those areas, for example, injuries to the inguinal, axillary, gluteal regions, or the so-called nodal bleedings [5].

Attention should be also focused on the possibility of application of modern contact hemostatic agents (CHA) which leads to significant progress in solving the problem of temporary pre-hospital hemostasis. It should be noted that the history of topical hemostatic agent use is quite long. Even Pirogov N. I. used the so-called “Nelyubin hemostatic water” and herbal powders with tanning action [6].

Topical hemostatic agents can conveniently be classified into several groups: vasoconstrictors, fibrinolysis inhibitors, plasma coagulation factors, inducers of aggregation and adhesion, medications that promote protein denaturation and combined agents [7].

Over the past two decades, a large number of hemostatic agents based on zeolites, chitosan, smectite, polysaccharides, thrombin and fibrinogen have been developed. Contact hemostatics TraumaDex, Celox, TraumaStat, QuikClot, QuikClot ACS +, Hemcon, Combat Gauze have received practical application [8].

Contact hemostatic agents (CHA) also have their specific disadvantages. Some CHA cause a toxic exothermic reaction, there is a problem of their subsequent removal from the wound, and therefore the risk of infectious complications have been increased [9].

A number of local emergency medical care protocols for acute blood loss at the pre-hospital stage recommend the administration of systemic hemostatic agents [10].

Despite the high social significance of a quick and reliable stopping of bleeding in order to save the lives (as a rule) of young employable people, the problem of developing an efficient unified solution algorithm for emergency medical care for external bleeding has not yet been resolved.

Purpose. To study the effectiveness of various methods of temporary external hemostasis at the pre-hospital stage of emergency medical care, taking into account the localization of injuries.

Methods

The cases (n=86) of pre-hospital emergency medical care for patients with external bleeding were studied. For this purpose, the reporting documentation of the KI "Sumy Regional Centre for Emergency Medical Care and Disaster Medicine" and the General Directorate of Statistics in the Sumy Region for the period 2018-2019 were analyzed, retrospectively.

The data were collected on the victims (age, gender), clinical status (type and location of injuries, type of bleeding), the volume of emergency care (hemostatic methods used, their effectiveness, adverse effects, difficulty of use), and the duration of the pre-hospital period were taken into account.

Anonymous non-personalized survey was conducted for employees (n=62) of the Sumy Regional Center for Emergency Medicine and Disaster Medicine. The questionnaires were distributed within a period of 2 months (February and March) 2020. Likert scale is a type of rating scale designed to measure attitudes or opinions of respondents to use the hemostatic agents (the assessment was carried out in the range from 1 to 7 points, where the 1st is the least efficient method and the 7th – extremely efficient) [11].

Statistics

The obtained data were processed on a personal computer using the statistical program IBM SPSS Statistics subscription trial for Microsoft Windows 64-bit (a legal program for temporary use 14.05, 2020). To represent the data, the mean value (M) and the standard deviations (σ) were calculated. The normality of distribution of characteristics was evaluated using the Kolmogorov-Smirnov test. Quantitative characteristics that did not follow the normal distribution are presented as medians (Me) and quartiles (Q) – Me (Q25; Q75). Assessment of the statistical significance of the obtained results was carried out taking into account the Kruskal-Wallis test to compare the quantitative characteristics of several unrelated groups and the Mann-Whitney test to compare significant difference between two independent groups. The discrepancy was considered statistically significant at $p < 0.05$.

Results

The total study array was victims (n=86) with external bleeding due to traumatic injuries of the great vessels. The average age was 43,8±16,05 years (M±σ), with a range of fluctuations from 15 to 70 years. In the vast majority of cases, the most of the victims were men (88.4%) (Table 1). The study found that the most common causes of external bleeding are the household accidents (45.35% of cases). The second ranking place belongs to injuries sustained during traffic accidents (16.28% of all cases). The significant amount of injuries received as a result of criminal acts and suicidal attempts (13.95% and 11.63%, respectively) may be considered as a conspicuous fact.

It was found that most of the victims (86.05%) had an injury to one particular anatomical region (head, neck, shoulder, forearm, hand, chest, abdomen, thigh, lower leg, foot). Multiple or combined injuries occurred in 13.95% of cases. In 7 cases (8.14%), first aid was provided to victims with traumatic amputations.

By the nature of tissue injuries, cutting wounds prevailed, which makes up to 54.65% of the total number of injuries. Lacerated or bruised and lacerated injuries make 37.21% of all cases. Chopped injuries were recorded in 5.81% of cases.

The results of applying various methods of

Table 1

Clinical and epidemiological, clinical and nosological characteristics of the study array

Indicators	Number of cases n (%)
Gender:	
Men	76 (88.4%)
Women	10 (11.6%)
Average age	43.8±16.05
Types of injuries:	
Household accidents	39 (45.35%)
Industrial accidents	2 (2.33%)
Street accidents	9 (10.47%)
Traffic accidents	14 (16.28%)
Suicide attempts	10 (11.63%)
Criminal injuries	12 (13.95%)
Injury localization:	
Shoulder	6 (6.98%)
Forearm, hand	47 (54.65%)
Thigh	12 (13.95%)
Lower leg, foot	15 (17.44%)
Adjacent anatomical areas	6 (6.98%)

Table 2

The efficiency of the use of various hemostatic agents

A method of temporary hemostasis	Number of cases n (%)	The duration of the pre-hospital stage, minutes Me (Q25; Q75)	The efficiency of the method (after Likert) Me (Q25; Q75)
Tamponade of a wound	7 (5.69%)	31 (21; 39)	6 (4; 6)
A compressive bandage	46 (37.4%)	32 (21; 44)	6 (5; 7)
A tourniquet	47 (38.21%)	21 (17; 38)*	7 (6; 7)
Contact hemostatic agent	2 (1.63%)	31,5 (28)	6 (5)
Combinated hemostatic methods	21 (17.07%)	39 (32; 43)*	6 (5; 7)
Total	123 (100%)	31 (20; 42)	6 (5; 7)

* – significance of differences with the common study array ($p<0,05$).

controlling external bleeding to victims with injuries of the great vessels at the pre-hospital stage are presented in table 2.

A tourniquet was the main device of controlling external bleeding. It was used in 47 cases, which makes 54.65% of all cases (Table 2). No Esmarch's rubber tourniquet was used.

Contact hemostatic agents were used only in 2.33% of cases of pre-hospital treatment for victims of this particular study array, which is due to understaffed emergency service and the lack of experience and skills in using CHA by its practitioners.

In some cases, when attempting to control the external bleeding, several hemostatic agents were sequentially used due to their lack of efficacy. In 21 cases (24.42%) after tamponade of a wound and applying a compressive bandage, emergency medical practitioners turned to the application of a tourniquet. For injuries in the thigh site, the first attempt of hemostasis was not efficient enough in 25% of the total number of this localization injuries.

In 15 (17,4%) cases, the victims with multiple or combined injuries received intravenous administration of systemic hemostatic agents (tranexamic acid).

In the complex of antishock measures, 67 (77.91%) victims underwent infusion therapy at the pre-hospital stage. Isotonic crystalloid solutions were used; the average infusion volume was 400±180,07 мl (M±σ).

Pre-hospital time averaged was 31 (20; 42) minutes. There was a significant increase of length of pre-hospital stay of the victims underwent combination of hemostatic methods – 39 (32; 43) minutes, $p\leq0.05$) and intravenous infusion – 41 (34; 44) minutes, $p\leq0.05$). An increase in the duration of pre-hospital delay occurs due to the time spent on receiving of intravenous access and the start of infusion therapy.

Discussions

Given the specifics of the pre-hospital stage with limited diagnostic and treatment capabilities and the need for immediate decisions, it considers to be expedient to divide the external bleedings into critical, that are life-threatening, and non-life-threatening.

The signs of critical bleeding include: localization of the wound in the projection of the great vessels, lack of pulse on the periphery, the change of the skin color and decrease of temperature, arterial bleeding from a wound above the knee and elbow joints.

The authors propose an algorithm of controlling the external bleeding during emergency medical care at the pre-hospital stage.

In case of traumatic amputation at any level of extremity, it is necessary to use a hemostatic tourniquet with the aseptic bandage wound contraction, and in the case of a tourniquet inefficiency it is recommended to use CHA additionally. In case of bleeding in the adjacent anatomical region, it is expedient to immediately use CHA. Pre-transport stabilization of a victim with performing of infusion therapy and introduction of systematic hemostatic agents is certainly an extremely important procedure, at the same time this is the reason for a significant increase of the pre-hospital stage. The volume of infusion should be limited by the time of transportation.

Undoubtedly, each of the methods of hemostasis cannot be recognized as universal one and, depending on the location of the wound, the type of bleeding, and the conditions for providing medical care, may be the most efficient.

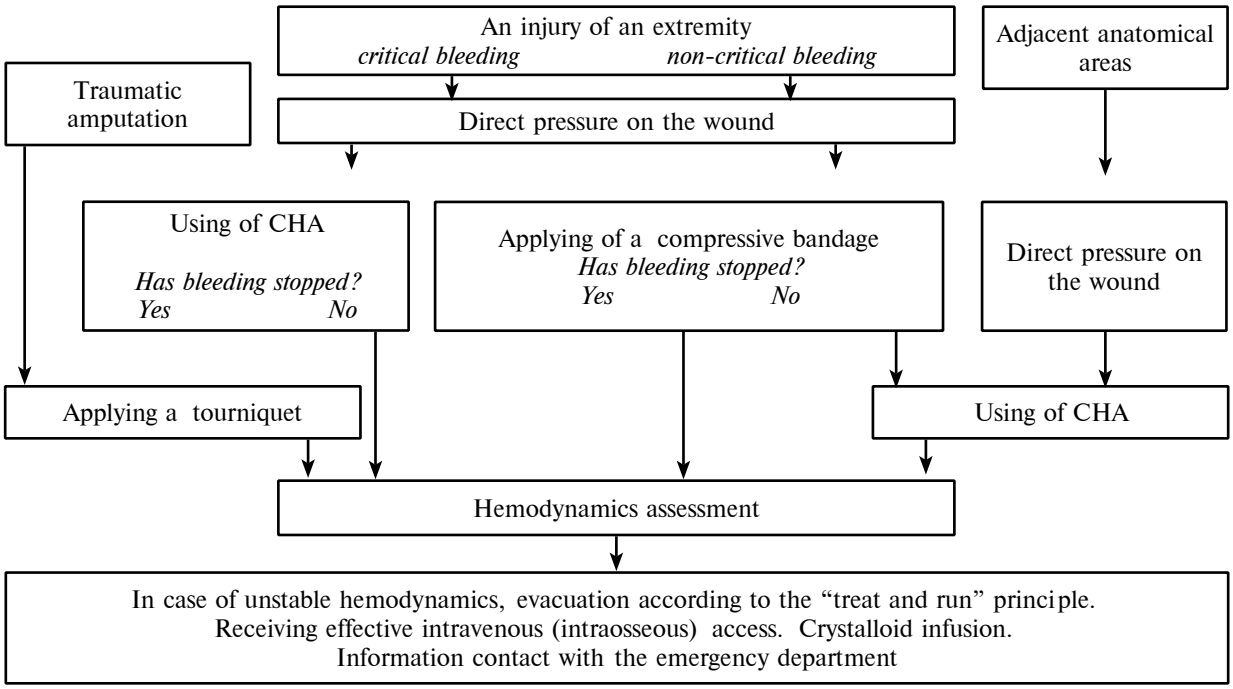
Conclusion

1. The main principles that should be guided when choosing any of the methods for bleeding control are the speed and reliability of hemostasis for the evacuation time and the minimal tissue damage.

2. The use of parenteral hemostatic agents leads to a delay in hospitalization and to the onset of specialized medical care.

3. The authors consider it promising to provide with the topical hemostatic agents the emergency medical services rendering the first aid to injured persons at the pre-hospital stage.

Fig. 1. Algorithm of external bleeding control during emergency medical care at the pre-hospital stage.



Funding

The work was carried out in accordance with the research plan of Sumy State University.

The authors did not receive any financial support from pharmaceutical companies.

Conflict of interests

The authors declare that they have no conflict of interest.

Ethics Committee approval

The study was approved by the bioethics committee of Sumy State University.

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Информация о статье

Поступила 19 мая 2020 г.
Принята в печать 2 ноября 2020 г.
Доступна на сайте 30 декабря 2020 г.

Article history

Arrived: 19 May 2019
Accepted for publication: 2 November 2020
Available online: 30 December 2020