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RATOWNICTWO MEDYCZNE

PERFORMING ADVANCED LIFE SUPPORT TREATMENTS IN INTENSIVE CARE UNIT PATIENTS DURING COVID-19

EMERGENCY PRE-MEDICAL CARE ON THE BATTLEFIELD AS A CRITICAL POINT TO SAVING THE LIFE OF THE WOUNDED

AGGRESSION TOWARDS PARAMEDICS IN EMERGENCY RESPONSE TEAMS

FULMINANT SOFT TISSUE INFECTIONS CAUSED BY ANAEROBIC BACTERIA – THE PARAMEDIC'S PERSPECTIVE

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DOI: 10.36740/EmeMS202203101 **ORIGINAL ARTICLE**

PERFORMING ADVANCED LIFE SUPPORT TREATMENTS IN INTENSIVE CARE UNIT PATIENTS DURING COVID-19 – NEW CHALLENGES AND PROCEDURES

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Abstract

Aim: To analyze the knowledge on Advanced Life Support procedures performed in Intensive Care Unit patients in the COVID-19 era as new challenges and procedures among medical staff from January 1 to April 30, 2021.
Material and methods: The survey included 102 people, mostly women (68%), the percentage of men was 32%.
Results: The vast majority of respondents – 82% are convinced that they know new ALS procedures in ICU patients in the time of the COVID-19 pandemic. The knowledge of procedures among medical personnel was influenced by the fact that they had qualification courses or specializations. The obtained results should be considered alarming, as they show significant gaps in the knowledge of the ALS guidelines during the COVID-19 pandemic.
Conclusions: Most of the respondents got acquainted with the new procedures for performing ALS procedures in the time of the COVID-19 pandemic on their own, hence an important conclusion of this survey is the absolute greater popularization, availability and periodic repetition of training among medical personnel in the field of ALS.

Key words

ALS, COVID-19, medical staff, resuscitation

INTRODUCTION

Coronaviruses, as the etiological factors of mainly respiratory system infections, were not previously the leading topic of scientific research from the point of view of public health. Only at the time of declaring a pandemic, more and more publications on this subject appeared in order to systematize what we already know, what was observed and to standardize the procedures. The high risk of infection of medical personnel with the SARS-CoV-2 virus justifies changes in the guidelines for Advanced Life Support (ALS). The guidelines were released on April 24, 2020. They may change as knowledge and experience in dealing with COVID-19 patients develops. Due to the different severity of the pandemic, there may be differences in clinical practice in individual countries. [1,2]

Safety is the most important element in which we take into account the following priorities:

1. Own person
2. Other healthcare professionals
3. Witnesses to the event
4. Patient.

The time required to safely undertake patient care is an acceptable part of the cardiopulmonary resuscitation (CPR) process [3-5].

NON-HOSPITAL CARDIAC ARREST

The data concerning the Italian population show that in the time of the COVID-19 pandemic, medical personnel undertook resuscitation less frequently than in 2019 (63.5% and 69.4% respectively). This may have been related to the observation of late death marks by medical personnel and a delay in calling in emergency medical teams. In the pre-hospital setting, 19.5% of resuscitations in 2019 were related to Return Of Spontaneous Circulation (ROSC). 13.2% of patients were admitted to the hospital during resuscitation. In turn, in 2020, the percentage of individual groups was – 7.8% for ROSC and 9.4% for patients who were transferred to the hospital during the ongoing resuscitation [1, 3-6].

Moreover, for pre-hospital treatment, obtaining an IO in a protective suit has been confirmed by many

authors of scientific publications as a method that is more effective than gaining access to peripheral vessels during resuscitation [7 ,8].

RESUSCITATION OF PATIENTS LOCATED ON THE ABDOMEN ("PRONE POSITION")

COVID-19 patients are often placed in the prone position to improve oxygenation and increase alveolar recruitment. In the event of a cardiac arrest in an unintubated patient in the prone position, the patient should be turned onto their back immediately prior to commencing advanced life support. When cardiac arrest occurs in a mechanically ventilated patient in the prone position, it is possible to compress the chest by generating pressure on the patient's back. This can ensure perfusion in vital organs while the team prepares to turn the patient onto his back according to the following sequence:

1. Medical personnel should wear PPE against airborne particles
2. Compress 5 to 6 cm between the shoulder blades at a rate of 2 compressions per second
3. Turn the patient over on his back if:
   a. chest compressions are ineffective – invasive blood pressure measurement below 25 mmHg of diastolic blood pressure,
   b. intervention is required in the supine position (e.g. problem with airway obstruction),
   c. failure to return to spontaneous circulation quickly (within one minute).
4. Turning the patient on his back requires additional help – plan this in advance.
5. Options for sticking adhesive electrodes to the prone position include:
   a. anterior-posterior electrode position or
   b. lateral position under both patient's armpits [9-11].

THE AIM

The aim of the study is to analyze the knowledge of medical personnel regarding the performance of treatments and procedures – ALS in Intensive Care Unit (ICU) patients in the COVID-19 era (from January 1 to April 30, 2021).

MATERIAL AND METHODS

The significance of the relationship between the two nominal variables was checked using the chi-square test of independence.

The significance of differences in the mean scores between the two groups was checked using the Student's t-test for independent samples.

The significance of differences in mean scores between more than two groups was checked using one-way analysis of variance (ANOVA).

The correlations between the variables were checked using the Spearman coefficient.

The significance level of $p = 0.05$ was adopted in the statistical analyzes. The analyzes were performed using the SPSS 24 software.

RESULTS

The survey included 102 people, mostly women (68%), the percentage of men was 32%. The respondents were aged 20 to 29 (28%), 30 to 39 (37%), and 40 to 49. The smallest group were people aged over 49 (9%). Most of the respondents are city dwellers (44% below 100,000 inhabitants, 41% above 100,000 inhabitants). The most numerous professional group among the respondents were nurses (59%), a smaller group were doctors (27%) and paramedics (15%). Among the respondents, 25% of the respondents had specializations, 13% of people had a qualification course, a large percentage of the respondents were in the course of a specialization or course (34%). Most respondents had work experience from 4 to 9 years (32%) and from 10 to 19 years (28%). New procedures for performing ALS procedures in ICU patients in the time of the COVID-19 pandemic were known to 82% of respondents, or so said. However, a relationship was found between the place of residence and the knowledge of procedures ($p = 0.005$). People living in large cities (95%) said they know the procedures more often, less often people living in smaller cities (78%), and the least often respondents living in rural areas (60%). There was also a statistically significant difference in the knowledge of procedures between the groups separated by occupation ($p = 0.044$). Nearly 89% of doctors claimed to know new procedures for ALS procedures in ICU patients in the time of the COVID-19 pandemic. The percentage of nurses that said so was not much lower and amounted to 85%. On the other hand, only 60% of the surveyed paramedics stated that they know the new procedures for performing ALS procedures.

The knowledge of procedures was statistically significantly influenced by the fact of having qualification courses or specialization ($p < 0.001$). All those who completed the course said they were familiar with the procedures. A slightly lower percentage of people who said so was among people who were in the course or specialization (94%) and among people who completed their specialization (88%). However, among people who did not have a course or specialization, the knowledge of procedures was worse, only 55% of the respondents from this group answered positively in the survey.

Later in the survey, only responses were collected from people who said that they know the procedures for ALS procedures in ICU patients in the time of the COVID-19 pandemic. Most of the respondents familiarized themselves with the new procedures (54%). The remaining respondents were introduced to the ward nurse or her deputy (22%), through training provided by the employer (12%), by the head of the ward (8%) or by another nurse from the ward (4%).

The biggest challenges related to the new procedures of ALS procedures performed in ICU patients in the time of the COVID-19 pandemic are the low amount of remuneration in relation to the duties performed (62%), helplessness (51%), lack of knowledge of the procedures by other members of the therapeutic team (45%) . A lesser challenge was the lack of Personal Protective Equipment (31%), perceptible fear and anxiety (28%).

On the other hand, only 35% of respondents knew that the latest ERC (European Resuscitation Council) guidelines state that chest compressions can be performed by generating pressure on the patient's back. In addition, 46% of respondents knew that the ERC (European Resuscitation Council) guidelines do not recommend the routine use of sodium bicarbonate during cardiac arrest and CPR or after ROSC.

The results of the research are presented in Figures 1-6 and in Tables 1-2.

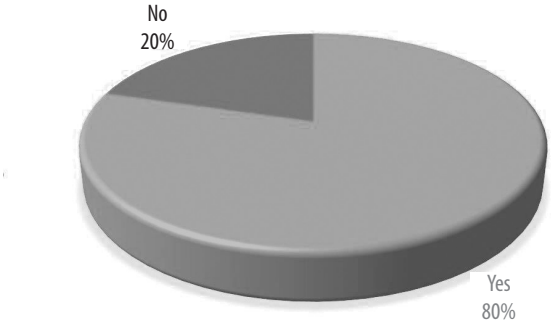

Fig. 1. Does the respondent know the new ALS procedures in ICU patients in the time of the COVID-19 pandemic? (n = 102).
Source: own study.

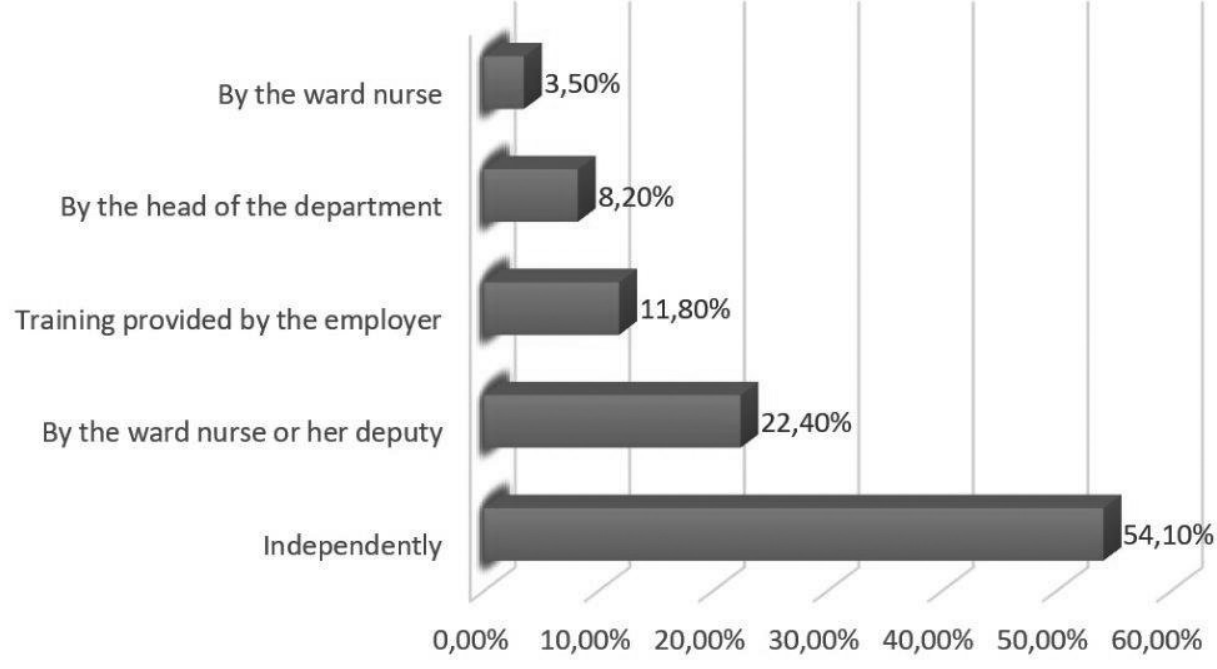

Fig. 2. How to get acquainted with the new procedures. (n = 102).
Source: own study.

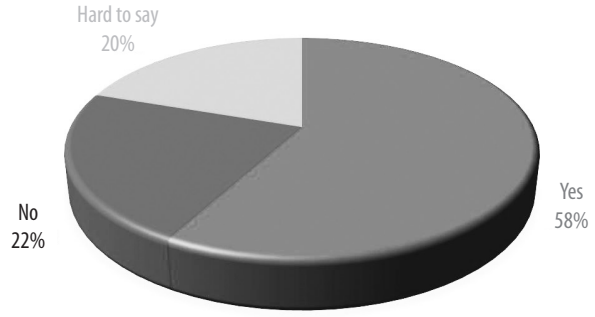

Fig. 3 Are new ALS procedures in ICU patients a challenge for the respondent? (n = 102).
Source: own study.

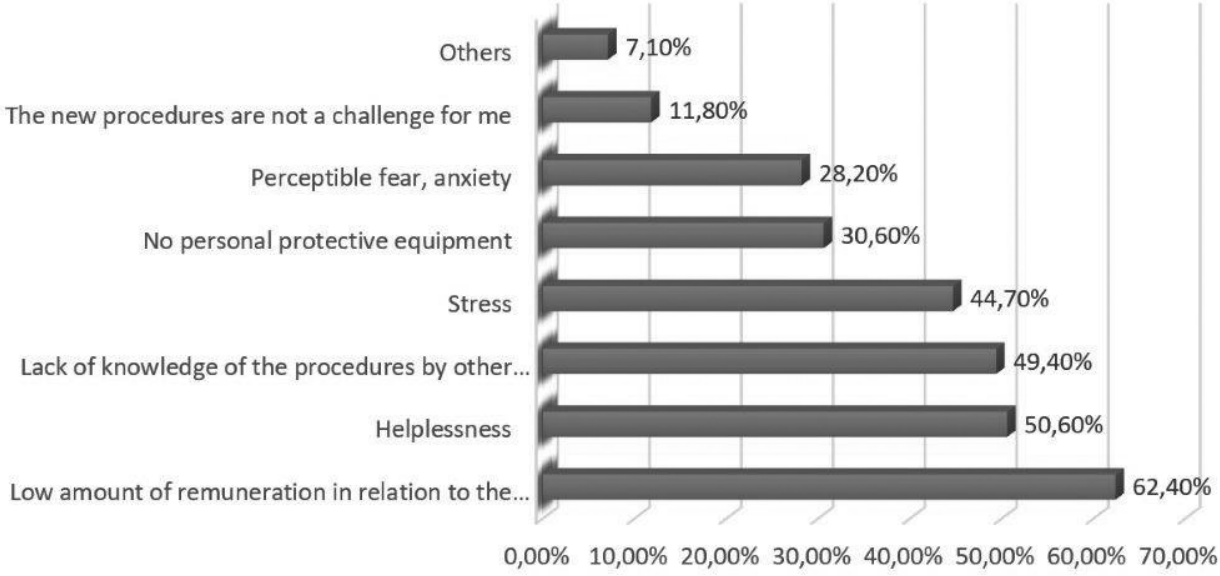

Fig. 4. Challenges related to new ALS procedures performed in ICU patients in the time of the COVID-19 pandemic? Multiple responses possible. (n = 102).
Source: own study.

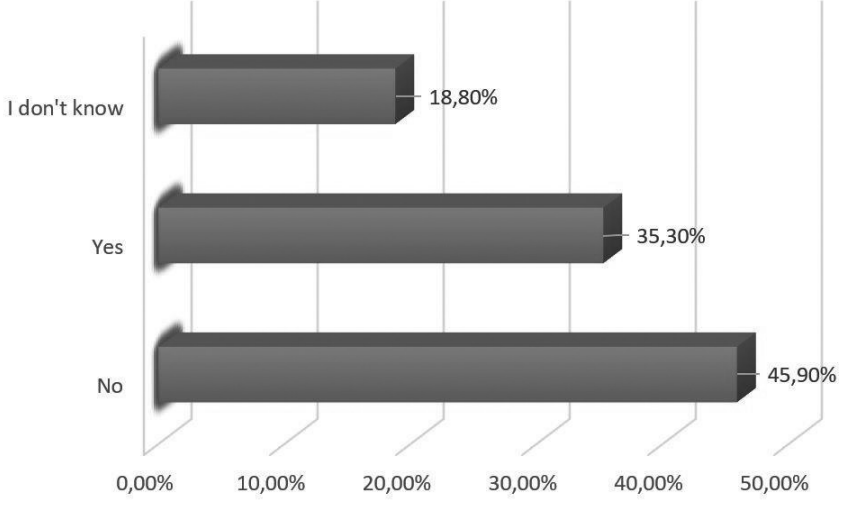

Fig. 5. Does the latest ERC (European Resuscitation Council) guidelines include the possibility of chest compressions by generating pressure on the patient's back? (n = 102).
Source: own study.

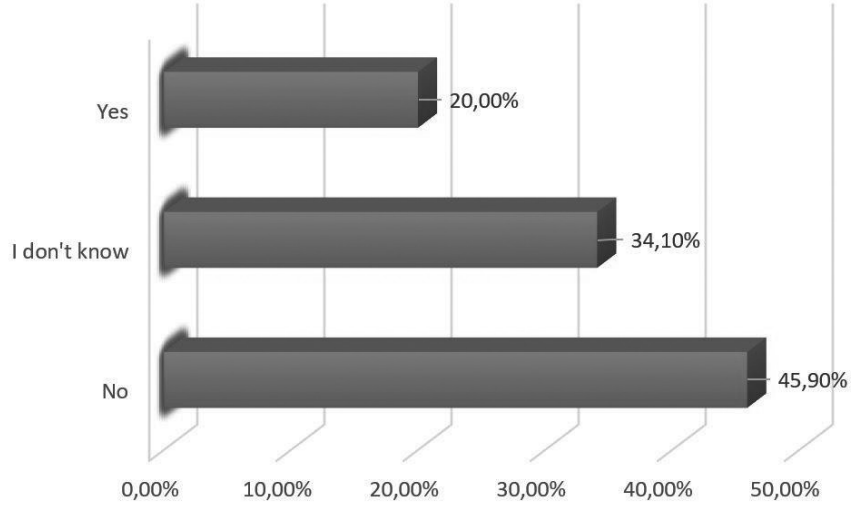

Fig. 6. Does the ERC (European Resuscitation Council) recommend the routine use of sodium bicarbonate during cardiac arrest and CPR or after ROSC? (n = 102)
Source: own study.

Table 1. Distribution of answers by place of residence (n = 102).

			Knowledge of procedures	
			Yes	**No**
Domicile	Village	Abundance	9	6
		% of domicile	60,0%	40,0%
	City: < 100,000 inhabitants	Abundance	35	10
		% of domicile	77,8%	22,2%
	City: > 100,000 inhabitants	Abundance	40	2
		% of domicile	95,2%	4,8%
Chi square test of independence			$\chi^2 = 10,60$; $p = 0,005$	

Source: own study.

Table 2. Distribution of answers by qualifications (n = 102).

			Knowledge of procedures	
			Yes	**No**
Qualifications held	Specializations	Abundance	22	3
		% of qualifications	88,0%	12,0%
	Qualification course	Abundance	13	0
		% of qualifications	100,0%	0,0%
	I am in the course of a course / specialization	Abundance	33	2
		% of qualifications	94,3%	5,7%
	No course or specialization	Abundance	16	13
			55,2%	44,8%
Chi square test of independence			$\chi^2 = 21,51$; $p < 0,001$	

Source: own study.

DISCUSSION

Representatives of medical professions are obliged to constantly improve their professional qualifications by updating their knowledge and skills and the right to professional development in various fields and types of education. Working in the Intensive Care Unit in the time of the COVID-19 pandemic, medical personnel should be 100% familiar with the procedures for dealing with cardiac arrest. The survey conducted with the questionnaire showed that some of the medical personnel do not know the above-mentioned procedures. According to the research conducted by Nowicki et al., Nursing teams want to improve their professional competences, gaining, inter alia, specialization, and the motivation to raise qualifications is to improve the quality of care provided and increase job satisfaction. However, Grześkowiak et al. Note that the number of nurses participating in first aid courses is still too small. This may to some extent explain the reason for the medical staff's lack of knowledge regarding, for example, resuscitation. The results obtained by the authors cited above, as well as our own, can be considered disturbing, given that the 2020 Cardiopulmonary Resuscitation Guidelines, as well as the AHA Guidelines, indicate a relationship between the knowledge of medical personnel and the patient's chance of survival. No studies were found regarding the current state of knowledge of medical personnel regarding the management of cardiac arrest in a COVID-19 patient, therefore it is not possible to compare the original study with another. It can be observed and hypothesized that since the deficit of knowledge about advanced life support procedures occurred in medical personnel before the COVID-19 day, this problem worsened during the pandemic. Nevertheless, intensive care unit personnel seem to be better prepared to perform advanced life support because of their frequency during daily shifts [12-16].

It seems justified to adopt the rule of cyclical refresher training, conducted on a mandatory basis, and the progress of training and course participants should be constantly assessed. The requirements of the accreditation standards of the Hospital Accreditation Program impose such training to be conducted by all employees once a year. Increasing their frequency and introducing regular exercises of practical skills in the therapeutic team should be considered. Hospital management in advanced resuscitation procedures in patients of intensive care units in the COVID-19 era in different cities and in equal countries differs in the area of professional qualifications of personnel, equipment, geographical conditions and broadly understood operational problems. "To quote the founder of modern CPR, Peter Safar: Excellence is not just an option, so you should always start at the top and work your way up" [7-9, 16-20].

CONCLUSIONS

1. The vast majority of respondents – 82% are convinced that they know new ALS procedures in ICU patients in the time of the COVID-19 pandemic.
2. The knowledge of procedures was influenced by the fact of holding qualification courses or specialization.
3. There is a relationship between the place of residence and the knowledge of procedures. People living in large cities show a better level of knowledge of current ALS procedures in ICU patients during the COVID-19 pandemic than people living in the countryside.
4. The obtained results should be considered alarming, because they show significant gaps in the knowledge of ALS guidelines during the COVID-19 pandemic (the problem for the respondents was to indicate the correct options for placing adhesive electrodes in the patient's prone position, only 35% of respondents knew that the latest guidelines report the possibility of chest compressions, generating pressure on the patient's back, only 46% of respondents knew that the guidelines do not recommend the routine use of sodium bicarbonate during cardiac arrest and CPR or after obtaining ROSC).
5. For most of the respondents, the new ALS procedures were quite a challenge (helplessness, lack of knowledge of new guidelines and procedures among the members of the therapeutic team, dissatisfaction with remuneration for work).
6. It is absolutely recommended to increase the popularization, availability and cyclical repetition of training among medical personnel in the field of ALS. Because most of the respondents got acquainted with the new procedures for performing ALS treatments in the time of the COVID-19 pandemic on their own.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest.

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EMERGENCY PRE-MEDICAL CARE ON THE BATTLEFIELD AS A CRITICAL POINT TO SAVING THE LIFE OF THE WOUNDED

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Abstract

Aim: To reveal the peculiarities of providing emergency pre-medical care to the wounded in combat conditions.
Material and methods: Research methods: analysis and generalization of scientific and educational literature, data from the Internet; study and generalization of the experience of conducting military operations in Ukraine in 2014-2022, the experience of the armies of the leading countries of the world and NATO in providing emergency pre-medical care to the wounded in combat conditions.
Results: It has been found that up to 90 % of all the potentially possible causes of death on the battlefield can be avoided thanks to the timely and high-quality provision of pre-medical care to the wounded. The main peculiarities of providing emergency pre-medical care to the wounded during hostilities in the "red", "yellow" and "green" zones have been revealed. The algorithm for providing emergency pre-medical care according to NATO standards has been presented.
Conclusions: It has been proven that high-quality tactical and medical training of personnel significantly reduces the percentage of combat casualties, increases the combat capability of the unit and the effectiveness of the combat mission.

Key words

emergency pre-medical care, tactical medicine, wounded

INTRODUCTION

Tactical medicine is one of the sections of combat training of troops (forces) and has independent significance. Training in tactical medicine is organized and carried out with the aim of acquiring the ability of a serviceman to save and preserve the life of a person who is in an emergency, in the conditions of a combat situation. The main task of training in tactical medicine is to provide a serviceman with theoretical knowledge, mastering practical techniques and skills for providing emergency pre-medical care to the extent of self– and mutual care in case of wounding, injuring and lesions [1].

The analysis of the causes of the deaths of servicemen during hostilities indicates that a significant part of them could be saved if timely and high-quality emergency pre-medical care was provided. This number ranges from 9% to over 25% [2]. About 90% of deaths in combat occur before the wounded reach a medical facility. Most of them are incompatible with life (extensive chest injury, extensive head injury, etc.). However, some conditions, such as bleeding from an arm or leg wound, tension pneumothorax, and respiratory problems can be treated on the battlefield. Death on the battlefield can be reduced by 15-18% if proper measures of self-help, mutual care and skills of a fighter-rescuer are implemented [3].

According to the statistics [4], penetrating head injuries make 31% of the causes of death in combat; injuries of the trunk that cannot be treated with surgical intervention – 25%; injuries that can potentially be treated with surgical intervention – 10%; blood loss as a result of wounds after avulsion of extremities – 9%; non-life-threatening injuries received as a result of the explosion – 7%; tense pneumothorax – 5%; problems with the respiratory airways – 1 %; death from wounds after evacuation to a medical facility mostly associated with infections and complications from shock – less than 5%. According to the specialists [5], it is possible to avoid the mortality of potential survivors, whose death in the vast majority are due to exsanguination and violation of the patency of the anatomical airways and breathing, in other words, conditions that can and should be resolved at the scene of the injury. The scientists [6, 7] indicate that up to 90 % of all the potentially possible causes

of death can be avoided by simply using a tourniquet for bleeding from the extremities, rapid treatment of a tense pneumothorax, and creating a patency of the anatomical airways.

THE AIM

The aim is to reveal the peculiarities of providing emergency pre-medical care to the wounded in combat conditions.

MATERIAL AND METHODS

The research was conducted at the Department of Legal Psychology of the National Academy of Internal Affairs (Kyiv, Ukraine) in 2020-2022.

Research methods: analysis and generalization of scientific and educational literature, data from the Internet (13 sources on the topic of the article from the scientometric databases PubMed, Scopus, Web of Science Core Collection and others were analyzed); study and generalization of the experience of conducting military operations in Ukraine in 2014-2022, the experience of the armies of the leading countries of the world and NATO in providing emergency pre-medical care to the wounded in combat conditions; pedagogical observation.

The research was performed according to the requirements of the Regulations on Academic Honesty at the National Academy of Internal Affairs, which were developed on the basis of Ukrainian and world experience of ethical rulemaking. This document was approved by the Academic Council of the National Academy of Internal Affairs (Protocol No. 5 of March 27, 2018 and implemented by the order of the Rector of the Academy (Order No. 422 of March 30, 2018. According to its provisions, the members of the scientific community are guided by the rules of ethical conduct and professional communication; respect the principles, values, norms, rules, and conditions of academic honesty in their activities.

RESULTS

Providing medical care on the battlefield, in the pre-hospital phase, is very important because it is rendered during the most important time when there is still possibility to help with any combat injury. Pre-medical care includes urgent actions and organizational measures aimed at saving and preserving the life of a person in an emergency and minimizing the consequences of the impact of such a condition on his / her health, carried out at the scene of the incident by persons who do not have a medical education, but in accordance with their official duties must possess the basic practical skills for saving and preserving the life of a person who is in an emergency, and in accordance with the law are obliged to carry out such actions and measures [8].

Injuries that occur in modern armed confrontations significantly limit the time of providing pre-medical care on the battlefield: the wounded person dies within 2 minutes (localization of the wound is shoulder area (inguinal pit) or thigh (inguinal area)) in the case of bleeding from the main vessels of the extremities (femoral, brachial) when the cause of death is rapid loss of a significant amount of blood; death also occurs within 2 minutes (localization of the wound is neck area) in the case of bleeding from the vessels of the neck (carotid artery, jugular vein) when the cause of death is rapid loss of a significant amount of blood, air absorption into large veins and clogging of blood vessels; the injured may die from a few seconds to an hour (localization of the wound is the hairy part of the head) in the case of bleeding from the vessels of the head when the cause of death is rapid loss of a significant amount of blood, air absorption into large veins and clogging of blood vessels; death can occur within one hour in the case of external arterial bleeding from wounds of the forearm, lower leg or trunk when the cause of death is rapid loss of a significant amount of blood, development of shock; the injured person dies in the supine position within 5 minutes in the event of obstruction of the upper respiratory airways due to the tongue sticking out, under conditions of loss of consciousness (head injury, shock) when the cause of death is cardiac arrest due to insufficient oxygen supply; death occurs within 5 minutes in the case of sudden cardiac arrest due to a shock wave, closed chest injury, severe stress when the cause of death is stopping the activity of the heart and, as a result, stopping oxygen transportation to the cells; death occurs within one hour (localization of the wound is the area of the chest) in the case of a penetrating wound of the chest when the cause of death is exclusion of the lung from the side of the wound from the act of breathing, loss of a significant amount of blood [9].

Modern views on the provision of pre-medical care have developed into the so-called "tactical medicine", which involves a clear division of the volume of pre-medical care depending on the sector of the battlefield. There are three stages of providing care to the wounded in combat conditions. The first stage is care in the "red zone" (Care under Fire). The second stage is care in the "yellow zone" (care on the battlefield, care in the field, care in the shelter area (Tactical Field Care). The third stage is the provision of care during tactical evacuation from the battlefield to medical facilities of the "green zone" i. e. mobile

field hospitals, military or civilian hospitals, specialized clinics (Tactical Evacuation).

When providing care in the "red zone", all actions are carried out under enemy fire, which significantly limits care. Approaching the wounded, it is necessary to obtain as much visual information as possible about him and the scene of action: how the injury occurred, what is the lying position of the wounded, what are the visible injuries, are there any foreign objects in the body, are there pools of blood, where is his personal weapon, is there no danger to a rescue fighter (a grenade hidden under the body with a joint pin removed, etc.). The signs of life of the wounded person in the effective field of fire are determined only by addressing him verbally: "Are you wounded? Do you need help?". The lack of response is interpreted as fainting and the need to provide emergency pre-medical care. The help mainly consists in applying a tourniquet to stop life-threatening bleeding from wounds in the extremities and moving the victim to a safe place as soon as possible. In combat, being a rescue fighter is a secondary mission. The main function is to carry out a combat mission, therefore, care in the effective field of fire ("red zone") is provided only by the order of the commander. In some cases, when the tactical situation allows, decisions are made independently. It is not possible to remove protective equipment (helmet, bulletproof vest) from a wounded person, as you thereby expose yourself to an additional risk of being hit by enemy fire. During the performance of any actions in the effective field of fire, the wounded and the one who rescues him are in danger, so everything must be done as quickly as possible and in compliance with the rules of personal safety (the rescuer does not rise above the body of the wounded, who is lying on the ground). The wounded person should be transported (evacuate) from the effective field of fire only if the tactical situation allows.

It is necessary to start providing medical care in the "yellow zone" after the rescue fighter and the wounded are no longer under direct enemy fire. At this stage, there is more time to provide care. However, the battle environment may change and you may find yourself under fire again. In the case of providing medical care in the "yellow zone", medical equipment and supplies are often limited to those brought to the battlefield by the rescue fighter. The procedure for providing medical care in the "yellow zone" is the following: to examine the injured person for life-threatening bleeding; to take the necessary measures to restore the patency of the respiratory airways, including the insertion of a nasopharyngeal airway (if necessary); to debride any open chest injuries; to check the condition of the hemostatic tourniquet (it is necessary to check the bleeding if a tourniquet was applied to the injured person in the "red" zone at the stage of providing pre-medical care); to examine the injured person for any unattended wounds on the extremities that may be life-threatening and debride them; to continue debriding other injuries (applying splints to fractures, dressing other wounds, burns, etc.); to introduce painkillers and antibiotics from the field pre-medical care kit (it is necessary to use the pre-medical care kit of the wounded, as you may need your own); to take the necessary measures to prevent the development of a shock state or provide care in case of shock that has already developed; to communicate information about the medical and sanitary situation to the unit commander. If necessary, to call a military medic (sanitary instructor) with additional equipment. It is necessary to notify the unit commander if the wounded cannot continue the combat mission. You have to monitor the injured (level of consciousness and breathing). If he is conscious, talk to him, encourage him if possible, calm him down, explain what you are going to do.

During evacuation, care is provided until the victim arrives at a medical facility. A distinction is made between non-medical and medical evacuation. Non-medical evacuation of the victim consists in moving the victim using a non-medical vehicle. During such an evacuation, a rescue fighter can stay with the victim to help him during transportation. Medical evacuation involves the evacuation of victims using specialized medical transport. Medical evacuation vehicles are equipped with medical personnel to assist victims during evacuation. Injured people must be moved quickly to the next level of care; otherwise valuable resources will be spent on patient support, preventing other victims from receiving care.

In accordance with NATO standards, the specialists [10] have developed a basic "C. A. B. C." algorithm for working with a casualty on the battlefield. It is the order and priority of providing emergency medical care. C stands for critical bleeding, A – for airways, B – for breathing, C – for circulation. According to NATO statistics, about 70% lost their lives due to uncontrolled critical bleeding out of 100 % of casualties on the battlefield. In the event of damage to a main artery, such as a femoral artery, a fighter can die from critical blood loss in a few minutes (he will lose consciousness in 35-40 seconds and will not be able to help himself), therefore the item of "Critical bleeding" occupies the first place in the "C. A. B. C." algorithm. This means that the first thing to pay attention to when examining a wounded person is the presence of blood stains on clothes, wounds pulsat-

ing with blood, etc. If the wounded person has critical bleeding, based on the tactical situation, we use an arresting bleeding tourniquet / binder / finger pressure / improvised means.

About 27% of the wounded die due to obstruction of the upper respiratory airways and chest injuries. Therefore, the second priority items of the "C. A. B. C." algorithm are: A – checking the patency of the upper respiratory airways, B – checking the presence, frequency and depth of breathing. We have up to 4 minutes to solve the problem of obstruction of the upper respiratory airways; chest injuries, for example, pneumothorax – up to 20 minutes. The separation of the two seemingly similar concepts (A and B are responsible for breathing) is due to anatomy i. e. before entering the lungs, air passes through the upper respiratory airways, from the mouth to the beginning of the lungs. Obstruction of the passage of the upper respiratory airways, for example by a fell behind tongue, vomiting masses or fragments of jaw bones and teeth, will lead to the impossibility of performing the act of breathing, even if the lungs themselves are whole and healthy.

Point C requires restoring the level of fluid (blood) in the body, if it was lost due to critical bleeding, and carrying out a number of manipulations to stabilize the victim's condition and preventing hypothermia (lowering of body temperature). All this must be done within 30-40 minutes from the moment of injury, therefore item C is the fourth priority.

DISCUSSION

According to the experience of the armies of the leading countries of the world and NATO, all servicemen are trained in tactical medicine. Training is carried out periodically: during the period of demobilization and combat cohesion of the unit and in the intercombat period (during the restoration of combat capability), in peacetime – at the beginning of each period of combat training throughout the soldier's service life. Training in tactical medicine is a component of the individual training of each serviceman. Training sessions in tactical medicine should be easy to understand, have a general character with the coverage of the main theoretical principles of providing pre-medical care (25 % of the training time), and also involve the honing of practical skills (75 % of the training time). Practical reinforcement of skills in tactical medicine is carried out during training sessions on other types of combat activities (weapons practice, tactical, tactical-special, and other types of training) as an integral element of the comprehensive training of a serviceman [11-13].

According to the results of our research, it was found that providing care to the wounded in the engagement area (in the "red" zone) involves: suppressing the enemy with fire; self-help / mutual help; approach to the wounded with the permission of the commander; assessment of the condition of the wounded (5-10 s); elimination of heavy bleeding by applying a tourniquet; evacuation of the wounded to a safe place (in the "yellow" zone). Medical support is limited and includes the use of only an individual first-aid kit. In the risk zone (in the "yellow" zone): care is provided by a medic to a victim who was evacuated from the enemy's fire zone in a shelter or care is provided by a medic at the place of injury after suppressing the enemy's fire. Available medical supplies are limited to what's in the medic's bag; the time to evacuation is different (depending on the situation and the severity of the injury). Tactical care in the "green" zone is provided during evacuation, for example, while waiting for medical transport, in medical transport before hospitalization. Additional medical supplies and personnel may be provided that have been pre-arranged. Herewith, the priorities on the battlefield are: 1) fulfillment of the assigned task; 2) personal safety; 3) help to the wounded. It is important to remember that an attempt to provide emergency pre-medical care at the wrong moment of the battle can result in new casualties.

CONCLUSIONS

The main causes of death on the battlefield were revealed. It was found that up to 90% of all the potentially possible causes of death on the battlefield can be avoided thanks to the timely and high-quality provision of pre-medical care to the wounded. It was found that about 15-27 % of the wounded who die before reaching a medical facility can be saved if the necessary measures are taken: to stop the bleeding, to reduce the consequences of pneumothorax, to restore the patency of the respiratory airways. The main peculiarities of providing emergency pre-medical care to the wounded during hostilities in the "red", "yellow" and "green" zones were revealed. It was proven that high-quality tactical and medical training of personnel significantly reduces the percentage of combat losses, increases the efficiency and combat capability of the unit.

PROSPECTS FOR FURTHER RESEARCH

We intend to study and generalize the experience of combat operations regarding methods of emergency evacuation of the wounded from the battlefield, as well as measures to provide them with further medical and psychological aid.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest.

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DOI: 10.36740/EmeMS202203103 **ORIGINAL ARTICLE**

AGGRESSION TOWARDS PARAMEDICS IN EMERGENCY RESPONSE TEAMS

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Abstract

Aim: Aggressive behaviours at work are one of the many problems encountered by Emergency Response Team paramedics. Aggression towards them may inhibit proper conduct, intensify anxiety and disease symptoms. Problems stemming from occupational exposure to aggression are not well-recognised phenomena. The aim of the research was the evaluation of occupational exposure to aggression from patients among paramedics employed in Emergency Response Teams in the Mazovian voivodship.

Material and methods: The study took place between May and September 2019 using diagnostic survey methodology among 238 (223 male and 15 female) paramedics in mobile emergency response teams in the Masovian voivodship. The mean age was 39,03±9,27 years for males, and 31,93±7,76 years for females. The research tool was a questionnaire, developed for the purpose of the present study. The significance level was $\alpha = 0.05$. The statistical analysis was carried out with the STATISTICA ver 13.1 PL software.

Results: 55.46% of the participants said that a patient's aggressive conduct is a problem in everyday work. Participants come in frequent contact with verbal (62.61%) and physical (49.17%) aggression from patients.

Conclusions: Aggressive behaviours towards paramedics employed in Emergency Response Teams is a significant problem not only in professional work, but also for public health. In order to minimise the incidence of aggression toward paramedics, cooperation between every party responsible for the proper functioning of the Emergency Medical Service System is necessary.

Key words

occupational exposure, paramedic, patient, work safety, aggressive behaviour

INTRODUCTION

There are many public professions inherently related to a continuous risk of exposure to negative health consequences caused by the work environment. One such job is the work of a paramedic in an Emergency Response Team (ERT). The main duty of ERTs is providing medical services by coming to help people in stressful, unpredictable, or situations of potential instability as part of the Emergency Medical Service System (EMSS). The work of ERT paramedics is inevitably related to the exposure to negative psychosocial factors, which include the occurrence of aggression among others [1].

In the general sense, the work of a paramedic consists of saving people's lives and health through medical rescue procedures which stabilise basic bodily functions and prepare the patient for transport in case of sudden health or life-threatening emergency. A paramedic carries out lifesaving procedures in ambulances and helicopters, emergency stations, emergency wards, and other healthcare establishments [2].

The possibility of adverse health effects related to exposure to environmental factors occurring is not widespread or exposed in the process of work organisation. Work conditions and work environment factors have a definite effect on the health condition of employees. It is for that reason that understanding psychosocial work conditions, including the phenomenon of aggression towards ERT paramedics, is so significant. The above is not only relevant due to the statutory obligation of the employer to employ necessary prophylactic measures decreasing occupational risk, but also as a way to execute the concept of worker health aimed at limiting adverse health effects in the work process [3].

The aggression faced by ERT paramedics most often manifests in a verbal, but also physical form. The intensity and severity of the aggression may

end up in a dispute, as well as a paramedic being beaten. The consequences of aggression are various types of physical and mental injuries, which many a time cause the paramedic to be temporarily unable to work, result in the worsening of the overall health condition, hinder functioning and limit proper EMSS conduct [4].

The International Labour Organization (ILO) recognised the medical environment to be the occupational group second most at risk of violence at work. ILO believes that every situation that involves an employee being insulted, threatened or attacked in work-related circumstances and that is a direct or indirect threat to their safety, wellbeing and health can be characterised as violence [5]. Similarly, the European Commission is of the opinion that aggression in the workplace can be defined as every situation wherein an employee is insulted, threatened or attacked in work-related circumstances, and it is a direct and direct threat to their safety, wellbeing and health [6, 7].

According to health economics, the betterment of psychosocial work conditions, including preventing the phenomenon of aggression, should be executed and treated as a measure preventing adverse health consequences on par with physical, chemical or biological factors present in the work environment of this professional group [3].

THE AIM

The aim of the study was the evaluation of the risk of occupational exposure to aggression from patients among paramedics employed in Emergency Response Teams in the Mazovian voivodship.

MATERIAL AND METHODS

According to the Statistics Poland data for 2019, there were 1577 (100%) mobile emergency response teams (ERT) functioning for the National Emergency Medical Service System in Poland, (369 specialized and 1208 basic level). In the same time frame in the Masovian voivodship, there were 200 functioning mobile ERTs, which constituted 12.7% of all teams (46 specialized and 154 basic) [8].

The study was carried out among occupationally active paramedics in ERTs from five operational regions in the Mazovian voivodship, located in Warsaw, Płock, Ostrołęka, Siedlce, and Radom in the period between May and September 2019.

The sample selection was deliberate, as the Mazovian voivodship has the highest number of functioning mobile ERTs on a national scale. The research was carried out in accordance with rules outlined in the Helsinki Declaration, being anonymous and voluntary. Every participant granted informed consent and was given information about the aims of the study and their right to withdraw participation at any stage.

The research method used to gather necessary data to analyse the research material was a diagnostic survey and a questionnaire technique. The tool was a self-constructed questionnaire which was developed for the purpose of the present study. The independent variable was participant gender. The qualitative variables included distribution (n) and frequency (%). To verify the independence of the nominal (qualitative) variables, a χ^2 test was conducted. For the quantitative continuous variables (age and years of work), basic statistical parameters regarding the central tendency (mean M) as well as the spread (standard deviation

Table 1. Participant age in years between genders.

Gender	n	M	SD	Min	Max	p-value
Male	223	39.03	9.27	23.00	65.00	0.003*
Female	15	31.93	7.76	23.00	50.00	

**Mann-Whitney U Test, p<α, α=0.05*

Table 2. Years of participant work experience between genders.

Gender	n	M	SD	Min	Max	p-value
Male	223	12.62	9.41	0.50	41.00	0.000*
Female	15	5.36	7.04	0.50	28.00	

**Mann-Whitney U Test, p<α, α=0.05*

Table 3. Level of education between genders.

Level of Education	n(%)	Secondary/Further Secondary Education	Professional Higher Education	Master's Higher Education	p-value
Male	223 (100.00)	48 (21.52)	132 (59.19)	43 (19.28)	0.109*
Female	15 (100.00)	1 (6.67)	8 (53.33)	6 (40.00)	

* χ^2 Test, p>α;, α=0.05

Table 4. Subjective opinion of participants regarding the occurrence of aggressive conduct among patients towards the participating paramedics.

Occurrence of aggressive conduct among patients	Overall		Male		Female	
	238	100.00	223	100.00	15	100.00
Yes	132	55.46	123	55.16	9	60.00
No	68	28.75	63	28.25	5	33.33
No opinion	38	15.96	37	16.59	1	6.67
χ^2=1.276095, df=2, p=0.528; p>a, a=0.05						

Table 5. Subjective opinion of participants about their feeling safe at work.

Feeling safe at work	Overall		Male		Female	
	238	100.00	223	100.00	15	100.00
Yes	157	65.96	146	65.47	11	73.33
No	49	20.59	48	21.52	1	6.67
No opinion	32	13.44	29	13.01	3	20.00
χ^2=2.591013, df=2, p=0.274; p>a, a=0.05						

Table 6. Participant opinion on the frequency of verbal aggression from patients at work.

Frequency of verbal aggression from patients	Overall		Male		Female	
	238	100.00	223	100.00	15	100.00
Everyday	53	22.27	52	23.32	1	6.67
Quite frequent	149	62.61	141	63.33	8	53.33
Sometimes	28	11.76	23	10.31	5	33.33
Rarely	8	3.36	7	3.14	1	6.67
χ^2=7.379821, df=3, p=0.067; p>a, a=0.05						

SD, minimum and maximum). Shapiro-Wilk test was carried out to assess whether data was normally distributed, and the differences in the distributions of these variables between the grouping variable were examined by the non-parametric Mann-Whitney U test. Normality of distribution for quantitative variables was verified (checked, made) using the Shapiro-Wilk test. Due to the lack of fulfilled assumptions about the use of a parametric test, statistical analysis was performed using a non-parametric test (which is indicated in the lack of normality of the analyzed quantitative variables). For qualitative variables qualitative variables, statistical analysis was performed using the χ^2 non-parametric test, which is indicated for this type of variables. The study set a significance level at the threshold of $\alpha = 0,05$. The statistical analysis was carried out with the STATISTICA ver 13.1 PL software.

Table 7. Participant opinion on the forms of verbal aggression.

Forms of verbal aggression from patients	Overall		Male		Female		p-value
	238	100.00	223	100.00	15	100.00	
Yelling	217	91.18	203	91.03	14	93.33	0.752, p>α
Accusations	123	51.68	116	52.02	7	46.67	0.688, p>α
Malice	73	30.67	68	30.49	5	33.33	0.819, p>α
Humiliation	69	28.99	65	29.15	4	26.67	0.836, p>α
Profanities	194	81.51	182	81.61	12	80.00	0.877, p>α
Threats	159	66.81	150	67.26	9	60.00	0.568, p>α
Insults	147	64.29	141	65.92	6	40.00	0.043, p<α
Blackmail	85	38.66	78	38.12	7	46.67	0.511, p>α
Mockery	48	22.27	43	21.52	5	33.33	0.309, p>α

Data do not add up to 100%, because participants could choose more than 1 answer.

Table 8. Frequency of physical aggression from patients.

Frequency of physical aggression from patients	Overall		Male		Female	
	238	100.00	223	100,00	15	100,00
Everyday	26	10.92	25	11.21	1	6.67
Quite frequent	117	49.17	116	52.02	1	6.67
Sometimes	78	32.77	73	32.74	5	33.33
Rarely	17	7.14	9	4.04	8	53.33
χ^2=31.31445, df=3, p=0.000; p<α, α=0.05						

RESULTS

A vast majority of the participants were male (93.69%). Among the participants, 58.82% reported higher education, 25% reported secondary or further secondary education, and the same percentage reported having received a master's degree.

The final analysis included 238 participants, 223 male and 15 female. The mean age of the participants was 39.03±9.27 years for males, and 31.93±7.76 years for females (Table 1).

The mean work experience of the participating paramedics showed significant gender differences (p=0.000). It was 12.62±9.41 years for males, and 5.36±7.04 years for females. In both groups, the shortest work experience was approximately half a year (Table 2). Participants had further secondary education, or professional/master's degree in higher education (Table 3).

According to 55.46% (n =132) of the participants, a patient's aggressive conduct is a problem in ERT work. There was no statistically significant relationship between the occurrence of aggressive conduct in patients towards participating paramedics and the gender of the latter (p=0.528) (Table 4).

A vast majority of the participants 65.96% (n = 157) have a sense of safety at work despite the occurrence of aggressive behaviours in patients. However, it is worrying that in every fifth participant's subjective opinion, they do not feel safe in their workplace. This issue may have a negative effect on the professional activity of participants, and this phenomenon is not significantly related to their gender (p=0.274) (Table 5).

62.61% (n = 149) ERT paramedics come in contact with verbally aggressive behaviour quite frequently. This issue is majorly an everyday concern for male participants, meanwhile every third woman is some-

times an object of such conduct from patients. The frequency of the occurrence of the aforementioned phenomenon is not significantly related to the gender of the participants (p=0.067) (Table 6).

Participating ERT paramedics most frequently pointed to the following forms of verbal aggression from patients: yelling 91.18% (n = 217), profanities 81.51% (n = 194) and threats 66.81% (n = 159). In their professional work, participants most rarely encountered patients who exhibited aggression in the following manner: mockery 22.27% (n = 48), humiliation 28.99% (n = 69) or malice 30.67% (n = 73). The only statistically significant relationship with gender found in this point of discussion was for insulting ERT members, a negative behaviour men come into contact with more than women (p=0.043) (Table 7).

Participating ERT members experience physical aggression from patients, however men are more often exposed to this form of aggression (p=0.000). Almost half of the participants 49.17% (n = 117) stated that they come in contact with this kind of behaviour quite frequently, every third – sometimes. One in ten participants is exposed to this kind of aggression every day (Table 8).

DISCUSSION

The present study was carried out in order to analyse the phenomenon of aggression in the workplace towards Emergency Response Team paramedics in the Mazovian voivodship in Poland.

The present study broadens the hitherto knowledge regarding the issue of aggression towards medical personnel, especially in the context of paramedics, which has not been the subject of many prior studies [7, 9-11].

It is estimated that physical violence was suffered by ERT paramedics at least once in their life ranges from 23% to 90%, while 21% to 88% of paramedics have suffered verbal violence at least once in their life [12].

The present research has shown that aggression occurs in a constant manner in the work of ERT paramedics, therefore it should be continuously monitored. What is more, necessary prophylactic measures should be undertaken by healthcare system organizing parties, which would diminish its risk of occurrence.

The obtained results of the present study relating to aggressive behaviours towards paramedics are consistent with research published by other authors. According to Frydrysiak et al.'s study, which involved 128 participating ERT members, a vast majority of the participants encountered aggressive behaviour from patients – 83.30%. ERT members most often encountered verbal aggression (76.6%), while the prevailing form of physical aggression was being pushed away (56.2%) [7]. Meanwhile, in Mikos et al.'s research involving a group of 48 paramedics, as many as 96% of them declared that during the previous year they encountered aggression directed at them while working for the EMSS, with 88% of the participants experiencing verbal aggression, while 68% of the participants confirmed that they were the direct object of attack from patients or accompanying persons [10]. A study into cases of threats and violence in the Swedish emergency medical service, including 134 participating nurses and paramedics from 11 EMS stations located in four districts showed that 66% of the employees experienced threats and/or violence while at work, while 26% and 16% experienced threats and violence respectively in the previous year. In most cases, the perpetrator was the patient themselves [11]. Research carried out in Kerman, Iran regarding 200 EMS showed that the most frequent forms of violence in the workplace were verbal (47%) and physical (32.5%) aggression [13]. Meanwhile, a 2018 study involving a group of 137 employees of emergency medical service centres in Hamadan, Iran, postulated that 72.2% and 22.6% of the participants came in contact with mental and physical abuse respectively, while carrying out medical procedures [14].

The results of the present study which showed that 62.61% of the participants come in quite frequent contact with verbally aggressive behaviour from patients, while almost half (49.17%) encounter physical aggression, are closest to the results obtained by Gormley et al., whose study showed that verbal abuse (67%) was more frequent than physical abuse (43.6%) among paramedics [15].

It can be concluded from the present study that in the opinion of the participants, the most prevalent forms of verbal aggression from patients included yelling (91.18%), profanities 81.51%, threats 66.81% and insults 64.29%. Similarly, research conducted by Frydrysiak et al. found that 76.6% of ERT members encountered verbal aggression. Among the forms of verbal aggression, the most prevalent kind indicated was the use of profanities, meanwhile other forms such as verbal threats, and a high and pretentious tone of voice had a comparable incidence percentage [7]. In another study, it was found that 46.6% of paramedics are of the opinion that they were victims of verbal abuse instances in the previous year [16].

Verbal abuse and physical assault were the forms of violence most often reported by paramedics [17-20], which is in line with the results obtained in the present study.

As the present study showed, despite the incidence of aggressive behaviour from patients, 65.96% of the participants felt safe in the workplace, which is consistent with Frydrysiak et al.'s research, which found that 53.6% of the respondents experience a feeling of safety at work [7].

The occupational risk of aggressive behaviours that paramedics experience while carrying out their professional duties is a global phenomenon and is multidimensional in nature, comprising of many factors. As shown in various research, the incidence of aggressive behaviours towards paramedics may be different depending on the country, or even city, due to cultural differences, the specificity of healthcare facilities, the distinct professional nature of the work of medical personnel and behavioural traits of the medical personnel.

CONCLUSIONS

Aggression towards ERT paramedics is a serious public health issue and a highly widespread one at that. This state of things may have a tangible effect on ERT paramedics, especially on their wellbeing, and may lead to a lower motivation to work.

Ensuring the safety of ERT paramedics as they carry out medical aid is undoubtedly one of the fundaments of proper EMS functioning, therefore it seems necessary to undertake measures aiming at ensuring safety in practice, rather than solely declaring to do so in legal regulations.

It seems valid and deliberate to formulate and implement a "zero tolerance policy for ERT paramedics" by EMS goal performers, as well as set in place a mechanism to report such instances, and offer psychological and legal help to its victims.

A constant element of prophylactic procedures for ERT paramedics should be courses in deescalating the phenomenon of aggression, and the ability to effectively communicate and resolve conflicts.

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CONFLICT OF INTEREST

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COMPREHENSIVE TREATMENT OF COMPLICATED COURSE OF LIVER CIRRHOSIS IN CASE OF BLEEDING FROM THE VARICOS VEINS OF ESOPHAGUS, ENCEPHALOPATHY AND ASCITES

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Abstract

Aim: To develop a complex treatment for patients with decompensated cirrhosis in case of bleeding from the varicose veins of the esophagus.

Material and methods: With bleeding from varicose veins of the esophagus for the period 2015–2020. in the clinic of the Transcarpathian Regional Clinical Hospital. A. Novak examined and treated 64 patients with C-class liver cirrhosis according to the Child-Turcotte-Pugh criteria.

Results: In 17 patients they used extracorporeal ultrafiltration of ascitic fluid with it's subsequent intravenous reinfusion. In the subgroup of 39 patients with effective sclerotherapy the mortality rate was 23.1%. In the subgroup of 25 patients where the ES was ineffective and the Blackmore tube was applied, the mortality rate was 32%. Among the 20 patients after laparocentesis with ascitic fluid evacuation 8 (40%) died. In the 17 patients after extracorporeal ultrafiltration of ascitic fluid with its subsequent intravenous reinfusion 2 (11.8%). In the subgroup where albumin peritoneal dialysis was applied 7 patients died (25.9%).

Conclusions: The prognostic factors for the lethal outcome of bleeding from varicose veins of the esophagus in patients with decompensated liver cirrhosis are: the ineffectiveness of endoscopic sclerotherapy as a means of primary hemostasis, bleeding recurrence in the first 5 days. The use of staged treatment using extracorporeal methods can significantly improve the results of treatment, reduce mortality.

Key words

treatment,
liver cirrhosis,
bleeding,
varicose veins dilated esophagus

INTRODUCTION

Complications of portal hypertension in liver cirrhosis (LC), which lead to death, are bleeding from varicose veins, ascites and hepatic encephalopathy [3, 4].

Ascites is detected in 50-85% of patients with liver cirrhosis; it is an unfavorable prognostic sign of the course of liver cirrhosis [1]. The occurrence of ascites indicates circulatory decompensation in the portal vein system and intra-abdominal hypertension (IAH) [2, 5].

Pathophysiological changes in IAH depend on the elastic properties of the anterior abdominal wall and the volume of the abdominal cavity. The dependence of IAH on the volume of abdominal contents is nonlinear. Stretching of the abdominal wall decreases with an increase in the contents of the abdominal cavity, and intra-abdominal pressure increases disproportionately sharply in response to the same increase in volume [6, 8].

An increase in abdominal pressure slows bleeding through the inferior vena cava and reduces venous "return". In addition, high intra-abdominal pressure pushes the diaphragm upward and increases the mean intrathoracic pressure transmitted to the heart and blood vessels. Elevated IAP (intra-abdominal pressure) reduces the pressure gradient on the myocardium and decreases stroke volume. Cardiac output (CO) is reduced despite compensatory tachycardia. The total peripheral vascular resistance increases with increasing intra-abdominal pressure [2, 7, 9].

The functional residual capacity and other lung volumes decrease, the alveoli adjacent to the diaphragm swell, leading to atelectasis. Ventilation-perfusion ratios worsen, pulmonary bypass increases [2, 4, 10].

Intra-abdominal hypertension reduces renal bleeding and glomerular filtration rate [12, 13, 15, 16].

Intra-abdominal pressure (IAP) 15 cm. and more, reduces volumetric bleeding in all organs of the ab-

domen and retroperitoneal space except for the adrenal glands [2, 8, 14]. The decrease in organ blood flow is not proportional to the decrease in cardiac output and occurs earlier [11]. The blood circulation in the abdominal cavity begins to depend on the difference between the mean arterial pressure and IAP. This difference is called the perfusion pressure of the abdominal cavity and as is believed, it is its value that determines the ischemia of the internal organs [2].

Acute intra-abdominal hypertension contributes to an increase in intracranial pressure. Mechanisms of violation of the outflow of blood through the jugular veins are possible due to increased intrathoracic pressure and the effect of IAH on the cerebrospinal fluid due to epidural venous plexuses. Perfusion pressure of the brain decreases or does not change, it depends on the value of the mean blood pressure. IAP in patients with central nervous system (CNS) lesions is highly undesirable. It can lead to brain hypoxia even with latent and mild neurological symptoms, which occur in almost all patients with cirrhosis, and especially in hepatic encephalopathy [2, 15].

Therefore, the doctor is faced with a difficult task, against the background of bleeding from the varicose veins of the esophagus in liver cirrhosis, it is necessary to simultaneously treat the compartment syndrome, manifestations of encephalopathy, improve splanchnic circulation, central hemodynamics, hepato-renal insufficiency with correction of protein, electrolyte metabolism. Stopping bleeding in the provision of urgent care is a priority, and the sequence of correction of the listed complications of decompensated cirrhosis of the liver requires further study.

THE AIM

To develop a complex treatment for patients with decompensated cirrhosis in case of bleeding from the varicose veins of the esophagus.

MATERIAL AND METHODS

With bleeding from varicose veins of the esophagus for the period 2015–2020. in the clinic of the Transcarpathian Regional Clinical Hospital. A. Novak examined and treated 64 patients with C-class liver cirrhosis according to the Child-Turcotte-Pugh criteria.

The study included patients consecutively hospitalized with bleeding from varicose veins of the esophagus and stomach, which developed on the basis of intrahepatic portal hypertension caused by liver cirrhosis. The examined patients ranged in age from 28 to 65 years, with a mean age of 42.1±6.8 years. There were 67.2% of men and 32.7% of women.

The group was homogeneous in severity of liver cirrhosis, the influence of sex and age on the results of liver cirrhosis treatment was not taken into account. The presence of comorbidities and changes in other systems, history of bleeding episodes, and medication were evaluated equally. All patients received a single standardized conservative treatment. The effect of conservative therapy was not taken into account.

The obtained data were processed by the method of variation statistics taking into account the value of arithmetic mean and mean error (M±m), estimating the reliability of values by Student's t-test, as well as determining the correlation coefficient using the Pearson pair method.

The presence of liver cirrhosis was confirmed by clinical, laboratory and ultrasonographic criteria.

The etiological factor of liver cirrhosis, regardless of the possibility of its installation, was not taken into account, since the survival prognosis of patients who had bleeding from the esophageal or gastric varices, according to the available data from prospective randomized trials, is due to bleeding and does not correlate with the etiology of cirrhosis.

Only 39 (61%) patients managed to achieve primary stop of bleeding using a complex of conservative therapy and endoscopic sclerotherapy (ES). In 25 (39%) patients, due to the ineffectiveness of repeated ES, we used the Blakemore-Sengstaken probe.

Of 39 patients, bleeding resumed in 11 (28.2%) within 5 days. In 7 of them, hemostasis was achieved by repeated use of endoscopic sclerotherapy, in 4 of them the Blakemore probe was used. After stopping the bleeding, 9 patients died from the progression of multiple organ failure.

Of the 25 patients in whom the Blakemore probe was used for the purpose of primary hemostasis, bleeding from the varicose veins of the esophagus resumed in 20 (80%) within 5 days. In 6 out of 20, ES was effective, and in 14, the Blakemore probe was re-inserted. Of the 14 patients, the Blakemore probe was effective only in 4; in the remaining 10 patients, due to continued bleeding, we were forced to perform a laparotomic surgical intervention. In order to stop bleeding, a modified operation of proximal devascularization of the stomach and abdominal esophagus was used with preservation of the vagus nerves. In 2 patients, a splenectomy was also performed for more adequate access to the abdominal part of the esophagus. Eight patients died after laparotomy. Three more patients died after stopping bleeding with a Blakemore probe without surgery. A total of 11 patients died.

Of the 64 patients, 37 (57.8%) were diagnosed with grade III encephalopathy according to West-Haven criteria, and 27 with grade IV.

In total, ascites was transient in 3 (4.7%) patients, and refractory in 61 (95.3%) patients.

Measurements of IAP in patients with C-class liver cirrhosis showed that the latter fluctuated between 16-25 mmHg. At III Art. encephalopathy in 11 patients, IAP was 12-15 mmHg, in 17-16-20 mmHg. and in 9-21-25 mmHg. With IV degree of IAP encephalopathy, I degree was observed only in one, II degree in 8, and III degree in 18 patients.

When assessing the distribution of IAP values among patients with various degrees of hepatic encephalopathy (HE) according to the χ^2 criterion, it was found that the differences in the distribution of IAP between the group with III stage. HE and a group with IV Art. statistically significant (χ^2 = 13.333, at χ^2emp = 5.993 p <0.05). Thus, IAH can be considered a significant factor causing a high degree of HE.

Therefore, the elimination of intra-abdominal hypertension in patients with refractory ascites is an integral part of the treatment of hepatic encephalopathy.

Bleeding and encephalopathy sharply limited the time frame for the conservative treatment of ascites in compliance with all standards, therefore, minimally invasive interventions aimed at its elimination came to the fore – laparocentesis with evacuation of ascitic fluid or extracorporeal ultrafiltration of ascitic fluid with its subsequent intravenous reinfusion (EUAIR).

We used both methods of treatment in 37 patients with grade III hepatic encephalopathy, despite the fact that in 3 of them ascites was transient, that is, it tended to decrease under the influence of conservative therapy.

Before the start of the procedure, ascitic fluid was taken from patients after puncture with a syringe to perform the following studies:

- protein level in ascitic fluid – at a low level (less than 5 g/l), only laparocentesis was performed with evacuation of ascitic fluid; EUAIR was not performed due to minor protein losses in ascites, which were compensated by the introduction of amino acid and plasma solutions;
- the number of leukocytes in the ascitic fluid – in the presence of leukocytes ≥250 x109 / l EUAIR was not performed;
- the presence of atypical cells in the ascitic fluid – in the presence of atypical cells, EUAIR was not performed.

In 20 patients, against the background of a complex of conservative treatment, we performed laparocentesis with evacuation of ascitic fluid. In 17 patients, extracorporeal ultrafiltration of ascitic fluid was used with its subsequent intravenous reinfusion to eliminate ascites and IAH (Table 1).

Table 1. The number of procedures performed in patients with decompensated cirrhosis depends on the degree of encephalopathy and the magnitude of IAP.

IAH decompensation methods	The degree of encephalopathy and the level of IAP					
	III			IV		
	12-15	16-20	21-25	12-15	16-20	21-25
Laparocentesis	-	11	9	-	-	-
EUAIR	11	6	-	-	-	-
APD	-	-	-	1	8	18

Footnote: There were no statistically significant differences detected (p>0.05).

Table 2. Dynamics of some parameters of blood serum of patients before and after EUAIR.

Parameter	Before treatment	Days of treatment		
		1	3	5
Total bilirubin [μmol/l]	94.38+35.88	89.9+35.60	80.46+33.7	65.38+29.0
Creatinine [μmol/l]	99.4+19.6	89.6+18.70	78.3+18.3	67.19+19.4
Urea [mmol/l]	7.4+4.6	5.31+1.50	5.01+1.0	4.9+1.07
Prothrombin index [%]	39.6+3.3	40.2+2.4	39.5+2.7	39.2+2.6
ALT [mmol/h x l]	3.92+1.07	3.11+0.68	2.94+0.85	1.66+0.37
AST [mmol/h x l	4.4+1.15	4.3±0.55	2.71+1.07	2.08+0.71

Footnote: There were no statistically significant differences detected (p>0.05).

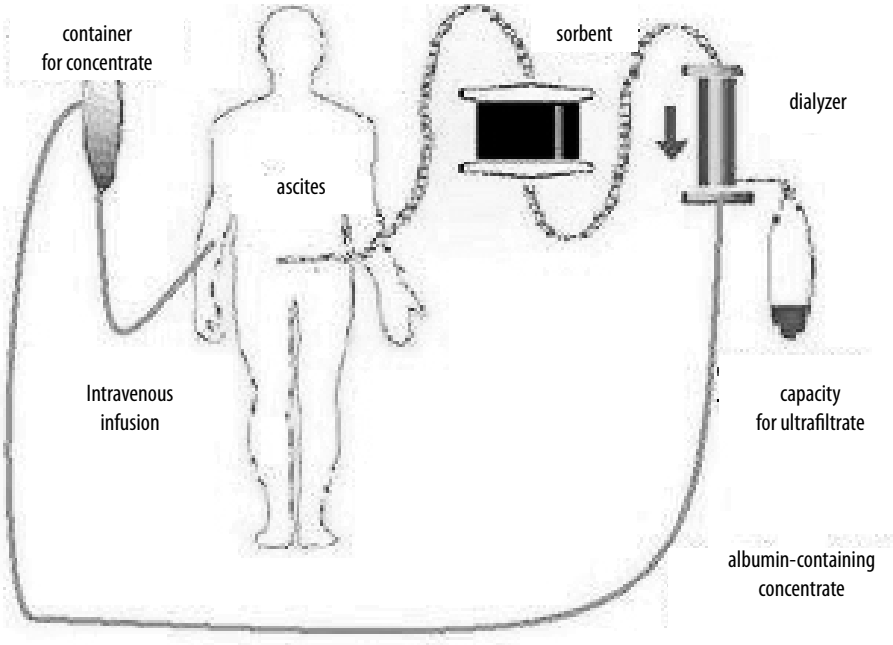

Fig. 1. Scheme of extracorporeal ultrafiltration of ascitic fluid with its subsequent reinfusion.

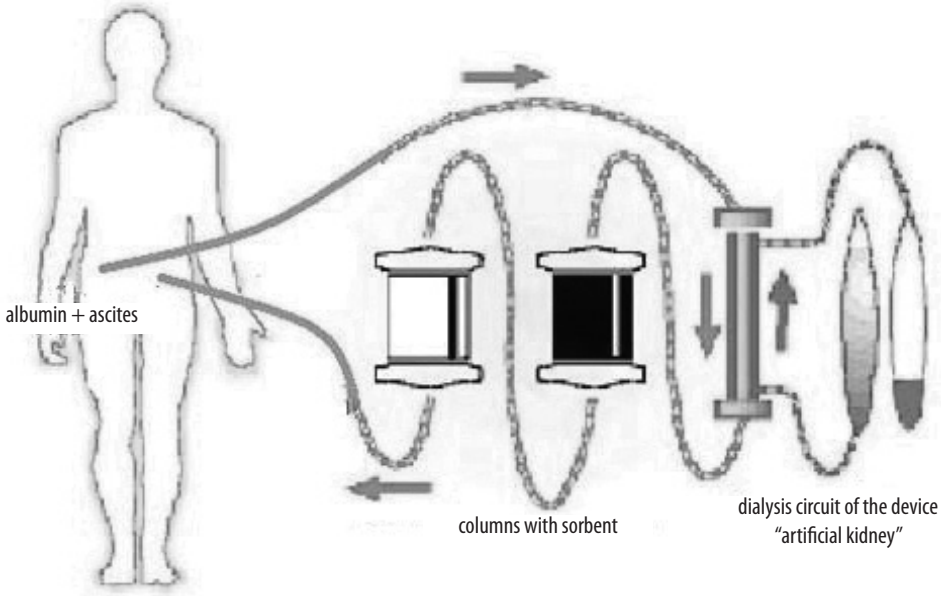

Fig. 2. Scheme of albumin peritoneal dialysis.

Before performing laparocentesis or EUAIR under ultrasonographic (USG) control in the lower abdominal cavity, the site of the subsequent puncture of the abdominal cavity and placement of the catheter was indicated.

Laparocentesis was performed according to the standard technique. A tube was inserted into the abdominal cavity, through which the maximum possible amount of fluid was simultaneously evacuated. During evacuation, hemodynamic parameters were monitored. In order to prevent the development of ascites-peritonitis, antibiotics were prescribed. Dextran solutions and, in most cases, fresh frozen plasma were administered intravenously to increase plasma oncotic pressure and prevent rapid recurrence of ascites.

For EUAIR under aseptic conditions, a multiperforated drainage catheter was inserted into the lower abdominal cavity through a pre-designated place on the anterior abdominal wall, which was connected to the circuit through a set of dialysis lines: a roller pump of the "artificial kidney" apparatus to account for the volume of evacuated ascitic fluid, a flask with a hemosorbent, a dialyzer, in which negative pressure was created using a second roller pump (Fig. 1).

Ascitic fluid after sorption and removal of excess water was collected in pre-prepared sterile vials. In one session, they tried to evacuate the maximum amount of ascitic fluid, from which, after ultrafiltration, 2-3 liters of concentrate were obtained – in fact, a solution of one's own albumin.

During ultrafiltration with sorption, intravenous drip reinfusion of purified ascitic fluid was carried out in an amount of about 1000 ml in order to maintain oncotic pressure, the remainder of the fluid was frozen in a freezer and then administered to patients after defrosting for the next 2-3 days.

In order to assess the effect of EUAIR on liver function, we assessed the dynamics of some laboratory parameters before and after treatment (Table 2).

In 27 patients with grade IV hepatic encephalopathy, the treatment of choice was albumin peritoneal dialysis (APD). APD is a technique for the treatment of acute and chronic liver failure, developed in the surgical clinic of Uzhgorod National University (Fig. 2). The key point of this technology is the transfer through the peritoneum, as a highly permeable dialysis membrane, of toxins that have an affinity for albumin, from the blood to the acceptor. The acceptor is donor human albumin, which circulates in a closed circuit. Water-soluble low molecular weight substances are released along a concentration gradient, as in dialysis.

In most clinical cases where the cause of liver failure was cirrhosis, the patient's own ascitic fluid mixed with albumin was used to fill the dialysis circuit. This technological detail was of great importance, since it provides for the use of the body's own biological environment and, in part, the albumin of the patient himself is used.

In order to assess the effect of APD on liver function, we assessed the dynamics of some laboratory parameters before and after treatment (Table 3).

It should be noted that the imposition of hydroalbumin perithenium can dramatically worsen the function of external respiration and the development of IAP. That is why before the APD procedure it is necessary to evacuate the ascitic fluid up to 6 liters and only after that the APD session is performed. Depending on the physical method and correction of the ascites value, the average characteristics of IAH changed. IAH decreased by 60–65% during laparocentesis, by 21-27% during EUAIR, and by 12–18% during APD.

RESULTS

In total, 17 patients died in the group during the observation period up to 5 days. The overall mortality was 26.6%. In the subgroup of 39 patients where ES was effective, mortality was 23.1%, in the subgroup where ES was ineffective and the Blakemore probe was used, it was 44%. In the group of operated patients, the lethality was 80%.

Of the 20 patients who underwent laparocentesis with ascitic fluid evacuation, 8 patients died. Mortality in the subgroup was 40%. Of the 17 patients who were treated with EUAIR, 2 died, the mortality rate in the subgroup was 11.8%. In the APD subgroup, 7 out of 27 patients died, accounting for 25.9%.

According to the Fisher criterion, we analyzed the difference in the recurrence rate of bleeding in patients in the subgroup where ES was effective in terms of primary hemostasis, and in the subgroup where they were forced to use the Blakemore probe – in the subgroup with ES ineffectiveness, the rate of rebleeding was significantly (φ*2 at φ* 0.05=1.64) differed from that in the subgroup with effective ES and was 2.8 times higher.

Mortality in the subgroup of patients with effective ES significantly (φ*emp = 1.749, at φ*0.05=1.64) differed from that in the subgroup using the Blakemore probe and was 1.9 times less.

Mortality in the subgroup of patients treated with EUAIR significantly (φ*emp=2.025, with φ*0.05=1.64) differed from that in the subgroup using conventional laparocentesis and was 3.4 times less.

Mortality in the subgroup of patients treated with EUAIR was 2.2 times higher than in the subgroup with APD, but this difference was not significant. Mortality in the subgroup with APD and the subgroup with simple laparocentesis also differed insignificantly, in the subgroup with APD it was 1.5 times lower.

Table 3. Dynamics of some parameters of blood serum of patients before and after APD.

Parameter	Before treatment	Days of treatment		
		1	3	5
Total bilirubin [μmol/l]	218.25+223.5	202.13+206.9	156.37+164.3*	133.25+143.1*
Creatinine [μmol/l]	214.5+162.13	202.88+124.3*	169.5+72.8*	133.13+48.15
Urea [mmol/l]	18.38+1.63	16.63+1.5*	10.38+1.03	8.13+0.9
Prothrombin index [%]	38.9+1.4	37.9+1.4	38.5+1.4	39.2+2.6
ALT [mmol/h x l]	4.25+0.48	4.11±0.17	2.89+0.55	2.31+0.5*
AST [mmol/h x l	6.6+1.52	5.77±1.12	4.74+0.93	3.13+0.54*

* – significant difference in t-test at $p < 0.05$ from baseline before treatment

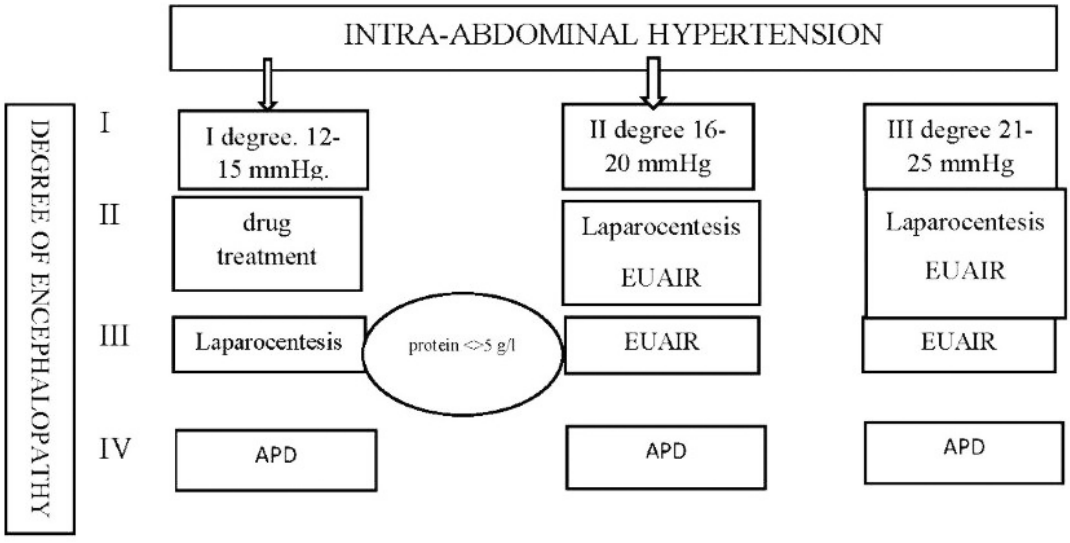

Fig. 3. Drug and extracorporeal methods of treatment of decompensated cirrhosis complicated by bleeding from the esophageal varicose veins depending on the degree of HE and IAH.

Analyzing the obtained results, it should be noted that the use of the EUAIR method has a positive effect not only on intra-abdominal pressure, as expected, but also on other factors of hepatic decompensation that we have not established, significantly reducing mortality in such a severe contingent of patients.

Attention is drawn to the high detoxification ability of the APD method, which manifests itself in a decrease in the concentration of so-called markers of intoxication – low and medium insoluble compounds – aspartateaminotransferase (AST), alaninaminotransferase (ALT), creatinine, as well as water-soluble compounds – urea and ammonia.

Considering that APD was applied to patients with profound encephalopathy, that is, those who were clinically much more severe than other subgroups, the absence of significant differences in mortality rates indicates an extremely positive effect – mortality rates in patients with HE IV using this method succeeded. approximate to those of HE II (to which laparocentesis was applied).

When evaluating the distribution of IAP values among patients with different degrees of hepatic encephalopathy according to the χ^2 criterion, it was found that the difference in the distribution of IAP between group III c. HE and a group from the IV century. are statistically significant (χ^2=13.333, at χ^2emp=5.993 at $p<0.05$). Therefore, IAP can be considered a significant factor causing the highest degree of HE (Fig. 3).

Therefore, in case of decompensated cirrhosis, complicated by bleeding with grade I–II encephalopathy against the background of intra-abdominal hypertension, in the presence of protein less than 5 g/l in ascitic fluid, it is necessary to use laparocentesis against the background of generally accepted drug therapy.

With grade III encephalopathy at a protein level of more than 5 g/l in ascitic fluid and IAP (stages II-III), it is better to perform EUAIR. With IV degree of encephalopathy, regardless of the size of IAP, it is more advisable to use APD.

In our opinion, the elimination of intra-abdominal hypertension in patients with refractory ascites is an essential component in the treatment of hepatic encephalopathy. Where bleeding and encephalopathy against the background of the abdominal compartment of the syndrome associated with ascites sharply narrow the possibilities of conservative (drug treatment, and the efforts of resuscitators are primarily aimed at stopping bleeding and stabilizing the patient's hemodynamics. In connection with this, a medical procedure is diagnosed – endoscopic esophago-gastroscopy, which gives an answer to the source of bleeding and the possibility of stopping it endoscopically, in case of an unsuccessful attempt to stop bleeding endoscopically, Blakemore's probe is used (Fig. 4).

All this is carried out against the background of hemostatic therapy and drug attempts to reduce portal pressure. After the degree of encephalopathy is determined (the need for intubation for endoscopic examination), IAH is measured to determine the magnitude of the abdominal compartment syndrome. At the same time, depending on the level of protein in the ascitic fluid, the patient is evacuated either by laparocentesis and / or by EUAIR, albumin peritoneal dialysis is performed in all patients with IV century HE. regardless of the magnitude of the IAP. After stabilization of the patient's condition, a basic

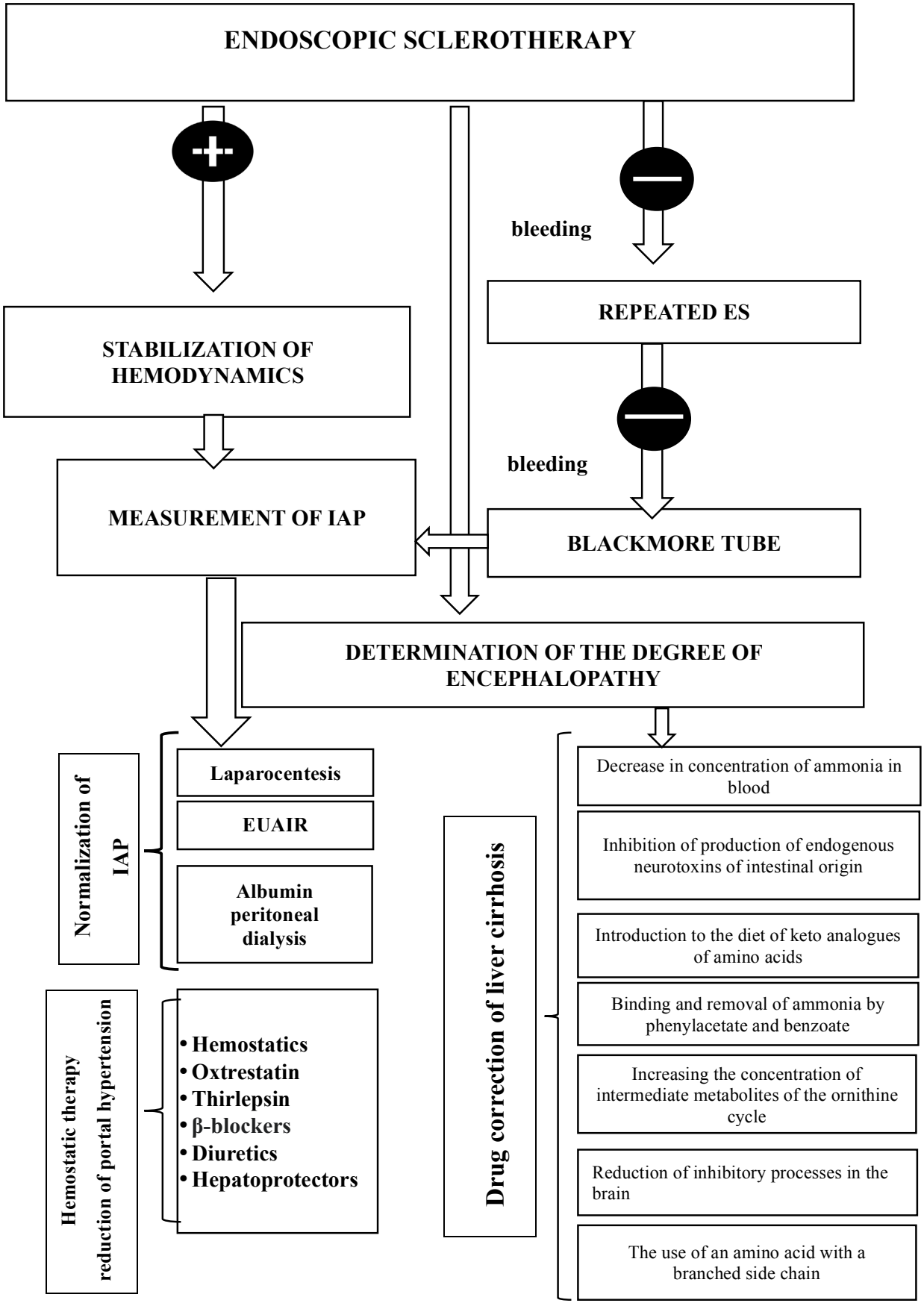

Fig. 4. Scheme of complex treatment of complicated course of cirrhosis by bleeding from the esophageal varicose veins, encephalopathy, ascites.

medical correction is carried out, aimed at reducing the concentration of ammonia in the blood, reducing inhibitory processes in the brain, and inhibiting the production of endogenous neurotoxins.

Basic drug correction is the main thing in stabilizing and improving the quality of life in patients with cirrhosis.

DISCUSSION

Variceal bleeding is a major complication of portal hypertension secondary to decompensated cirrhosis or portal vein obstruction, which is associated with significant mortality [17-19].

In our study, it was found that early rebleeding has significant positive correlation with Child-Pugh grade. Also, this agrees with Yang et al. [17]. Also, our results are consistent with Benedeto-Stojanov et al. who stated that patients with the most severe hepatocellular dysfunction have the shortest period between the first bleeding and rebleeding (mean 20.8 days) [18]. Our results agree with Berreta et al. who proved that Child-Pugh C was an independent risk factor of death from rebleeding [19].

Also, this agrees with Amitrano et al. that patients with hepatic decompensation bleed more severely than those without hepatic decompensation [20, 21].

In our opinion, the elimination of intra-abdominal hypertension in patients with refractory ascites is an essential component in the treatment of hepatic encephalopathy. Where bleeding and encephalopathy against the background of the abdominal compartment of the syndrome associated with ascites sharply narrow the possibilities of conservative (drug treatment, and the efforts of resuscitators are primarily aimed at stopping bleeding and stabilizing the patient's hemodynamics. In connection with this, a medical procedure is diagnosed – endoscopic esophago-gastroscopy, which gives an answer to the source of bleeding and the possibility of stopping it endoscopically, in case of an unsuccessful attempt to stop bleeding endoscopically, Blakemore's probe is used.

Endoscopy is essential in the modern multidisciplinary management of variceal bleeding [22]. This study demonstrated that endoscopic therapy was effective in controlling the initial acute variceal bleed and that ultimate survival was influenced by rebleeding and underlying liver reserve. However, despite urgent endoscopic and pharmacological therapy, variceal bleeding is reported to recur in up to 20% of patients after initial endoscopic intervention [23]. Early variceal rebleeding also significantly increases the risk of death within 6 weeks of the initial bleed [23-25]. Prevention of rebleeding is a crucial element of management, considering the frequency of rebleeding after initial control [26, 27].

CONCLUSIONS

The prognostic factors for the lethal outcome of bleeding from varicose veins of the esophagus in patients with decompensated liver cirrhosis are: the ineffectiveness of endoscopic sclerotherapy as a means of primary hemostasis, bleeding recurrence in the first 5 days.

The use of staged treatment using extracorporeal methods can significantly improve the results of treatment, reduce mortality.

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ANALYSIS OF THE CAUSES OF HYPOTENSION IN RECOVERY ROOM SURGICAL PATIENTS

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Abstract

Aim: The present paper attempts to find the risk factors for hypotension suffered by patients in the postoperative period taking into account the following aspects: gender, type of anaesthesia, ASA score, type of surgery, and time after surgery when it is likely to be at its lowest.

Material and methods: The main method used in the study was to analyze the medical records regarding patient data in the perioperative period. Patients had their mean arterial pressure (MAP) measured and documented in the Intensive Care Chart. Information on the type of surgery and choice of anesthesia was obtained from the Anaesthesia Records. Eighty patients participated in the study.

Results: There was no clear correlation between the gender of the patients and the decrease in blood pressure. Hypotonia occurred in the 8th hour after surgery in both men and women in the study group. It was observed that in subjects under 80 years of age, hypotonia occurs mainly in the 8th hour after the procedure, while in older subjects – after 12 hours following surgery. The type of procedure affects the occurrence of hypotonia. In patients undergoing general and epidural anaesthesia, the highest decreases in mean arterial pressure values were observed 8 hours after surgery compared to other methods of anaesthesia. The ASA classification proved useful in predicting the incidence of hypotonia; in Class 4 patients, it was pronounced and persisted for 12 hours after surgery.

Conclusions: It cannot be conclusively stated which factors most influence the occurrence of hypotension in patients after surgery.

Key words

blood pressure, hypotension, ASA (scale)

INTRODUCTION

Surgical techniques are some of the most common methods used for treatment. Sometimes there is no other possible way to improve the patient's health. The number of surgical procedures performed in Poland has been rising for years. This is mainly due to the continuing increase in the incidence of cancer, the growing number of plastic and reconstructive surgeries and treating injuries requiring surgical intervention.

Surgical treatment has a number of advantages but also involves complications. The benefits of this approach are remarkable and can be seen within a short time. Nevertheless, during the perioperative period, blood pressure fluctuations are very common. Most patients experience a decrease in MAP values after surgery. This is a problem which requires detailed observation and frequently also medical intervention.

Measuring blood pressure is one of the basic parameters characterizing the clinical condition of the human body. The components of arterial blood pressure are systolic blood pressure (SBP) and diastolic blood pressure (DBP). The normal values are <120 for systolic blood pressure and <80 mm Hg for diastolic blood pressure [1]. Hypotension is analyzed only by the values achieved and not by the diseases it causes. According to the World Health Organization, blood pressure values which are defined as low are under 100/60 mm Hg in women and under 110/70 mm Hg in men. With regard to these values, it is most important to keep in mind that each person reacts to a drop in blood pressure in a unique way. The resulting change in the way each person feels is different for everyone [2]. Blood pressure is an indirect reflection of blood flow and hypoperfusion results in organ damage. Research on the effects of perioperative hypotension on organ damage began in the 1950s. Fred Wasserman et al. reported 25 cases of postoperative myocardial infarction associated with blood pressure reductions by more than 40/20 mm Hg [3]. In another study involving over 5127 patients, Sun et al. found that acute kidney injury can be caused by intraoperative lowering of MAP to 60 mm Hg for 20 min or below 50 mm Hg for 10 min [4, 5]. The characteristic clinical symptoms of hypotension are: weakness, pale skin, increased sweating, apathy, tachypnoea, and syncope (up to and including loss of consciousness) [6].

Hypotension in patients after surgery may be induced by pharmacological agents (e.g. anaesthetics,

analgesics) or may occur as a result of postoperative complications related to e.g. excessive bleeding during and after surgery [7]. Other causes of hypotension may include preoperative fluid restriction and starvation, restrictive fluid therapy during surgery, chronic medication, and the patient's general condition. Chronic diseases, such as hypothyroidism, adrenal insufficiency, pituitary insufficiency, neuropathy, diabetes mellitus, cardiovascular disease, and alcohol consumption contribute to hypotension. Skilled management at the time of detecting hypotension is important. Treatment includes causal therapy, fluid therapy – filling the vascular bed, catecholamines.

THE AIM

The aim of this study is to evaluate the causes of hypotension in patients during their stay in the recovery room. In the present study we attempted to analyze the reasons for the occurrence of decreased MAP values after surgery, in particular the influence of gender, age, type of surgery performed, type of anaesthesia and classification on the ASA scale.

MATERIAL AND METHODS

The study used the methods of medical record analysis and observation. Blood pressure measurements were taken, entered into an Exel spreadsheet and interpreted. The study was performed at the Department of General, Oncological, Metabolic and Thoracic Surgery of the Military Institute of Medicine, Warsaw. Permission to access the medical records of the patients staying at the Clinic from 10 January to 16 March 2016 was obtained from the Head of the Clinic. Data from the Intensive Care Chart and the Anaesthesia Records were used. The ASA scale class was defined for each patient. The selection of respondents was randomized.

Patients gave informed consent to participate in the study. Blood pressure measurements were taken before the procedure, at "0" hour, and 1, 3, 6, 8, and 12 hours after the procedure. The results of the measurements were recorded. Each blood pressure measurement was analyzed and MAP was calculated from the formula: MAP=(SBP+2xDBP)/3.

There were 80 participants in the study. Most of them were women (55%), among whom young ones aged 20-40 years predominated (17 out of 44). On the other hand, men were predominantly aged 60-80 years (16 out of 36) (Fig. 1).

The procedures were performed using both classical and laparoscopic methods. In the majority of the subjects, open surgery was performed (48 out of 80). More than half of the subjects had undergone abdominal suregery (50 out of 80), head and neck surgery (9 out of 80), and thoracic surgery (21 out of 80). Most subjects were categorized as ASA scale Class 3 (27 out of 80). Analyzing the ASA scale class versus the age of the patients, it was found that Class 4 consisted only of patients over 40 years of age. Among the oldest patients, there were no ASA Class 1 cases. General anaesthesia was used in the majority of patients (67%). The smallest proportion of patients (14%) received regional anaesthesia.

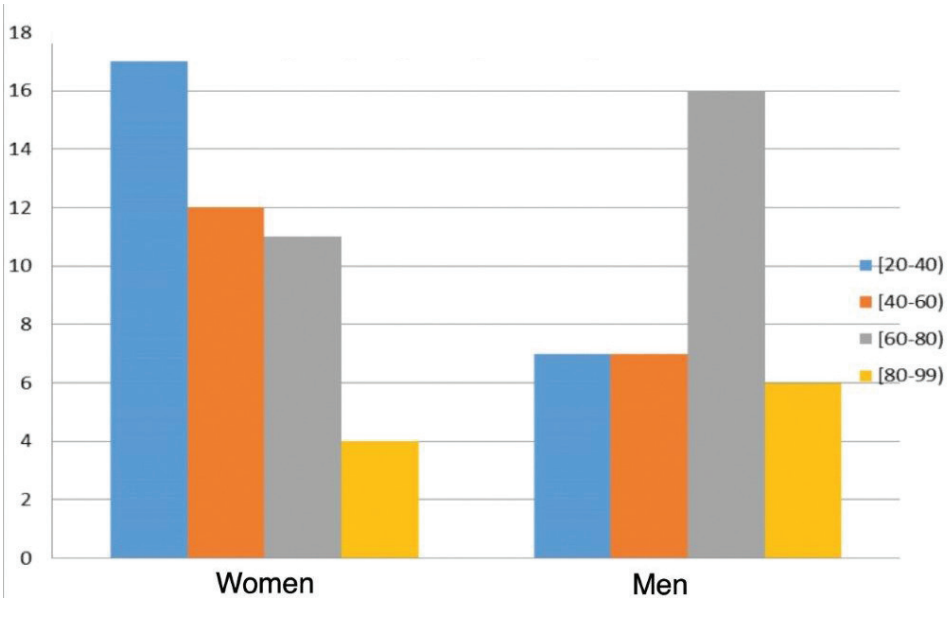

Fig. 1. Number of patients studied by age group and gender.

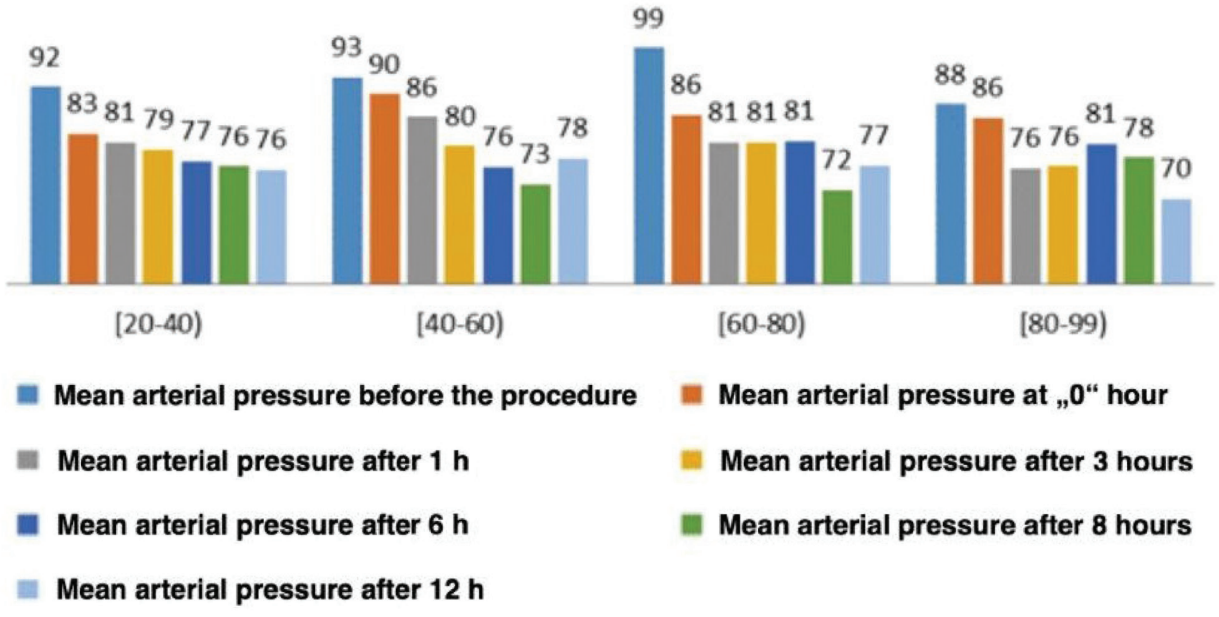

Fig 2. Mean arterial pressure by age group.

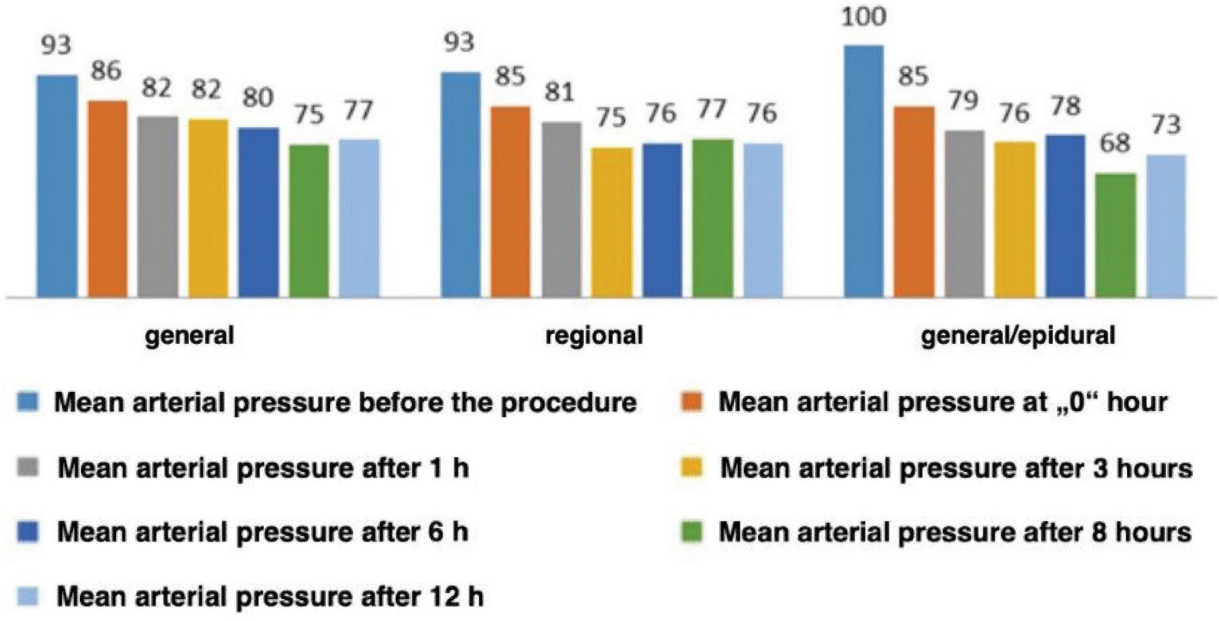

Fig. 3. Mean arterial pressure and the type of anaesthesia used.

RESULTS

In men, baseline mean arterial pressure (MAP), was higher than in women, i.e. 95 mm Hg. A significant decrease in blood pressure was observed in women when comparing measurements before the procedure and at "0" hour. A clear downward trend in mean arterial pressure was observed in both men and women in the postoperative period. The greatest decrease was observed in the course of the 8th hour after surgery. The study showed that elderly patients spent the longest time in the recovery room (33 hours on average), while young patients – the shortest (21 hours).

The analysis of mean values of arterial blood pressure versus age showed that in all age groups there was a tendency for it to decrease. A significant drop in blood pressure in the 8th hour after the procedure was observed in patients in three age groups. Only in the oldest subjects (i.e., those aged from 80 to 99), a decrease in blood pressure occurred during the 12th hour after the procedure (Fig. 2).

The analysis of mean arterial pressure values and the type of surgery revealed that the lowest values occurred in the course of the 8th hour after surgery. This applies to both open and laparoscopic methods.

When looking for the relationship between mean arterial pressure values and the type of anaesthesia used, it was noted that the lowest blood pressure values occurred during the 8th hour after surgery – primarily after general and epidural anaesthesia and general anaesthesia. After procedures under regional anaesthesia, no marked hypotonia was evident in the follow-up hours – the values remained the same (Fig. 3).

The analysis of mean arterial pressure values versus ASA score classification revealed that in Class 1 patients, a marked decrease in blood pressure occurred in the 6th hour after surgery. In patients in Class 2, this drop occurred in the course of the 8th hour after surgery. On the other hand, in Class 3 patients, the decrease was observedin the 8th hour and persisted until the 12th hour after surgery. Among Class 4 patients, a visible decrease in mean arterial pressure values occurred as early as one hour after surgery. An increase in these values was observed in the 6th hour, but subsequent measurements showed ongoing hypotonia.

DISCUSSION

Many complications can develop within several hours after surgery. According to the present study, hypotonia and its sequelae are common perioperative complications in patients after surgical procedures. Retrospective studies conducted by the staff of the Kraków Oncology Centre, which is a branch of the Maria Skłodowska-Curie National Research Institute of Oncology, have shown that postoperative hypotension occurs in more than half of the respondents. During that study, the medical records of 500 patients were analyzed. It was proved that hypotension after major abdominal surgery is a multicausal phenomenon. Major factors contributing to postoperative hypotension include older age, chronic β-blocker use, and renal dysfunction. In patients, in whom hypotension was treated by administering vasopressors, hospital stay after surgery was significantly longer [8].

It should be stated that the problem of postoperative hypotension is still unnoticed by researchers – both doctors and nurses.

The paper confirms the fact that the occurrence of postoperative hypotonia is clearly evident, even in such a small study group. It would, therefore, be interesting to see the results of studies based on a much larger group of patients and in different clinical units.

It is also important to note the complications brought on by low blood pressure. If medical intervention is not introduced, even the death of the patient may occur.

Hypotension during anaesthesia is harmful, but there are effective methods to prevent it. This problem was addressed in a study comparing the efficacy of ephedrine and phenylephrine administered after subarachnoid anaesthesia to prevent hypotension in the elderly [9]. Phenylephrine was not administered in the group of patients we studied.

One of the factors leading to postoperative hypotension is general anaesthesia administered early after dialysis. According to the study, in a group of patients operated on less than 7 hours after dialysis, a drop in blood pressure occurred in 63.6%, compared with 9.2% when the operation was performed over 24 hours after dialysis. During the 48 hours of follow-up after anaesthesia, hypotension was more common in patients whose interval between dialysis and anaesthesia was less than 7 hours. Therefore, if possible in cases of urgent surgical procedures, a delay of ≥7 hours may reduce postoperative hypotension [10]. Our study did not show any association between the kind of anaesthesia used and the occurrence of hypotension.

However, in a study comparing the classical and laparoscopic techniques in pheochromocytoma surgery, there were no significant differences in operative time, postoperative blood pressure control, major complication rates, postoperative hypotension, or cardiovascular disease between the two groups [11], which is consistent with the results of the present study.

Intraoperative and postoperative hypotension is associated with myocardial and renal damage and 30-day mortality. Deviations from normal blood pressure in the postoperative period occurred more frequently, were more prolonged, deeper, and largely undetected in a group of patients undergoing routine vital sign assessment (in a cohort of adults recovering from abdominal surgery). Frequent or continuous blood pressure monitoring may more effectively detect hemodynamic abnormalities and potentially facilitate treatment [12].

Another study linked the occurrence of hypotonia episodes solely to the length of surgery. Simi-

larly to our work, age and gender dependence were excluded [13].

In contrast, in 2019, the recommendations of the international organization called PeriOperative Quality Initiative (POQI) regarding postoperative blood pressure, risk, and outcomes of elective surgery were formulated as follows: (a) there is evidence of harm associated with a postoperative systolic blood pressure <90 mm Hg; (b) for patients with preoperative hypertension, the threshold at which organ damage occurs may be higher than a systolic blood pressure of 90 mm Hg; (c) there is insufficient evidence to precisely define the level of postoperative hypertension above which damage will occur; (d) more frequent postoperative blood pressure measurements can identify the risk of damage and clinical deterioration earlier; and (e) there is evidence of harm in withholding beta-blockers, angiotensin receptor blockers, and angiotensin-converting enzyme inhibitors in the postoperative period. Despite evidence suggesting associations of postoperative hypotension or hypertension with poorer postoperative outcomes, further research is needed to determine the optimal levels at which intervention is beneficial, to specify the best methods and timing for measuring postoperative blood pressure, and to improve postoperative management of chronic hypotensive treatment [14]. The current recommendations were presented to the team, in order to avoid and prevent hypotension and its consequences.

CONCLUSIONS

It cannot be concluded which factors most influence the occurrence of hypotension. Therefore:

1. When analyzing postoperative hypotension, complications and fluid deprivation associated with the procedure should be considered
2. In preventing hypotension it is recommended to:
   - implement rational fluid therapy and early oral fluid supply,
   - maintain fluid balance,
   - implement classical or extended monitoring dependent on the patient's general condition.
3. In the early diagnosis of hypotension and while implementing treatment, a key role is played by the cooperation of nursing and medical teams. Because of the frequent occurrence of hypotension in the eighth hour of observation, increased monitoring (including instrumentation) is necessary in the late postoperative period.

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REVIEW ARTICLE

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THE FUNCTIONING OF EMERGENCY DEPARTMENTS DURING THE FIRST WAVE OF THE COVID-19 PANDEMIC

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Abstract

Aim: Emergency Departments (EDs) work organization is a significant challenge for the medical personnel managing them. Space limitations and architectural differences between individual hospitals still existing in many places are one of the main reasons for such a state. The resulting diversity of communication routes, the distribution of particular areas, and the variety of bed resources are only among the many factors hindering the unification of the organization of ED work on a national scale. The "first wave" of the SARS-CoV-2 pandemic had a significant impact on the daily functioning of these departments, which resulted, among others, from the necessity to isolate patients with COVID-19, which should have been carried out according to top-down recommendations. These recommendations imposed specific organizational and logistic solutions on the EDs, including, in particular, the formation of isolation zones for patients suffering from a new infectious disease while maintaining the continuity of providing services to patients not suffering from COVID-19. Their implementation, in the context of the significant diversity of the existing organization of EDs, was, therefore, a challenging task requiring "individual" adaptation of each ED to new, even more, difficult working conditions. This article discusses the related challenges in the ED functioning during the first wave of the COVID-19 pandemic.

Key words

emergency department, COVID-19, covid pandemic

INTRODUCTION

The organization of Emergency Departments (EDs) should be similar and adapted to the applicable legal solutions. Unfortunately, the architectural conditions resulting, among others, from the forced adaptation of some admission rooms to the EDs, caused the premises conditions in terms of the distribution of individual areas differ from each other. Moreover, the hitherto marginally treated rooms, such as isolation rooms or decontamination zones, have become strategic logistic points in the face of the epidemiological threat. The SARS-CoV-2 pandemic and the rapid increase in COVID-19 patients resulted in the need to introduce new procedures in the "first line of defense," which EDs became, apart from Emergency Medical Service (EMS) teams.

THE AIM

This paper aims to present the activities undertaken in ED functioning during the first wave of the COVID-19 pandemic, with particular emphasis on the issues of work organization, transport logistics, and isolation of a patient suffering from an infectious disease.

REVIEW AND DISCUSSION

PRE-TRIAGE

The epidemiological situation in Poland in the first quarter of 2020 forced the implementation of "new" procedures in the EDs functioning. They aimed to protect medical personnel and patients by minimizing the risk of SARS-CoV-2 virus transmission. First, patients arriving at the EDs had to undergo a modified algorithm to assess disease severity (Fig. 1). Before the pandemic outbreak, patients admitted to the ED were subjected to classic triage carried out within the ward. Upon the announcement of the epidemic threat associated with SARS-CoV-2, it was required to introduce a tool that would initially allow dividing patients into those with suspected infection and those potentially healthy. Pre-triage is a model of taking history (Table 1) and doing a physical examination, which,

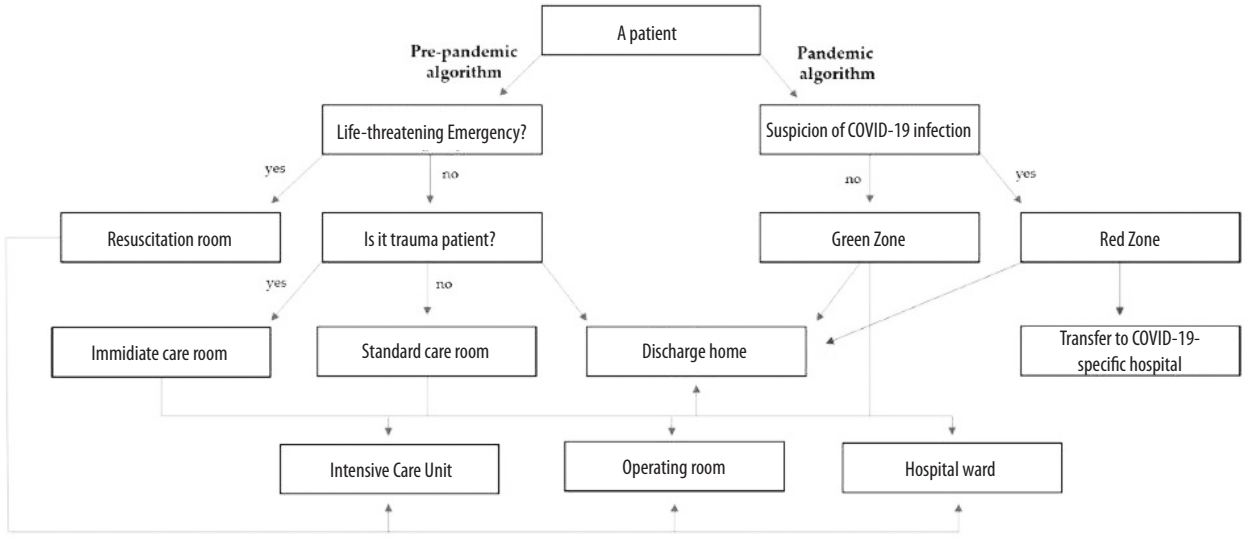

Fig. 1. Patient flow algorithm through the ED depending on epidemiological conditions.

Table 1. Elements of medical history taking, and epidemiological inquiry performed during the pre-triage [2-5].

Medical history	Epidemiological inquiry
1. Have you suffered from a cough in the last 14 days?	1. Have you traveled abroad in the last 14 days? If so, what country you visited, and when you came back?
2. Have you experienced an incident of shortness of breath or dyspnea within the last 14 days?	2. Have you met any people infected with the new coronavirus (SARS-CoV-2) or displaying its symptoms (cough, fever, shortness of breath) within the last 14 days?
3. Have you got a fever in the last 14 days? If so, how severe?	

without a swab result for the presence of the virus, gives a hint on how to manage the patient further [1].

The medical history taking, and epidemiological inquiry were to answer the question in which risk group the patient was. The model of the transmission of infectious diseases developed in the 1920s by William Kornack and William McKendrick is now known as the SEIRV segregation model [2]. In the case of a significant number of patients exposed to a biological factor, applying a model that uses the natural course of an infectious disease and the relationship with the external environment is recommended. Patients are marked with a code corresponding to the stage of the disease: S – SUSCEPTIBLE, E – EXPOSED, I – INFECTIOUS / INFECTED, R – REMOVED (death, recovery), V – VACCINATED. Using the above model, it should be assumed that all persons considered sensitive were equally exposed to infection with a constant and similar period of contagiousness [3-5]. As above, at least one affirmative answer to the questions presented in the table classifies the patient into the group of patients suspected of being infected with SARS-CoV-2. Independently from the taken medical history, each patient undergoes a brief physical examination. The pre-triage physical examination relies primarily on the measurement of the body surface temperature using a non-contact thermometer and the overall assessment of the patient's clinical condition. Patients with a body temperature above 37ºC, as well as patients showing other symptoms of COVID-19, considered typical in the first period of the pandemic, i.e., cough and dyspnea, are classified under the pre-triage system to the group of patients suspected of being infected with the SARS-CoV-2. Similar solutions, i.e., patients showing respiratory symptoms, regardless of the epidemiological history, are used in other centers [6]. Other models for diagnosing the risk of COVID-19 infection were proposed by Levenfus et al., where AIFELL was used, in which the parameters: increased concentration of lactate dehydrogenase and the presence of lymphopenia were also assessed. The presence of such features increased the sensitivity of pre-triage and the probability of correct qualification of the patient to the appropriate ED zone [7]. Other methods of screening were proposed by Soltan et al., where artificial intelligence was used to analyze a whole range of laboratory tests (e.g., blood gas test, blood counts, clinical symptoms). The results regarding potential infection were obtained much faster than the PCR results [8]. Thanks to the method used, it was possible to obtain cheap and relatively simple screening, which reached 92.3% accuracy (with a negative predictive ability of 97.6% and with AUROC equal to 0.881). Studies were also carried out on much "poorer" screening models, where the severity of diseases was assessed solely based on

the subjective assessment of the person responsible for triage in patients who met the epidemiological and clinical risk criteria for COVID-19 infection. Interestingly, such a subjective assessment model (i.e., does the patient look sick?) was effective in terms of the correct qualification of patients according to the need for hospitalization. Still, it was insufficient for the proper phenotyping of patients for the symptoms of COVID-19 disease [9].

One of the most noticeable imperfections of the pre-triage system was its implementation among patients admitted to the ED in a life-threatening state. Such patients, requiring immediate medical intervention, repeatedly found themselves in a state of disturbed consciousness, which significantly hindered the medical history taking and examination. Patients from this group were assumed to be COVID-19 patients. Such a patient had to be admitted and treated by personnel secured with a full set of personal protective equipment (PPE), which undoubtedly made manual work difficult. In the initial stage of the pandemic, it also caused secondary but significant problems due to the limited availability of such equipment. Additionally, patients of this group were placed in a part of the ward where the diagnosed or probable SARS-CoV-2 infection patients were staying, which further exposed them to infection transfer and encouraged the spread of the virus. Interestingly, at Bristol Royal Infirmary, critically ill patients were still phenotyped for risk of infection. Depending on the probability of infection, seriously ill patients were placed in the "green" or "red" zones [10]. This is a significant difference because, within the ED in which the author works, all critically ill patients were treated as infected with SARS-CoV-2.

Patients who were asymptomatic or mildly symptomatic carriers of SARS-CoV-2 often ended up in part of the ED for patients who were not suspected of having an infection, which favored the transmission of the virus to healthy people and medical staff.

MANAGING THE FLOW OF PATIENTS IN TIMES OF COVID-19

The need to separate the population of patients suspected of having SARS-CoV-2 infection from the remaining patients in the ED forced the reorganization of the ED. The following zones have been formed: green, orange, and red (Fig. 2a, b). The green zone is an area for admitted patients with no history of a possible infection. The orange one, which is a kind of "airlock" between the green and red zones, is a space for medical personnel who have had contact with the red zone. There, the staff is decontaminated, and medical clothing is changed.

One of the organizational requirements was the presence of a sanitary facility in such a zone and instructions on how to dress and remove protective clothing appropriately. The red zone included patients whose pre-triage epidemiological and clinical picture of the disease could indicate infection with the SARS-CoV-2 virus, as well as those who waited for a swab result before admission to the target hospital ward. However, it should be remembered that in the first period of the pandemic, the organization of the above-mentioned zones became only an attempt to systematize patients in terms of infection. The current epidemic and the nature of the COVID-19 disease are characterized by an extensive "gray zone" – one can never be sure that the patient in the green zone is not an asymptomatic vector that infects [11]. Due to the above, it seems rational to maintain a similar sanitary regime as in the red zone. Nevertheless, in the green zone, medical personnel are required to use at least surgical masks (their estimated reduction in the risk of droplet transmission from 1-2 meters from an infected patient is approximately 80% [12]). It is worth mentioning that the transport of patients to the green and red zones was carried out using separate routes, i.e., patients suspected of being infected did not travel the same corridors as patients without suspicion of infection, which was in line with WHO recommendations regarding the organization of EDs [13].

Minor procedures performed in the green zone were subject to a strict sanitary regime, with the use of a disposable gown, goggles, or facial shields, as well as sterile gloves (the distance between the healthcare worker and the patient is then direct). The use of advanced personal protective equipment was obligatory within the red zone. Therefore, the personnel were equipped with an additional apron or coverall, a HEPA mask, a head cap, goggles, or a facial shield, as well as two layers of gloves during their entire stay in this space. Such clothing meets the international standards for preventing viral aerosol transmission [14].

Within the described zones, isolation rooms were also separated in the ED. In the red zone, an isolation room with its own sanitary facility and the possibility of monitoring the patient, as well as an intensive care standard room, were organized. In addition, isolation rooms were organized in the green zone, without the presence of a sanitary facility and the possibility of monitoring – they were provided for patients who waited for a nasopharyngeal swab result during a short stay. Such an adaptation for the isolation of patients was a radical change in relation to the ward

Fig. 2a, b. Safety zones separated within Emergency Departments.

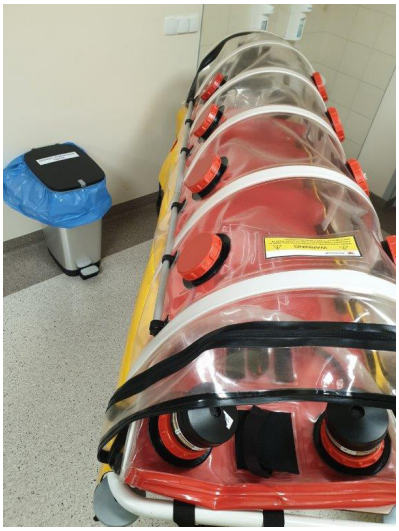

Fig. 3a, b. Isolating devices for patients with confirmed COVID-19.

organization before the pandemic. Previously, there was only one isolation room for the entire ED in the author's workplace. For obvious reasons, medical staff, divided into the one serving the red zone and the person serving the green zone, should not have contact with each other or at least have this contact to a minimal extent [15].

PARALYSIS OF EMERGENCY DEPARTMENTS DURING A PANDEMIC

One of the essential complications hindering the ED's functioning is transferring patients to target departments. To minimize virus transmission in the hospital prior to admission, every patient had to have a SARS-CoV-2 swab. In the initial phase of the pandemic, the introduction of this type of regime meant that patients' staying in the ED extended to several days, which delayed the time of admitting "new" patients. Additionally, due to the more and more frequent situations in which departments of neighboring hospitals were temporarily closed due to infections of medical personnel or the need to decontaminate rooms periodically after identifying an asymptomatic carrier in the green zone, a more significant number of patients were sent to the same ED. Moreover, a patient who showed a positive swab result during staying at the ED and required admission to the target ward had to be transported to a hospital prepared for the treatment of such patients. In situations of frequent lack of places in the wards intended for hospitalization of patients with COVID-19, the period of admission to the ward was significantly extended. It is worth noting that due to the large number of tests performed in the hospital laboratory, there were often situations where there were no reagents to perform the PCR test. In such situations, an external unit performed the swabs analysis, which led to a critical extension of the waiting period for the result, making the results known in the best situation only on the second day. The constellation of the above-mentioned difficulties translated into a long wait for admission to the ward and excessive occupancy of the ED, which resulted, among other things, in a long time necessary to find a free bed and admit patients remaining in ambulances standing in front of hospitals.

Fig. 4. Intubation training in individual personal protective equipment.

PROCEDURES FOR DEALING WITH COVID-19 PATIENTS

One of the challenges in dealing with patients with confirmed or highly probable SARS-CoV-2 infection was the implementation of procedures to isolate patients in a way that would prevent transmission of the virus. Bio-Bag devices (Fig. 3a,b), isolation tents, or special covers protecting medical personnel in the first phase of a pandemic often turned out to be unavailable.

Physiologically difficult airways in patients with COVID-19 do not arise from anatomical anomalies but profoundly disturbed physiological functions of lung tissues, which cause gas exchange disturbances. Intubation of a patient with decompensated respiratory failure is always difficult, stressful, and at risk of failure. Tracheal intubation, as well as extubation and bronchofiberoscopy, is considered to be one of the procedures with a high risk of aerosolization [16].

This means that during its performance, an aerosol is sprayed (from the respiratory tract of the intubated patient) from the upper respiratory tract [11, 16], which may be aspirated into the lungs by the person performing the procedure and by assisting staff, exposing them to potential infection. In addition, the occurrence of the SARS-CoV-2 virus generated difficulties in intubating COVID-19 patients, due to the necessity to perform this medical procedure in full security in PPE and use to carry out additional barrier covers. Therefore, medical personnel were required to equip themselves with coveralls, masks with high filtration efficiency, goggles, or facial shields, which significantly reduces the possibility of obtaining optimal visualization of the entrance to the larynx during laryngoscopy, as well as communication and teamwork (Fig. 4).

Therefore, intubation of a COVID-19 patient could not have been an unprepared, ill-considered, and chaotic medical procedure. In most cases of COVID-19 cases, we were able to predict the upcoming need for intubation and prepare for it accordingly. The preparation of drugs or equipment necessary for endotracheal intubation of a patient with SARS-CoV-2 infection did not differ from the principles of supplying the upper respiratory tract to patients with other diseases. However, one must keep in mind that the preparation to perform this procedure for a patient with COVID-19 required considerable attention to every detail because after entering the red zone where the patient was, the need to replenish the missing equipment or medicines required leaving the red zone, which was associated with a time-consuming staff decontamination procedure.

CONCLUSIONS

The COVID-19 pandemic forced the implementation of measures to minimize the transmission of the virus to both patients and medical staff, which in the initial period was a serious problem for health care facilities. However, the systems proposed in the first wave turned out to be far from sufficient, which became even more evident with the increasing number of people infected with the virus.

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FULMINANT SOFT TISSUE INFECTIONS CAUSED BY ANAEROBIC BACTERIA – THE PARAMEDIC'S PERSPECTIVE

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Abstract

Anaerobic bacterial infections are a broad group of conditions ranging from superficial skin infections to deeply embedded necrotic soft tissue infection. It has been observed that amongst all the microorganisms causing soft tissue infection, as many as 70% of anaerobic bacteria are unquestionably related to mortality in fulminant infections. Such infections are most commonly caused by an open wound that is insufficiently disinfected, or through the wound coming into contact with soil or human or animal faeces. This is particularly the case for wounds resulting from traffic accidents and injuries sustained in agriculture. In 80-95% of cases, the bacteria Clostridium perfringens is responsible for the appearance of gas gangrene manifested by sharp pain and crepitus in the wound area, as well as disseminated intravascular coagulation and septic shock. Due to time-consuming diagnosis and delays in obtaining the results of bacteriological tests, identifying the condition and commencing treatment relies mainly on a paramedic's knowledge and experience. Improving the body of knowledge on soft tissue infection and awareness of the potential risks can affect the patient's prognosis.

Key words

anaerobic bacteria, fulminant soft tissue infections, medical response team

INTRODUCTION

Despite medical advances, anaerobic bacterial infections are still a group of conditions that are life threatening. The danger posed by the infection is mainly the result of the rapid spread of the disorder, and without appropriate diagnosis and the implementation of aggressive treatment often leads to death [1-5]. It has been observed that amongst all the microorganisms causing soft tissue infection, as many as 70% of anaerobic bacteria are unquestionably related to mortality in NSTI (Necrotizing Soft Tissue Infections). An increased relative amount of Gram (-) bacteria has also been noted in patients with abscesses, which is linked to a worse prognosis for the satisfactory effects of treatment [6-8]. Due to time-consuming diagnosis and delays in obtaining the results of bacteriological tests, identifying the condition and commencing treatment relies mainly on a paramedic's knowledge and experience [9-11].

Skin and soft tissue infections (SSTI) cover a range of infections, usually in the form of abscesses, which are infections limited to the host matrix and require only minimal medical intervention. ABSSSI (Acute Bacterial Skin And Skin Structure Infections) are severe bacterial infections of the skin and its structure (previously known as SSTI complications), that reach deep into layers of tissue and may require surgical intervention. The group of conditions known as Necrotizing Soft Tissue Infections (NSTI) are rapidly spreading infections that cause serious illness and systemic septic shock, and a mortality as mentioned above of 10-30%, despite intensive treatment [6, 12-14].

THE AIM

The Emergency Medical Service team is often the first to contact the injured, and the paramedic, based on a medical history and physical examination, quickly decides about urgent or planned diagnostic and treatment procedures. Although rare, fulminant infections of soft tissues are one of the most dangerous diseases; therefore, systematizing the current knowledge in this field will allow for effectively counteracting these dangerous infections.

REVIEW AND DISCUSION

ETIOLOGY

Some anaerobic infections (tetanus and gas gangrene) are caused by microorganisms carried by various environmental factors, for example soil. However, common types of anaerobic infections occur as an endogenous form of infection caused by a patient's own bacterial flora, which is why it is crucial to identify the place colonised by the anaerobes in order to determine the given pathogen and estimate its invasion path (Tables 1-2) [11, 15-17].

Table.1. Endogenous anaerobic bacteria in the human body [4].

Location	Bacteria
Oral cavity, upper respiratory tract	*Prevotella* (especially *P. oralis*), *Porphyromonas, Bacteroides (B.ureolyticus), Fusobacterium* (especially *F. nucleatum*), *Peptostreptococcus, Veillonella, Actinomyces, Propionibacterium*
Stomach	*Lactobacillus*
Small intestine	*Streptococcus, Lactobacillus*
Colon	*Bacteroides fragilis, Porphyromonas, Fusobacterium, Anaerobic cocci, Clostridium, Bifidobacterium, Propionibacterium*
Reproductive organs	*Prevotella, Porphyromonas, Bacteroides, Peptostreptococcus, Clostridium, Veillonella, Lactobacillus, Eubacterium, Propionibacterium*
Urethra	*Propionibacterium, Peptostreptococcus, Bacteroides, Fusobacterium*
Skin	*Propionibacterium, Peptostreptococcus*

Table 2. Classification of anaerobic bacterial infections of skin and soft tissue [7].

	Gas gangrene		Necrotizing infections	
	Clostridium	Non – Clostridium	Type I (multi-bacterial, connective tissue infection)	Type II (streptococcal gangrene)
Causative bacteria	Various infections: *Clostridium* with other bacteria	Various infections: *Bacteroides, Escherichia coli, Streptococcus* and other anaerobes	Facultative anaerobes	Group A β-hemolytic *Streptococcus*
Underlying condition	In the majority of cases contaminated wounds	Diabetes in many cases	Diabetes, obesity, alcoholism	No underlying condition in many cases
Progression of symptoms	Fast	Slow	Slow	Fast
Inflammatory tissue – morphology	Myositis, muscle necrosis	Infection of connective tissue, skin and subcutaneous tissue	Infection of connective tissue and muscles	Infection of skin, subcutaneous tissue, connective tissue, muscles
Skin symptoms	Localised pain, reddening, swelling, blisters, dark purple patches on the skin, necrosis and fluctuation	Localised pain, reddening, swelling, blisters, dark purple patches on the skin, necrosis and fluctuation	Localised pain, reddening, swelling, blisters, dark purple patches on the skin and necrosis	Swelling, marked erythema, blood blisters, well-defined necrosis, ulcer
Minor crackles and crepitations	+	+	-	-
Properties of pus/smell	Smell of rotten meat	Rotten smell	Fetid (+)	Fetid (-)
Bacteriological tests	Rod bacterium (+)	Rod bacterium (-) and grain bacterium (+)	Grain bacterium (+)	Grain bacterium (+)
Blood and urine tests	Anemia, jaundice, hemoglobinuria, elevated creatine phosphokinase (CPK)	General infection, diabetes	General infection	General infection, high level of antistreptolysin O (ASO)
X-ray results	aerosis displays plumage in the muscle layer	Image of subcutaneous aerosis	Gas (-)	Gas (-)
Hyperbaric oxygen therapy	Clearly effective	Ineffective	Ineffective	Ineffective

Classification of anaerobes and their frequency of isolation from samples:

- group of bacteria that form endospores:
  - *Clostridium bacteria* (11-14%),
- group of bacteria that do not form endospores:
  - Rod bacterium (-) (24-39%): *Bacteroides, Prevotella, Porphyromonas, Fusobacteria*,
  - Grain bacterium (+) (16-22%): *Peptostreptococci, Peptococcus*,
  - Grain bacterium (-): *Veillonella parvula*,
  - Rod bacterium (+): *Actinomyces, Bifidobacteria, Propionibacterium, Eubacterium* [3, 4, 7, 8].

BACTERIOLOGY

The main feature of anaerobes is their ability to exist only in anaerobic conditions or in environments with a minimal concentration of oxygen. Bacteria that live in environments with a concentration of oxygen between 0.1% and 5% are known as strictly anaerobic. Microaerophilic strains, or optionally anaerobic,

tolerate higher concentrations of O_2, but also develop only when the concentration is low. In addition, anaerobes produce energy during fermentation and lack cytochrome, peroxidase and catalase, which is why they are often involved in infections that affect the deeper skin layers, connective tissue and muscles rather than in superficial infections [5, 18-20].

The phrase 'air tolerance' suggests the ability of pathogenic anaerobic microorganisms to survive and be active in the oxygen concentrations present in tissue. A significant number of strains of anaerobes (e.g. *Bacteroides*) are able to survive in environments with oxygen at pressures of between 15 and 60 mmHg or above. Of key importance apart from oxygen concentration is the tissue redox potential, that is the ability to create electrons in metabolic cycles. Reduction of redox below +120mV encourages the development of anaerobes, irrespective of the oxygen concentration. Reduction of redox is also affected by ischemia, tissue necrosis and the development and action of aerobic bacteria [3, 21, 22].

Anaerobic bacteria are also divided into those that produce endospores and toxins responsible for their pathogenic effects (these belong to the strain *Clostridium* – which vegetate in soil and in the digestive tract of humans and animals), and those that do not produce endospores (these are most often saprophytic flora on mucous membranes) [3-5]. Of the 150 strains identified, those responsible for causing gas gangrene are: *Clostridium perfringens* (80 – 90% of muscle necrosis), *Clostridium welchii*, *Clostridium oedematiens* and *Clostridium novyi*. The remaining cases of necrotizing muscle infection are caused by the Bacteroides fragilis strain and by streptococci [23-25].

The classification of anaerobic infections, based on bacteriological and clinical criteria, currently refers above all to the type of tissue that was first infected. This division is as follows:

1. Muscle necrosis induced by *Clostridium* (gas gangrene), or by other microorganisms.
2. Infections of subcutaneous tissue, which, depending on the depth of the spreading infection, can be divided into:
   a. necrotic connective tissue infection affecting the deep connective tissue, subcutaneous tissues and surface connective tissue;
   b. skin infection including subcutaneous tissue and surface connective tissue [26, 27].

The most important features of necrotizing soft tissue infection are the place of the initial development of the infection (muscles, subcutaneous tissue, connective tissue), the location of the infection and how it is spreading. A common element to all infection variants is that they cover a large area of the body (irrespective of existing barriers), and the lack of characteristic purulent discharge (or rather the presence of a cloudy discharge with a serous specificity). In addition, after incision the tissue can be seen to be pale and often disintegrates to the touch of the hand or surgical instrument, as well as displaying areas of necrosis. There may be limited bleeding from the wound or no bleeding at all, as well as:

1. Under the microscope, massive accumulation of leucocytes, necrotic areas and developing microabscesses.
2. For the majority of the infection period, samples show the presence of microorganisms that are the cause of the infection.
3. Areas of dead tissue that appear as a result of thrombotic changes in the microcirculation.
4. Multiple clots that lead to local swelling of the tissue and as a result hypoxia – despite the larger blood vessels maintaining correct blood flow [3-5].

PATHOPHYSIOLOGY

Anaerobic infections usually progress in two stages. In the first stage, infection by aerobic microorganisms creates an anaerobic environment in the abscesses that form. One exception is the expansion of *Clostridium* bacteria, which spread in the form of an exogenic infection without the participation of other aerobes. *Clostridium* bacteria survive in the form of spores in environments rich in oxygen (soil, hospitals), and only an injury with an infected wound or damage to the mucous membrane of the large intestine (a source of endogenous anaerobic bacteria) favours the development of anaerobes. A specific pathogenic process is then activated due to the production of exotoxins (*C. perfringens* – gas gangrene, *C. tetani* – tetanus, *C. botulinum* – food poisoning, *C. difficile* – infection of the large intestine) [21, 28-30].

These toxins are proteins with a high molecular weight, and cause the majority of clinical symptoms. The most well-known is the α – toxin produced by *Clostridium perfringens*. This toxin causes necrotic changes to tissue and haemolysis. The main capture point of α – toxins are myocytes (myolysis), erythrocytes (haemolysis), thrombocytes (blood clotting disorder) and kidney tubule cells (haemoglobinuria). The other *Clostridium* toxins are β, δ, τ – [22, 31, 32].

Anaerobes that do not create endospores are less virulent that *Clostridium* as they do not produce such powerfully acting toxins. These are opportunistic strains that evolve in the form of pathogens under the influence of suitable circumstances. The substances they release are also responsible for the formation and development

of necrotic changes, i.e. procollagenase (breakdown of subcutaneous tissue, forcing a path for penetration into the interfascial spaces), and coagulase (clotting within the capillaries). Bacteroides strains form mucopolysaccharide capsules, which protect them from phagocytosis. Forcing in only isolated capsules may contribute to the formation of abscesses. At the same time they can limit the activity of Polymorphonuclear Leukocytes (PMN), reducing their opsonisation abilities [5, 31, 32].

An attempt has been made to classify anaerobic infections according to the degree of spread of microorganisms in the body:

1. Very high 'C' (frequency of anaerobe isolation 70–100%): gas gangrene, capillary cyst, diabetic foot ulcers, infection after appendectomy, perianal abscess, infection after procedures to the large intestine, lung abscess.
2. High (50–100%): aspiration pneumonia, lung abscess, brain abscess, intraperitoneal abscess, subcutaneous abscess, oral infections.
3. Low (9–40%): infection of the bones and bone marrow, bacteraemia.
4. Very low 'B' (1%): urinary tract infection [9-11].

Many different illnesses are conducive to the development of anaerobic bacteria. These include: blood vessel diseases (aneurysms, vasculitis, diabetic microangiopathy), vasoconstrictor drugs, shock, cold, hematomas, tissue swelling, trauma or surgery, foreign body, cancer, anaerobic microbial infection, malnutrition, alcoholism or immunosuppressive treatment [26, 27].

GAS GANGRENE

Infection is caused by: an open wound, an insufficiently disinfected wound, contact of the wound with soil or human or animal faeces, and leaving a foreign body in the wound. This is particularly true for wounds resulting from traffic accidents and injuries sustained in agriculture, that is crushing, damage to the blood vessels or open breakages. Infection can also be caused by chronic wounds such as diabetic foot (40% of cases), slow healing ulcers, infection resulting from surgical procedures (amputation, vascular surgery), iatrogenic causes (intramuscular injections, use of steroids and anti-inflammatory drugs), episodic cases of infection with intestinal flora and from the crotch area. A typical endogenic infection that initially develops from an anal abscess is the so-called Fournier's syndrome. At first there is reddening and pain around the crotch and anus, and then there is rapid development of necrotic changes to the skin including connective tissue toward the stomach, groin, buttocks and thighs. Just as quickly, a generalised systemic response to the infection also occurs [19, 20, 26, 27].

Fig. 1. Gas gangrene, infection of wound with *Clostridium perfringens* after open fracture of the lower leg.

Fig. 2. Necrosis of tissue in the crotch, anus and buttocks as a result of Fournier's syndrome.

Fig. 3. Necrosis of tissue in the abdomen, groin and scrotum as a result of Fournier's gangrene.

Fig. 4. Necrosis of tissue in the anus and crotch as a result of Fournier's gangrene.

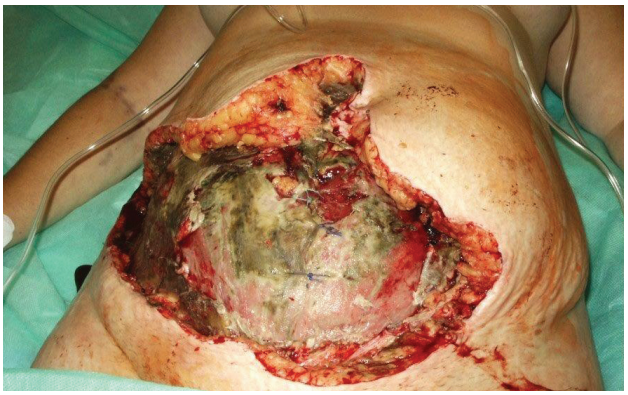

Fig. 5. Image of necrosis to the abdominal walls as a result of clostridial gangrene – infection with *Clostridium perfringens* of a postoperative wound.

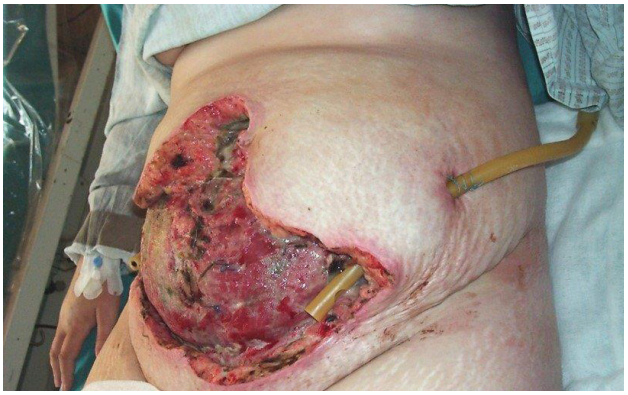

Fig. 6. Image of an operative wound infected with *Clostridium perfringens* during specialist treatment.

Fig. 7. Final results of effective treatment of a postoperative wound infected with *Clostridium perfringens* – healed skin graft.

The infection develops between 12 and 24 hours after contamination. Suspicions can be aroused by a pale, slow-healing wound. Among the first symptoms are: sharp, intensifying pain (not proportional to the size of the wound), loss of awareness, increased swelling, cold pale skin and small amounts of discharge from the wound. A considerable worsening of prognosis occurs with the appearance of hypotension, loss of awareness, yellowing of the skin, oliguria and coagulopathy. When an incision is made in the wound, a discharge is released and there is a strong characteristic smell of rotten meat [19-22].

On the X-ray image, bubbles of gas can be seen in the muscles, as well as a so-called 'feathering'. The appearance of gas bubbles is not a specific symptom as they occur in only 20% of cases. Gas is also produced by *E. coli, Proteus, Areobacter*, or can appear in the wound due to injections or after trauma. The basis for diagnosis are clinical observation and bacteriological tests. Diagnosis should be based above all on direct samples and the patient's clinical condition. However, bacteriological analysis takes time (culture of anaerobes) and should not be a reason for delaying intervention [3-5].

There are 6 strains of bacteria that cause gas gangrene (*C. perfringens, C. novyi, C. histolyticum, C. sporogenes, C. septicum, C. fallax*), however, in 80-95% of cases *C. perfringens* is responsible for this type of infection. The *Clostridium* type produces specific exotoxins responsible for thrombus formation, resulting in disseminated intravascular coagulation (DIC) and shock with renal failure due to rhabdiomyolysis (Fig. 1) [18-20].

NECROTIZING ANAEROBIC CONNECTIVE TISSUE INFECTION

The cause of these infections is mixed flora – most often grain bacterium (+) and rod bacterium (-). In 1977, Giuliano isolated 75 strains of bacteria in 16 patients, in particular *Streptococcus* (15), *Bacteroides* (10) and *Peptostreptococcus* (8). Several years earlier, in 1972, Stone and Martin did not isolate β–hemolytic streptococci from the wound, but mainly *Bacteroides, Enterococcus* and anaerobic rod bacterium (-) [3-5].

The principal cause of infections are trauma to the skin and mucous membranes caused by: physical trauma, surgical procedures, infection of pre-existing wounds (diabetic foot, bedsores, ulcers) or idiopathic causes (skin scratching, insect bites, tooth extraction, injections). Specific infections are seen as a result of the injection of the Prevotella strain in drug addicts [3, 7, 8].

Development of the infection occurs within 6-72 hours. Initially, a slight paling of the skin is visible

around the wound, local paresthesia, followed by a feeling of stretching around the wound, the appearance of reddening and increasing swelling and pain. The infection spreads very quickly with an aggressive increase in symptoms. A systemic response to the infection is seen in the patient that manifests itself as: fever, loss of awareness, extreme leucocytosis, coagulopathy, oliguria, and finally multiple organ failure. Reddening and inflammatory discharges increase locally, while the infected area is warm and very tender, with the skin becoming tight and swollen. Crepitations can also be observed in the tissues, but decidedly less often than in the case of gangrene. X-ray results show gas bubbles in the tissue, forming along the connective tissue and showing the shape of the muscles. The spread of a local infection to the whole limb can take less than 36 hours [26, 27].

In 1883, Fournier first described infection of the genitalia in men. Today, the condition of Fournier's gangrene is divided into: Fournier's disease (no defined starting place of the infection) and Fournier's syndrome (beginning of the infection in the rectum or anus). The dominating symptoms are reddening and pain in the crotch, rapid necrotic changes to the skin and connective tissue with an equally rapid spread of the infection toward the stomach, groin, buttocks and thighs, and an instant systemic response. A common cause has become infection of the hair follicles in the crotch or treatment for haemorrhoids or anal fissure (Fig. 2-6) [6, 7, 8].

NECROTIC INFECTION OF CONNECTIVE TISSUE IN THE FACE AND NECK – LUDWIG'S ANGINA

One factor in this infection is the bacterial flora of the mouth and throat. At first, the infection affects the tonsils, forming abscesses, and due to the lack of barrier to the infection, it easily spreads to the mediastinum, which is extremely dangerous. Initial symptoms are: a sore throat and (small) swelling to one side of the underjaw. The red swelling then spreads dramatically to cover the whole of the lower jaw. These changes spread to the face, neck, supraclavicular area and chest. In the final stage, the infection spreads to the mediastinum (very difficult to diagnose) the pleurae, lungs and pericardium [3-5].

ANAEROBIC SKIN INFECTION

These infections only affect the skin and subcutaneous tissue, and do not spread deep into the connective tissue. The infection also develops much more slowly. The most common cause are surgical procedures to the abdominal wall or chest, drainage of purulent lesions, ileostomy, colostomy or simply trauma to the skin.

Bacteria from the central area of the changes are not characteristic for the condition, but those from the edges are mainly anaerobic microorganisms, nonhemolytic streptococci (*Staphylococcus Proteus, Enterobacteria, Pseudomonas*) and many others. However, the main strains are streptococci, infection with which allow other bacterial strains to invade, which is why the condition was previously named 'progressive synergistic gangrene'. The patient gradually starts to complain of increasing pain in the affected area, a dark red patch appears in the centre of the affected area surrounded by redness. This is typically composed of: peripheral redness, a tender dark red middle zone and a centre with necrotic changes spreading in ulcers. The progression of the condition does not affect the deep connective tissue, and the infection usually develops without complications over several days or weeks [3-5].

TREATMENT OF ANAEROBIC INFECTIONS

Isolating anaerobes requires appropriate techniques for collection, transport and cultivation of the microorganisms. If the greatest care is not taken at every stage of this process, this can lead to implementation of the wrong therapy. The diagnosis and treatment of anaerobic infections is further complicated by their slow growth and their increasing resistance to antibiotics. The principal role of antimicrobials is to limit both the local and general spread of the infection. Of primary importance are surgical drainage and the cleaning of necrotic tissue, with additional therapy aimed at improving circulation, limiting blockages and increasing oxygen supply to the tissue [33, 34].

ANTIBIOTIC THERAPY

For a long time, Penicillin G was the drug of choice and is still effective against the strain S*treptococcus A*, as well as *Clostridium, Fusobacterium* and *Peptostreptococcus*. An increase in resistance (especially in *Bacteroides* and *Prevotella*) has forced modifications to be made in the form of using carboxypenicillins, ureidopenicillins and a combination of penicillin with imidazole derivatives. In the case of an allergy to penicillin, rifampicin, chloramphenicol, and macrolides can be used, as well as clindamycin, which is especially recommended due to its anti-anaerobic toxin properties [3-5]. For infections involving many strains, complex treatment is recommended consisting of penicillin, imidazole and aminoglycosides. The main reason for this is the considerably reduced effectiveness of Penicillin G against anaerobes due to the production of β–lactamase by aerobic strains of bacteria. The majority of authors

recommend using antibiotics for 3 weeks if there are no complications [29, 30, 35-37].

SURGICAL TREATMENT OF WOUNDS

Formerly, a condition of survival was rapid amputation of the limb affected by the infection. Today, treatment is complex and aims to remove necrosis and reduce swelling in order to improve microcirculation, and thus the penetration of antibiotics. Overriding surgical procedures aim at early removal of necrosis from the wound and making incisions to provide access to the subcutaneous tissue and connective tissue. Wounds are also rinsed with antiseptic agents (povidone, chlorhexidine), however the use of hydrogen peroxide is not recommended as it does not increase the concentration of oxygen in the wound, and also bears the risk of causing complications in the form of pulmonary edema and gas embolism [35-37].

After initial surgical treatment of the wound, it is recommended to reassess it every 8 hours for the first 5 days. In many cases, the necrosis is removed by additional rinsing of the wound and drainage. When the condition of the area has improved (after around 2 weeks), the dressings can be changed daily [1, 4, 5].

USE OF HYPERBARIC OXYGEN THERAPY – HBO

The physiological effect of hyperbaric oxygen (HBO) on anaerobic soft tissue infections results in: a direct toxic effect on the anaerobes (lack of antioxidant system in the anaerobes), an increase in the antibacterial properties of leukocytes as an indirect effect, and an increase in the activity of certain groups of antibiotics (aminoglycosides). Currently, however, there is no treatment protocol indicating exactly how many times the treatment should be conducted, for how long and what air pressure should be used. The usual procedure is to use 2.5 ATA for at least 60 minutes of breathing pure oxygen, with the treatment repeated twice a day (Fig. 7) [38, 39].

PROPHYLACTICS

Mortality from anaerobic infections depends on the location of the infection (Wattel, Mathieu): abdomen and chest – 68%, neck and mediastinum – 50%, abdominal wall – 45%, crotch – 32%, limb – 18%, neck 12.5%. The consequences of an infection are often affected by such factors as: age, general bad state of health (alcoholism, diabetes, cancer), hypothermia, blood coagulation disorders, renal failure, shock, ARDS and late diagnosed infection. If there is a risk of anaerobic infection after an injury where the wound is contaminated with soil or a foreign body, or after surgical procedures, it is recommended to conduct 5 to 7 HBO treatments over 2 to 3 days. However, the effect of treating anaerobic infections remains unsatisfactory, therefore it is recommended to implement appropriate prophylactics and to take immediate aggressive treatment the moment anaerobic infection is diagnosed [16, 27, 38-40].

CONCLUSIONS

Statistically, the percentage of anaerobes isolated is higher among outpatients than hospitalised patients. The use of wide spectrum antibacterial agents in hospitals means that anaerobes are often the cause of primary not secondary infections. Such infections are notable for the relatively serious condition of the patient (toxaemia), with symptoms of septic shock and fever, in contrast to a seemingly innocent-looking wound. A characteristic feature are areas of black necrosis without discharge of pus, but with a thin discharge accompanied by crepitations during palpation (crepitation is not specific only to *C. Perfringens* infections) and a typical fetid odour.

Paramedics working in Emergency Response Teams are often the first to come into contact with victims. Based on personal and physical examinations, they must decide whether to follow an urgent or standard procedure in the diagnosis and treatment of infected wounds. Continual improvement of their knowledge about soft tissue infections, as well as an awareness of the potential risks, including death, can both have an effect on the prognosis for further treatment of patients.

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CONFLICT OF INTEREST

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DOI: 10.36740/EmeMS202203108 **SHORT COMMUNICATION**

THE FREQUENCY OF MEDICAL INTERVENTIONS AT PASSENGER AIRPORTS IN POLAND IN 2016-2020

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Abstract

Aim: To estimate the frequency of medical interventions at passenger airports by calculating the ratio of the number of medical interventions per 100,000 passengers per year.

Material and methods: The study was planned as a retrospective study based on historical data on medical interventions at airports in Poland. The five-year period from 2016-2020 was adopted as the research period. The research was based on questionnaires sent to the authorities of all airports in Poland.

Results: The results were obtained only from 4 certified passenger airports in Poland (out of all 14 certified passengers airports in Poland). The rate of medical interventions was estimated. On the basis of data from 5 certified passenger airports in Poland, the method of providing medical care at airports was characterized in the article.

Conclusions: The medical intervention ratio at Polish airports in 2016-2020 was 9.54 per 100,000 passengers per year. The COVID-19 epidemic has significantly increased the number of medical interventions at airports.

Key words

airports,
emergency medical services,
aerospace medicine,
epidemiology,
COVID-19,
emergency medical technicians

INTRODUCTION

Air traffic is one of the main forms of human transport over long distances. Until the COVID-19 pandemic, the number of passengers transported increased every year, also increasing passenger traffic within airports. As the number of people in airports and airplanes increases, so does the number of medical incidents requiring medical assistance.

The airport is a very specific place for medical activities, mainly because of the security procedures that can restrict access to certain locations and make it difficult to carry medical equipment and drugs [1]. Polish aviation law provides for the obligation to provide an appropriate type of first aid or medical aid depending on the number of passengers served. This aid should be provided at all times during airport opening hours [2, 3].

THE AIM

The main aim of the study was to estimate the frequency of medical interventions at passenger airports by calculating the ratio of the number of medical interventions per 100,000 passengers per year. The presentation of such a ratio may allow for planning the demand for organized medical assistance at airports. Additional objectives of the work were to characterize the method of organizing medical assistance in individual airports in Poland.

MATERIAL AND METHODS

The study was planned as a retrospective study based on historical data on medical interventions at airports in Poland. The five-year period from 2016-2020 was adopted as the research period.

The study was approved by the Bioethics Committee of the Medical University of Warsaw, number AKBE / 114/2021.

The survey was carried out in the second half of 2021, when letters were sent to all 14 certified passenger airports in Poland, asking them to answer questions about the number and type of medical interventions at the airport, the number of passengers served and how to ensure the implementation of tasks in the field of emergency medical services (including the number and type of personnel employed, number of ambulances and ambulatory rooms). Annual aggregated data were requested.

Due to the expectation of anonymization of the answers of some respondents, all data was presented in the study in a combined manner, so that it was not possible to identify the airport which provided the answer and which did not.

The MS Excel 2019 software and the Statistica 13 package were used to perform the statistical work.

RESULTS

Responses were collected from August 2021 to the end of 2021. Of all 14 Polish passenger airports

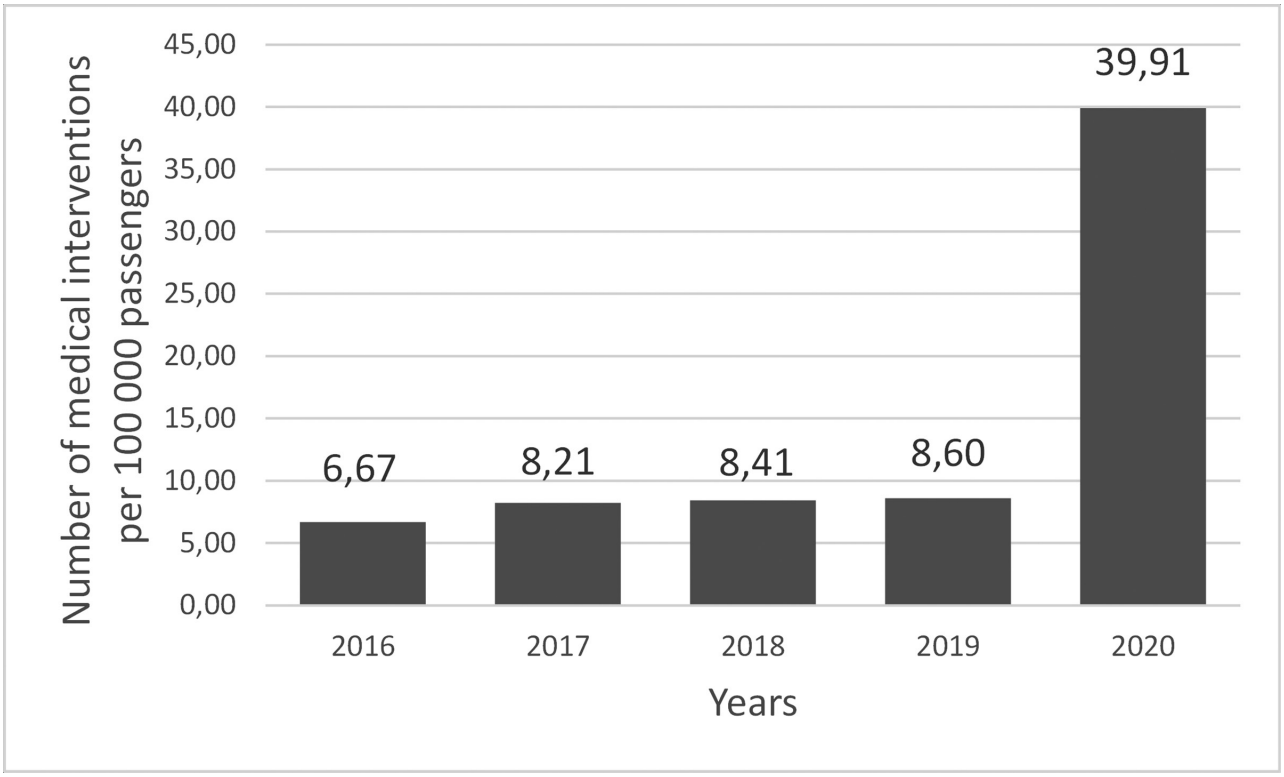

Fig. 1. Number of medical interventions per 100 000 passengers per year.

surveyed, only 7 (50%) of any responses were obtained. Only 3 airports provided complete answers to the questions asked, two provided partial data, and the remaining 2 either refused to provide data or did not have data available. Based on the data obtained from 4 Polish airports, it was possible to prepare for analysis data for the years 2016-2020, which include the total number of interventions – 2536 over 5 years with 26 583 653 passenger traffic. On this basis, an average rate of 9.54 medical interventions for every 100,000 passengers per year was calculated.

The obtained average of medical interventions in the years 2016-2020 amounting to 9.54 was not constant, its values significantly differ in terms of annually (from 6.67 in 2016 to 39.91 in 2020 – detailed data are presented in Fig. 1). In 2016-2019, the average annual number of interventions increased, but remained at a fairly similar level (max 8.60). It was only in 2020 that an avalanche increase in the number of interventions to 39.91 was observed, with a significantly lower number of passengers in air traffic in Poland (in 2020 over 70% fewer passengers were handled in Poland than in 2019) [4]. If the average for the years 2016-2019 was calculated only (excluding the pandemic year 2020), the ratio would be 8.13 interventions per 100,000 passengers per year.

Another examined element was the characteristics of organizing medical care at airports in Poland. Responses were obtained from 5 certified passenger airports in Poland (out of all 14). In the smallest airports, assistance was provided by paramedics employed in the structures of the Airport Fire and Rescue Services, in larger airports, on the basis of their own medical entity (a fully-fledged medical unit). In smaller airports there were no doctors or nurses employed at all, in larger airports, even if there were employees other than paramedics, they still worked in ambulances. To facilitate the provision of assistance at the airports examined, there are medical centers, but they do not have dedicated staff. Assistance there is provided by ambulance staff (basic – only with paramedics or nurses on board, or specialized with a doctor [5]). If there was no full medical support at a given airport, state emergency medical teams were called to transport the casualty to a emergency department [6] or to a trauma center [7].

DISCUSSION

It is difficult to try to estimate the frequency of medical events at airports because the data provided varies greatly. A Japanese study from Tokyo Narita Airport in 2002 reported the frequency of medical interventions as 1 in 4,000 passengers, which equates to 25 medical interventions per 100,000 passengers per year [8]. This is significantly more than the data from this study (9.54 per 100,000 passengers per year), which, however, may be due to the

fact that, according to the authors, more than 72% of interventions took place in airport employees. Polish airports are much smaller and have a less organized health care system (mostly based on paramedics and fire brigades) than at Tokyo Narita Airport (permanent doctors at the clinic who may offer help in less urgent conditions). Data from Bahrain International Airport from 2004 reported an even higher frequency of medical activities (0.12% of passengers required medical assistance, which equates to a ratio of 120 per 100,000 passengers per year), but here too the vast majority of cases were classified as minor cases [9]. At the same time, the data from the research conducted at International Airport Taoyuan in Taiwan [10], superimposed on the public data on the number of passengers [11], make it possible to estimate the ratio at only 1.66 per 100,000 passengers. However, it should be borne in mind that the studies from Taiwan included only cases requiring the use of an ambulance, not cases of outpatient care.

Comparison of the results with the local research shows that the ratio of 9.54 per 100,000 passengers per year does not differ significantly from other results, using a similar methodology. However, it must not be forgotten that in all the airports surveyed there were no outpatient clinics with 24-hour operation of doctors and nurses. The fact that the help was provided by personnel trained in strictly emergency activities, but without the authority to issue prescriptions or referrals for tests, must have had an impact on a smaller number of medical events than in some foreign studies.

The data obtained in this study indicate that in 2020 the number of medical interventions at the examined airports increased significantly, and at the same time the movement of patients decreased significantly. It is impossible not to link this fact to the global COVID-19 epidemic, which was most likely responsible for the increase in medical interventions.

LIMITATION OF THE STUDY

Two main limitations of the study have been identified. First of all, only over 20% of airports in Poland provided full data (3 out of 14), and another two provided only partial data. It can be assumed, however, that medical data from 4 centers are already representative for passenger air traffic in Poland. The second important limitation of the study is the fact that 2020 was the beginning of the COVID-19 pandemic, which certainly resulted in an increased number of interventions with very limited passenger air traffic.

CONCLUSIONS

1. The ratio of medical events to the number of passengers at Polish airports in 2016-2020 was 9.54 / 100,000 passengers per year.
2. The COVID-19 epidemic has increased the number of medical interventions at airports.

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CONFLICT OF INTEREST
The Author declares no conflict of interest.

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