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DOI: 10.36740/EmeMS202002101 **ORIGINAL ARTICLE**

HEMATOLOGY, C-REACTIVE PROTEIN AND PROCALCITONIN IN COVID-19 PATIENTS AND HISTORICAL PNEUMONIA GROUP

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Abstract

Introduction: Laboratory test play an essential role in the early detection and diagnosis in an Emergency Department. Laboratory tests are common w COVID-19, however, they are also encountered in diseases with similar presentation as COVID-19 but other etiopathogeneses.

The aim: To compare morphology, procalcitonin, and C-reactive protein in patients admitted with the diagnosis of COVID-19 to the Infectious Hospital to the patients with the discharge diagnosis of pneumonia admitted to the Emergency Department in January and February 2019.

Material and methods: The study group consisted of 46 COVID-19 patients (60.9% male) aged 63.3±15.3 and 48 pneumonia patients (56.3% male) aged 75.0±13.7. The COVID-19 patients were admitted to the Infectious Department of Boleslawiec County Hospital or were discharged from the Emergency Departments to the Infectious Departments. The age, gender, leucocyte count, lymphocyte count and percentage, hemoglobin, mean corpuscular volume, platelets number, procalcitonin level and c-reactive protein were retrieved from medical electronic records.

Results: The hematology tests did not reveal significant differences in lymphocyte count and percentage, however the white cells number was significantly higher in pneumonia than in COVID-19 group. C-reactive protein did not differ between groups. There was a trend to the higher level of procalcitonin in pneumonia group and hemoglobin level in COVID-19 group. Mean corpuscular volume and leucocyte number were significantly higher in the pneumonia group.

Conclusions: 1. Lower leucocyte number and lower mean corpuscular volume of erytrocyte in COVID-19 patients than in pneumonia patients may reflect differences in the reaction of the host to infectious factors or indicate predisposing factors to COVID-19 infection. 2. Further studies are indicated to confirm and explain obtained results.

Key words

COVID-19, pneumonia, laboratory tests

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is caused by a severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) belonging do the Coronaviridae family [1]. The clinical manifestation of the disease include fever, cough, shortness of breath, fatigue, diarrhoea, muscle pain, but recently more and more symptoms and signs are considered as the disease symptoms [2]. Moreover, COVID-19 may predispose to thromboembolism and as the consequence acute pulmonary embolism, ischemic stroke, myocardial infarction, systemic arterial embolism, and deep-vein thrombosis [3].

Direct myocardial and brain lesions due to viral involvement of cardiomyocytes and neurons may result in cardiac and brain injury [3, 4].

Laboratory tests play an essential role in the early detection and diagnosis in an Emergency Department. Laboratory abnormalities are common w COVID-19, however, they are also encountered in diseases with similar presentation as COVID-19 but other etiopathogeneses.

THE AIM

The aim of the study was to compare morphology, procalcitonin, and C-reactive protein in patients admitted with the diagnosis of COVID-19 to the Infectious Hospital to the patients with the discharge diagnosis of pneumonia admitted to the Emergency Department in January and February 2019.

MATERIAL AND METHODS

The study was designed as a retrospective analysis of medical documentation of patients aged at least 18 year.

The study group consisted of 46 COVID-19 patients and the control group were 48 pneumonia patients. The COVID-19 patients were admitted to the Infectious Department of Boleslawiec County Hospital or were discharged from the Emergency Departments to Infectious Departments. The pneumonia patients were admitted to Emergency Department of University Hospital in Wroclaw in January and Febrauary 2019 with the final diagnosis of community acquired pneumonia.

The age, gender, leucocyte count, lymphocyte count and percentage, hemoglobin, mean corpuscular volume, platelets number, procalcitonin level and c-reactive protein were retrieved from medical electronic records.

STATISTICAL ANALYSIS

Continuous variables were presented as means and standard deviations or medians and interquartile range depending on their distribution and compared with Student's T test or U Mann – Whitney test. Discrete variables were presented as numbers and percentages and compared with chi^2 test.

Receive operating curve (ROC) analysis was performed to find cut-off points between studied groups. P less than 0.05 was considered as significant.

RESULTS

The study COVID-19 group was significantly younger that the control pneumonia group. However, there was no differences between gender distribution in the groups. The demographic and laboratory results are presented in the table 1.

The hematology tests did not revealed significant differences in lymphocyte count and percentage, however the white cells number was significantly higher in pneumonia than in COVID-19 group. C-reactive protein did not differ between groups. There was a trend to the higher level of procalcitonin in pneumonia group and hemoglobin level in COVID-19 group. Mean corpuscular volume was significantly higher in the pneumonia group.

Table 1. The demographic and laboratory results in the COVID-19 group and the pneumonia group.

	COVID-19 group	Pneumonia group	p
Age (years)	63.3±15.3	75.0±13.7	<0.001
Male gender [n (%)]	28 (60.9)	29 (56.3)	0.65
C-reactive protein [ng/L]	79.2 (25.3-181.6)	100.8 (43.3-241.6)	0.19
Procalcitonin [ng%]	0.20 (0.08-0.30) N=27	0.28 (0,19-1.46) N=28	0.051
White blood cells [10^3/μL]	6.9 (5.3-9.7)	10.6 (8.0-14.8)	<0.001
Lymphocyte count [10^3/μL]	1.13 (0.66-1.46) N=31	1.04 (0.84-1.28) N=22	0.62
Lymphocyte percentage [n (%)]	15.9 (10.1-18.8) N=31	11.2 (7.3-18.3) N=22	0.28
Platelets per mm^3 [10^3/μL]	202.2±91.5	205.0±109.4	0.89
Hemoglobin [g/dL]	13.3±2.0	12.6±1.7	0.066
Mean corpuscular volume [fL]	88.6±5.6	92.8±6.1	<0.001

In the Figure 1 the ROC cure analysis for the lymphocyte number in COVID-19 and pneumonia group was presented. Cut-off point to differentiate the groups was 8.02 [10^3/μL]. Area under curve was 0.73; 95% confidence interval 0.62-0.83 p<0.001.

In the Figure 2 the ROC cure analysis for the mean corpuscular volume in COVID-19 and pneumonia group was presented. Cut-off point to differentiate the groups was 93.3 fL. Area under curve was 0.71; 95% confidence interval 0.60-0.82 p<0.001.

DISCUSSION

The first finding of the study is that the mean age of the COVID-19 patients is lower than pneumonia patients. This finding is concordant with the observation that COVID-19 affects patients at any age whereas pneumonia prevails in older and in very young age [5, 6].

The second finding is that men constitute a slightly larger proportion of patients in the both studied groups. In the systematic review of observational studies older age was clearly related with the risk of pneumonia, however the definite conclusions regarding male gender could not be drawn [5]. Contrary to community acquired pneumonia in the male gender the COVID-19 patients is less prevalent in the whole COVID-19 patients and more prevalent in those with more severe form of the disease [6, 7].

The third finding is that leucocyte number in COVID-19 patients is significantly lower than in

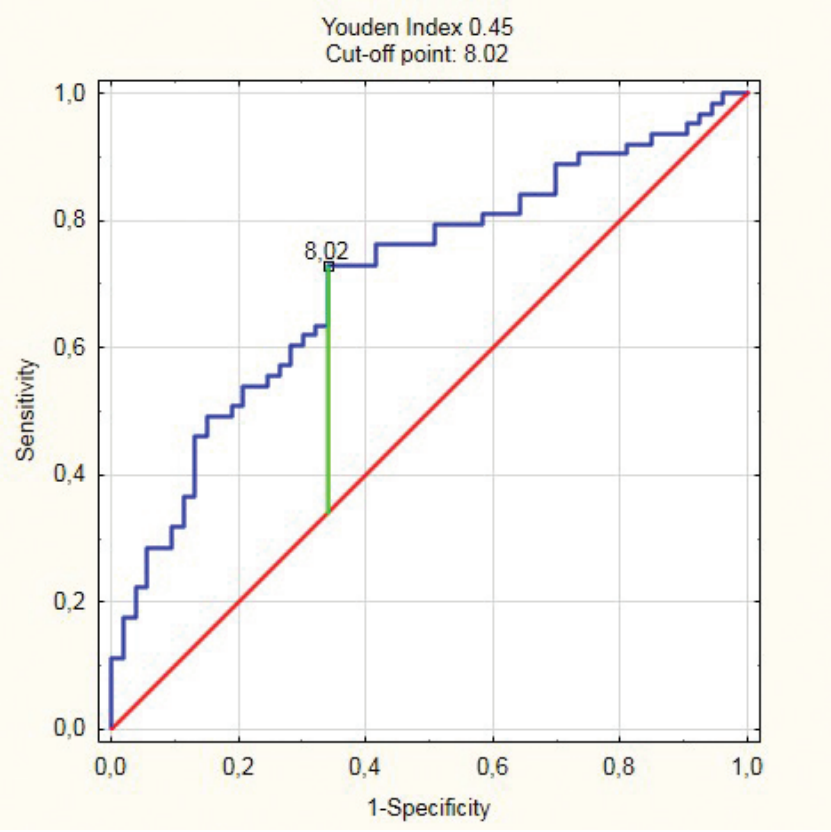

Fig. 1. ROC curve analysis to find the cut-off point for the leucocyte number to differentiate COVID-19 and pneumonia patients,

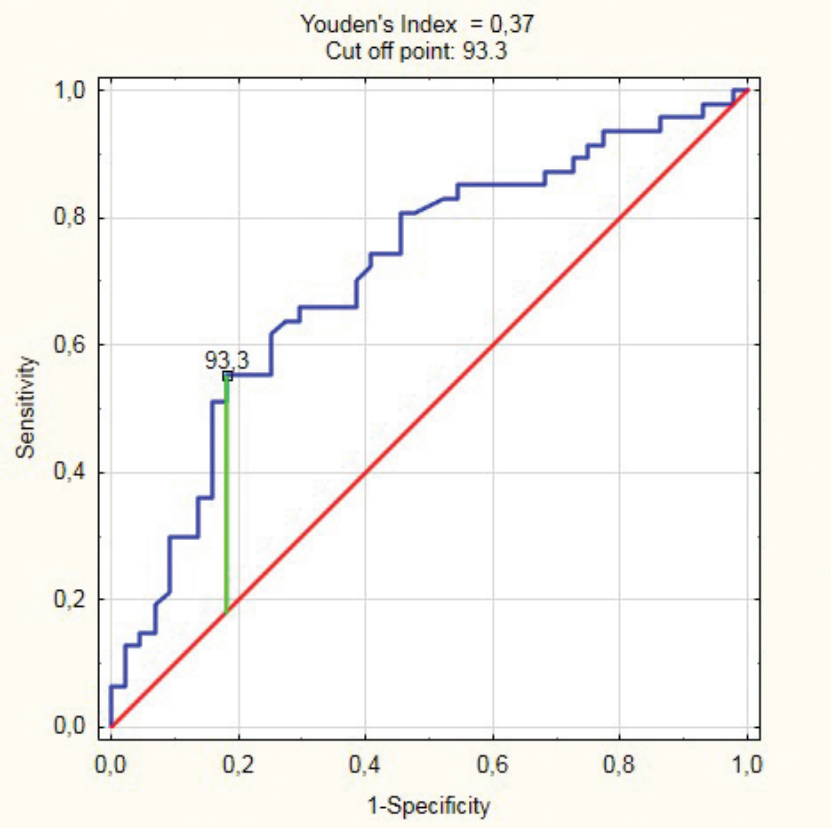

Fig. 2. ROC curve analysis to find the cut-off point for the mean corpuscular volume to differentiate COVID-19 and pneumonia patients.

pneumonia patients. The main cause of community acquired pneumonia in adults is Streptococcus pneumonia. Leucocytosis and increased procalcitonin concentrations are consequences mainly of bacterial infection contrary to viral infections [8, 9]. Procalcitonin may increase in COVID-19 patients due to bacterial superinfection.

The fourth finding is that lymphocyte number and percentage did not differ between studied groups. This finding is very important because due to reports regarding lymphocyte reduced number in COVID-19 [7], a patient with low lymphocyte count and percentage is believed to have COVID-19 what could be dangerous in term of delaying the start of antibiotic treatment. The possible reason for lymphopenia could be direct infection of the lymphocytes. Apostosis of the lymphocytes may also be caused by inflammatory cytokines. Moreover, increased lactic acid levels could supress proliferation of the lymphocytes [10].

The fifth finding is that erythrocyte mean corpuscular volume is lower in COVID-19 than in pneumonia patients. This observation warrants further investigations. The lower erythrocyte volume may be due to dehydration of the patients, however, it could not be excluded that subclinical iron deficiency is a factor related to the higher risk of COVID-19. Moreover, higher erythrocyte volume in the pneumonia patients may be related with higher prevalence of alcohol abuse, hypothyroidism, and malnutrition in pneumonia group.

Limitation

The main limitation of the study is its retrospective character and lack of data. Concomitant diseases and chronic treatment were not assessed, but could have impact on the obtained results. However, the COVID-19 is a dangerous disease and the observation regarding the infection should be reported as soon as possible.

CONCLUSIONS

1. Lower leucocyte number and lower mean corpuscular volume of erythrocyte in COVID-19 patients than in pneumonia patients may reflect differences in the reaction of the host to infectious features or indicate predisposing factors to COVID-19 infection.

2. Further studies are indicated to confirm and explain obtained results.

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THE APPLICATION OF HEMOPERFUSION WITH PERITONITIS IN CHILDREN: CORRECTION OF GAS COMPOSITION AND ACID-BASE BALANCE OF THE BLOOD

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Abstract

Introduction: The gas composition and acid-base balance of blood play a main role in assessing the patient in critical condition. Estimating the dynamics of acid-base balance, one can judge the severity of pathology and the adequacy of therapeutic measures.
The aim: to determine the effect of hemoperfusion on the gas composition and acid-base balance of blood in children with severe forms of peritonitis.
Material and methods: The study was performed on the basis of a prospective analysis of acid-base balance of blood and blood gas composition of 30 patients in the early postoperative period with severe forms of peritonitis, who were treated in the Department of anesthesiology and intensive care of the Grodno regional children's clinical hospital. This study was conducted in accordance with the standards of bioethics, was approved by the ethical Committee of the institution and complies with the principles of the Helsinki Declaration.
Results and conclusions: This article describes the methodology of hemoperfusion in children, analyzed the dynamics of changes in the basic parameters of acid-base balance and blood gas composition in the early postoperative period with severe forms of peritonitis during hemoperfusion. The positive dynamics of laboratory data obtained as a result of the study proves the high effectiveness of the use of antiproteinase biospecific hemosorbent. The use of biospecific hemoperfusion as an additional method in the complex therapy of peritonitis gives a real opportunity to improve the results of treatment of this category of patients.

Key words

acid-base balance,
blood gas composition,
extracorporeal detoxification,
hemoperfusion,
peritonitis,
children

INTRODUCTION

Secondary peritonitis (SP) is a severe form of abdominal infection that develops as a result of purulent diseases and damage to the hollow and parenchymal organs of the abdominal cavity. Despite the using of modern surgical technologies, the use of expensive antibacterial agents, the problem of treatment of generalized form of peritonitis remains relevant. This is due to: the high frequency of occurrence of this pathology, the prevalence among all age groups of the population, the severe clinical course, accompanied by the development of multiple organ failure, and usually leading to systemic disruption of many metabolic processes occurring in cells and tissues [1, 9]. The gas composition and acid-base balance (ABB) of the blood plays a key role in assessing a critical patient. Assessing the dynamics of the ABB indicators, one can judge the severity of the pathology and the adequacy of therapeutic measures [8].

In children, the most common causes of SP are: acute appendicitis, diverticulitis and intestinal perforation. The etiology of SP is traditionally associated with intestinal microorganisms, in particular, with the Enterobacteriaceae and Pseudomonadaceae families (including Ps. Aeruginosae). These strains can cause severe and often fatal infections due to the formed resistance to a wide range of antibiotics, including carbapenems and third generation cephalosporins, especially in the Enterobacteriaceae family [2, 6]. In this regard, it is necessary to look for additional available intensive care methods.

Hemoperfusion (HP) is an efferent therapy method based on the elimination of toxic substances from a patient's blood by perfusion through a hemosorbent

in an extracorporeal circuit. In the last decade, many clinicians have returned to previously created ones and began to apply new, selective sorbents [3, 7]. Belarusian researchers have proven the effectiveness of the domestic selective hemosorbent "Ovosorb" in the treatment of severe pancreatitis, peritonitis and burn disease in adult patients due to the adsorption of proteases, pro-inflammatory cytokines from the blood, the release of which increases hundreds of times in the blood during these pathological processes [4, 10]. However, to date in pediatric detoxification there are no sufficiently convincing results obtained on the basis of randomized controlled trials, and this limits the introduction of many methods into practice. Epidemiological trials and prospective studies, to study the practical aspects of extracorporeal treatment methods, are long-awaited and necessary.

THE AIM

To determine the effect of hemoperfusion on the gas composition and acid-base balance of blood in children with severe forms of peritonitis.

MATERIAL AND METHODS

The study was carried out on the basis of a prospective analysis of the ABB data and blood gas composition of 30 patients in the early postoperative period with severe forms of peritonitis who were treated at the Department of Anesthesiology and Resuscitation (DAR) of the Grodno Regional Children's Clinical Hospital. This study was conducted in accordance with bioethical standards, was approved by the ethics committee of the institution and complies with the principles of the Helsinki Declaration. By gender, the children were divided: boys 19 (63.3%), girls 11 (36.7%). The average age of the patients was 7.5 (5:12) years. All patients underwent traditional treatment: antibacterial drugs, infusion therapy, anesthesia, respiratory and inotropic support (if necessary) with additional use of HP. The study did not include patients with the following exclusion criteria: intercurrent diseases, significant congenital anatomical or functional abnormalities.

FEATURES OF HEMOPERFUSION IN CHILDREN

HP was carried out through the sorbent "GEMOPROTEAZSORB" and refers to biospecific antiproteinase hemosorbents. Before perfusion, the mass transfer module for hemoperfusion with a polyacrylamide hydrogel was washed for 40 minutes with a sterile 0.9% sodium chloride solution in a volume of 1000 ml with the addition of a 50 U/kg heparin solution to prevent possible sorbent thrombosis. The recommended flow direction is from top to bottom. The solution from the column was drained by replacing it with blood. In children with a body weight of less than 15 kg, a single-group Rh-compatible donor blood was used to fill the column and highways in order to avoid possible hemodynamic disturbances. The extracorporeal circuit was connected in compliance with asepsis and antiseptic rules. Before starting biospecific HP, the subclavian vein was catheterized. In order to prevent thrombosis before the start of the procedure, 50 IU / kg of heparin was administered intravenously into the central and peripheral veins.

Blood was drawn from the central vein into the blood line for single-use hemoperfusion using a roller pump. Blood was returned to a pre-catheterized peripheral vein with a blood perfusion rate of 20–70 ml / min. The total perfusion volume was 1.0 volume of circulating blood (VCB), for 60 minutes.

JUSTIFICATION OF THE PARAMETERS

The speed (ml / min) of blood perfusion along the line depends on the body weight and the volume of circulating blood of the patient. The calculation of bcc is as follows: in children aged 3 months to 1 year, bcc is 75 – 80 ml/kg, in older children (3 years – 10 years) – 70 – 75 ml/kg, in children over 10 years old – 60 – 70 ml/kg [5]. We give an example of calculation for a 1 year old child with a body weight of 10 kg: the BCC in a 1 year old child is 75 ml/kg x 10 kg = 750 ml, with a perfusion duration of 60 minutes, the blood speed along the line will be 12.5 ml/min, for sorption of 1.0 volume of circulating blood.

RESULTS AND DISCUSSION

In order to interpret the gas composition and blood ABB in the early postoperative period in children with severe forms of peritonitis, the analysis of the main laboratory parameters was carried out: pH (negative logarithm of the activity of the hydrogen ion); pO_2 (oxygen stress in the gas phase in equilibrium with blood, mmHg) pCO_2 (voltage of carbon dioxide in the gas phase, in equilibrium with blood, mm. Hg. Art.); ABE, c and SBE, c (standard deficit (or excess) of bases, mmol/l); $cHCO_3$ (standard bicarbonate), sO_2 (blood oxygen saturation, [%]), p50c (oxygen tension at 50% blood desaturation, reflects the affinity of hemogabin for oxygen, mmHg), ctO_2 (extractable oxygen concentration, mmol/l), cLactate (concentration of lactate, mmol/l) allowing to assess violations of the gas composition and blood ABB. These parameters were measured using an ABL-800 FLEX "RADIOMETER" blood gas analyzer immediately before hemoperfusion, 10 minutes from the start, 30 minutes after the session and 60 minutes after the completion

Table 1. The dynamics of changes in the parameters of the acid-base balance of the blood with respiratory acidosis (n = 7), Me (L;U) Me (25%;75%).

Indicator	Before HS	After 10 min of HP	After 30 min of HP	After HP	60 minutes after completion of HP
pH	7,33 (7.33:7.34)	7.36 (7.34:7.38)	7.35 (7.34:7.40)	7.38 (7.35:7.39)	7.39 (7.34:7.39)
pCO_2 [mmHg]	46.4 (46.0:47.3)	42.05 (41.6:43.2)	43.4 (42.5:44.1)	42.1 (41.1:45.4)	41.6 (40.4:42.7)
ABE, c [mmol/l]	0.7(-1.8:1.0)	-0.1 (-2,6:2.4)	-0.8 (-2.6:1.6)	0,0 (-2.6:1.9)	0.6 (-2.1:1.7)
SBE, c [mmol/l]	-0.2 (-1.4:1.5)	-0.2 (-2.2:2.5)	-0.5 (-2.2:1.7)	-0.5 (-2.3:2.0)	0.5 (-1.6:1.9)

Table 2. The dynamics of changes in the parameters of acid-base balance of blood during metabolic acidosis (n = 6), Me (L;U) Me (25%;75%).

Indicator	Before HP	After 10 min of HP	After 30 min of HP	After HP	60 minutes after completion of HP
pH	7.35 (7.34:7.36)	7.38 (7.38:7.4)	7.38 (7.38:7.41)	7.38 (7.36:7.39)	7,4 (7.37:7.4)
pCO_2 [mmHg]	36.1 (35.7:36.6)	38.4 (33.4:40.4)	38.4 (34.1:39.2)	39.3 (36.8:39.6)	38.2 (37.6:39.6)
ABE,c [mmol/l]	-2.5 (-4.4:-0.4)	-3.1 (-4.9:-1.0)	-2.8 (-4,6:-1,0)	-2.3 (-3.4:-0.4)	-2.6 (-2.8:-0,9)
SBE, c [mmol/l]	-4.1 (-4.5:-1.2)	-3,0 (-5.2:1.3)	-3,0 (-4.6:-1.0)	-2.3 (-3.4:-1.0)	-2.7 (-3.6:-1.1)
HCO_3 [mmol/l]	21.3 (20.7:23.7)	21.8 (20.4:23.5)	22,0 (20.4:23,5)	22.5 (21.6:23.5)	22.2 (21.2:23.6)

Table 3. The dynamics of changes in blood CSR parameters for respiratory alkalosis (n = 3), Me (L;U) Me (25%;75%).

Indicator	Before HP	After 10 min of HP	After 30 min of HP	After HP	60 minutes after completion of HP
pH	7.47 (7.40;7.48)	7.37 (7.34;7.39)	7.42 (7.34;7.48)	7.43 (7.43;7.43)	7.43 (7.43;7.43)
pCO_2 [mmHg]	32.3 (31.0;34.8)	39.2 (30.4;43.6)	38,6 (32.0;41.7)	42.3 (37.7;43.2)	42.3 (37.7;43.2)
ABE,c [mmol/l]	1.7 (-2.6;1.8)	-0,4 (-2.5;1.8)	-0,4 (-3.6;2.0)	0.6 (-2.8;2.5)	0.6 (-2.8;2.5)
SBE, c [mmol/l]	1.0 (-2.8;1.6)	-0.5 (-2.2;1.1)	0.4 (-3.4;1.5)	0,4 (-3.4;2.1)	0,4 (-3.4;2.1)
HCO_3 [mmol/l]	21.3 (20.7:23.7)	21.8 (20.4:23.5)	22,0 (20.4:23,5)	22.5 (21.6:23.5)	22.2 (21.2:23.6)

Table 4. The dynamics of changes in blood ABB parameters during metabolic alkalosis (n = 6), Me (L;U) Me (25%;75%).

Indicator	Before HP	After 10 min of HP	After 30 min of HP	After HP	60 minutes after completion of HP
pH	7.45 (7.43;7.46)	7.44 (7.40;7.46)	7.43 (7.42;7.46)	7.41 (7.41;7.43)	7.41 (7.41;7.43)
pCO_2 [mmHg]	40.5 (37.7;43.4)	40.6 (39.9;40.9)	42.1 (37.7;43.0)	39.1 (38.4;39.9)	39.1 (37.7;43.2)
ABE,c [mmol/l]	3.9 (2.6;4.1)	3.4 (2.5;3.9)	2.9 (2.7;3.8)	3.0 (1.9;3.8)	3.3 (2.2;4.2)
SBE, c [mmol/l]	4.0 (2.5;4.0)	3.5 (2.5;3.9)	2.9 (2.5;3.6)	2.8 (2.2;3.6)	3.2 (2.2;4.0)
HCO_3 [mmol/l]	27.5 (26.0;28.0)	27.3 (26.7;27.8)	26.8 (26.8;27.7)	27.6 (26.1;27.7)	26.6 (25.2;27.7)

Table 5. The dynamics of changes in blood gas composition in children (n = 22), Me (L; U) Me (25%; 75%).

Indicator	Before HP	After 10 min of HP	After 30 min of HP	After HP	60 minutes after completion of HP
pO_2 [mmHg]	63.6 (54.7;75.7)	76.1 (66.5;81.7)	75.4 (68.7;94.4)	77.85 (69;120)	80.9 (73;92.9)
ctO_2 [mmol/l]	6.9 (6.4;7.9)	7.4 (6.7;8.4)	7.8 (6.5;8.7)	8.8 (1.5;9.7)	7.2 (6.5;8.6)
p50,e [mmHg]	23.87 (22.4;25.6)	24.5 (23.5;26.1)	23.9 (22.5;25.7)	24.8 (22.3;26.8)	25.1 (23.1;26.2)
cLactate [mmol/l]	1.7 (1.5;2.1)	1.4 (1.1;1.7)	1.2 (1.0;1.4)	1.3 (0.9;1.5)	1.1 (0.9;1.3)
sO_2 [%]	95,1 (93.2;97.1)	96.1 (93.3;97.7)	95.8 (93.5;97.2)	95.0 (933;97.5)	97.4 (95.5;98.7)

of hemoperfusion. Before taking capillary blood, patients were in a stable condition, without clinical signs of shock (warm limbs), and respiration parameters remained unchanged throughout the study. Sampling and measurement of the sample, after a finger puncture before the time of examination, did not exceed 3 minutes. Statistical analysis of the data was carried out using the statistical processing program STATISTICA 10.0 ("StatSoft", USA). Continuous variables are expressed as the median and standard deviation: Me (L; U) Me (25%; 75%). The results were considered reliable by the Wilcoxon test $p < 0.05$.

When analyzing the data, before hemoperfusion, ABB disturbance was observed in 22 children (73.3%) of them: acidosis was detected in 13 children (43.3%), while in 7 children (53.8%) respiratory disorders were noted, and in 6 children (46.2%) – metabolic. Alkalosis was recorded in 9 patients (30%), with respiratory disorders in 3 children (23.1%), and with metabolic in 6 children (46.2%). And only in 8 children (26.7%) did the early postoperative period proceed without violation of the ABB.

RESPIRATORY ACCIDOSIS CORRECTION

Respiratory acidosis occurs with a decrease in pH <7.35 and an increase in pCO_2> 45.0 mmHg, in this case, this condition is more likely associated with intra-abdominal hypertension and the development of alveolar hypoventilation. As can be seen from the data in table 1, at the initial pH level of 7.33 (7.33: 7.34) and pCO_2 – 46.4 (46.0: 47.3) mmHg just 10 minutes after the start of the HP, normalization of these indicators (pH 7.36 (7.34: 7.38) and pCO_2 – 42.05 (41.6: 43.2) mmHg) was noted, but after 30 minutes their reverse change in the direction of respiratory acidosis is observed, pH 7.35 (7.34: 7.40) and pCO_2 – 43.4 (42.5: 44.1) mmHg. In a further study, immediately after hemoperfusion, these parameters returned to normal and remained unchanged for 60 minutes after completion.

METABOLIC ACIDOSIS CORRECTION

Metabolic acidosis is characterized by low pH <7.35, reduced bicarbonate concentration <22 mmol/l with normal or low pCO_2. This condition occurs as a result of various circulatory disorders. Table 2 demonstrates the change in the ABB parameters during metabolic disorders, where the pH level normalizes from 7.35 (7.34: 7.36) to 7.38 (7.38: 7.4) and from 10 minutes remains unchanged up to last stage of the study. The levels of ABE, c and SBE, c changed in a similar way. The $cHCO_3$ study showed a slight increase in this indicator from 21.3 (20.7: 23.7) to 22.2 (21.2: 23.6) mmol/l.

RESPIRATORY ALKALOSIS CORRECTION

Respiratory alkalosis is characterized by high pH> 7.45 and low pCO_2 <35.0 mmHg. The leading mechanism for the development of respiratory alkalosis is an increase in pulmonary ventilation. Due to this, the concentration of pCO_2 and carbon dioxide in the blood decreases, which causes a shift in the pH of the blood to the alkaline side. The main possible reason for this condition was the development of pain, an increase in body temperature with the development of tachypnea against the background of a septic state. Changes in blood ABB parameters for respiratory alkalosis in children in the early postoperative period with severe forms of peritonitis on the background of hemoperfusion are presented in table 3. After statistical processing of the results and further interpretation of the data, it was revealed that positive dynamics of the pH value was also observed for 10 minutes – with 7.47 (7.40; 7.48) to 7.37 (7.34: 7.39), at 30 minutes – 7.42 (7.34: 7.48), and subsequently immediately after completion and after 60 minutes, the pH level of 7.43 (7.43: 7.43) was stably in the normal range. The pCO_2 value, respectively: from 32.3 (31.0; 34.8) to 40.5 (37.5: 41.8) mmHg. at 10 minutes, at 30 minutes – 40.4 (37.9: 42.7) mmHg, immediately after completion of the HP – 39.6 (37.7: 43.0) mmHg, and after 60 minutes upon completion – 38.6 (36.7: 41) mmHg.

CORRECTION OF METABOLIC ALKALOSIS

Metabolic alkalosis is characterized by a high pH> 7.45 and a high concentration of bicarbonate > 26.0 mmol/l. The main reason for this category of patients was most likely the loss of acidic components through the gastrointestinal tract (vomiting, which is separated by the probe from the stomach). Table 4 shows the change in the parameters of the ABB during metabolic disturbances, where we see the positive dynamics of the indicators only 30 minutes after the start of sorption: pH – from 7.45 (7.43; 7.46) to 7.43 (7.42: 7,46), and in the future there were no significant changes. The value of HCO_3 was slightly normalized only 60 minutes after completion of hemoperfusion from 27.5 (26.0; 28.0) to 26.6 (25.2; 27.7) mmol/l.

BLOOD GAS CORRECTION

An analysis of the results of the study of the gas composition of the blood showed that the pO_2 value before hemoperfusion in all patients was at the lower limit of the norm, which indicates inadequate intake of O_2 from the lungs. Upon further investigation, already at 10 minutes, the pO_2 level increased by 10%, at 30 minutes and immediately after completion of the HP

– by 15%, and 60 minutes after completion remained within normal limits with an increase of 20% from the original. At the same time, this was accompanied by a significant increase in sO_2 from 95.1 (93.2; 97.1)% to 97.35 (95.5; 98.7)%. An increase in p50 (mmHg) from 23.87 (22.43; 25.64) to 25.1 (23.1; 26.29) with the normalization of ctO_2 (mmol/l) from 6.9 (6.4; 7.9) to 8.8 (1.5; 9.7) and a decrease in cLactate (mmol/l) from 1.7 (1.5; 2.1) to 1.1 (0, 9; 1.3), indicates an increase in the affinity of hemoglobin for oxygen, a shift of the dissociation curve of oxyhemoglobin to the left, and a significant delivery of oxygen to tissues, which leads to a decrease in oxidative stress, and an improvement in microcirculation. Changes in the parameters of the blood gas composition in children in the early postoperative period with severe forms of peritonitis during hemoperfusion are presented in table 5.

CONCLUSION

Thus, the above results allow us to conclude that the use of hemoperfusion on the sorbent "HEMOPROTEAZSORB" in patients in the early postoperative period with severe forms of peritonitis normalizes the parameters of blood oxygenation. The inclusion in the complex of intensive care of hemoperfusion in the early postoperative period in children with severe forms of peritonitis also stabilizes the acid-base balance of the blood. Most likely, this is due to a decrease in the severity of endogenous intoxication and, as a result, a decrease in the intensity of microcirculatory disorders with the subsequent resolution of the pathological process. The use of biospecific hemoperfusion as an additional method in the complex treatment of peritonitis provides a real opportunity to improve the treatment results of this category of patients.

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CONFLICT OF INTEREST

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DOI: 10.36740/EmeMS202002103 **ORIGINAL ARTICLE**

ASSESSMENT OF PHYSICAL ACTIVITY OF MEMBERS OF THE HELICOPTER EMERGENCY MEDICAL SERVICE (HEMS)

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Abstract

The aim: Assessment of physical activity of members of the Helicopter Emergency Medical Service.
Material and methods: The study was conducted in a group of 131 people (65 paramedics, 66 pilots), members of HEMS teams from all bases in Poland, aged 27-59. The characteristics of physical activity was obtained using the author's questionnaire.
Results: The mean age of the study population was 42.73 ± 9.58 years. Pilots were significantly older than paramedics and had significantly higher BMI values ($p < 0.05$). No significant relationship between the age and BMI in the analyzed groups was found ($p > 0.05$), while the relationship between the frequency of physical activity and BMI was demonstrated. 70% of subjects undertook physical activity less than three times a week. The most frequently chosen forms were cycling, walking and swimming. Paramedics statistically significant more often than pilots chose wall climbing ($p = 0.001$). Downhill skiing (61%) was the most common declared winter sport played by pilots, while hiking in the mountains – by paramedics (49%). The most important reason for pilots to take up physical activity was concern for their health (47%), while for paramedics – the pleasure (63%). Paramedics statistically significant more often than pilots indicated a large number of other activities (90.6 *vs.* 74.2%) and financial issues (18.8 *vs.* 6.1%) as barriers that prevented more involvement in physical activities.
Conclusions: The frequency of physical activity undertaken by HEMS members is insufficient. Low physical activity of HEMS team members has an adverse effect on their nutritional status. It is necessary to take initiatives to promote physical activity in this professional group.

Key words

HEMS, physical activity, motivation, barriers

INTRODUCTION

Physical activity is one of the main components of a healthy lifestyle. Insufficient physical activity is an important, though still underestimated, factor affecting health, morbidity, and mortality. It should be emphasized that physical effort is a protective factor independent of genetic conditions and other recognized risk factors – biological and socioeconomic [1]. Systematic physical exertion is crucial in the prevention of many chronic diseases [2]. Although we know more and more about physical activity and its beneficial effects, still over 30% of European adults, including Poland, characterize its low level [3]. It is connected with technical progress, where the increase of work automation, development of means of transport and everyday life facilities allow people to meet the needs with limited physical effort [4].

According to the Report of the Minister of Sport and Tourism from, only 39% of Poles are physically active in their free time to the extent recommended by the World Health Organization [5]. The report also shows that physical activity of Poles is strongly associated with age and education. Young people are more active than older ones. Higher education also favors greater physical activity [5]. European studies have shown that the physical activity of Polish citizens is similar to that of other European countries [6]. A very important issue is undertaking research on the assessment of physical activity of various social and professional groups in our country.

This article presents the results of research on physical activity conducted among the personnel of the Helicopter Rescue Service (HEMS). The work of a HEMS crew in changing atmospheric conditions requires both physical and mental fitness. This is a professional group that is exposed to frequent stressful situations. The HEMS crew includes a pilot, a rescuer (paramedic or nurse) and a doctor. Their tasks include flying flights for accidents and sudden illnesses and helping their victims, transporting

patients requiring medical care between health care facilities, as well as air medical transport outside the country. The crew during duty must be ready to fly at any time, so proper physical condition is extremely important to carry out the rescue operation efficiently.

The study aimed to assess the physical activity of HEMS crew members. An attempt was also made to indicate the factors motivating the subjects to active rest and barriers hindering their participation in physical activity. To our knowledge, this is one of the first studies on physical activity in this professional group.

MATERIALS AND METHODS

The study was conducted in a group of 131 people (65 paramedics, 66 pilots), members of HEMS crews from all bases in Poland, aged 27 – 59. Most subjects were men, and women stand for 3.8% (only among paramedics). To assess the frequency of overweight and obesity in HEMS crew members, the BMI index was calculated and interpreted on the basis of the WHO classification [7]. The characteristics of physical activity was made using a diagnostic survey with a proprietary questionnaire. The questions concerned, inter alia, the frequency of undertaking physical activity, the choice of forms of physical activity, motivation for undertaking physical activity, as well as barriers preventing regular activities.

For statistical analysis of results, the PS IMAGO PRO program (IBM SPSS Statistics 25) was used. Chi^2 and Mann-Whitney U tests were used for comparative analyzes between groups (type of occupation), and relationships between variables were checked using Spearman rank correlation. The statistical significance value was adopted at the level $p < 0.05$.

RESULTS

The mean age of the subjects was 42.73 ± 9.58 years. Pilots were statistically significantly older than paramedics (49.12 ± 7.52 vs. 36.23 ± 6.64 years; $p < 0.0001$). In addition, no statistically significant differences between paramedics and pilots in terms of body weight (83.10 ± 11.81 *vs.* 89.20 ± 16.75 kg, $p = 0.0478$) and BMI values (25.84 ± 3.17 *vs.* 28.27 ± 4.95 kg/m^2, $p = 0.0023$) were found. Analyzing the obtained mean values of the tested parameters, one could observe that pilots characterized a definitely less favorable nutritional status compared to the group of paramedics. Detailed data are presented in Table 1 and Figure 1. There was no statistically significant relationship between the age of the subjects and BMI values in the study groups ($p > 0.05$).

When asked about the frequency of undertaking any form of physical activity, only 30.8% of subjects indicated the answer "3 times a week", the others performed physical activity less often (Fig. 2). Data analysis showed a relationship between the frequency of physical activity and BMI only among paramedics. In those who performed physical activity three times a week, according to BMI statistically significant more people with normal body weight were found in comparison with paramedics who exercised less often ($p = 0.043$) (Fig. 3).

The most frequently chosen forms of physical activity by pilots and HEMS paramedics were cycling, walking and swimming. Paramedics statistically more often than pilots chose wall climbing (16.9 *vs.* 1.5%, $p = 0.0010$) (Fig. 4). Downhill skiing (60.6%) was the most frequently declared winter sport practiced by pilots, while by paramedics – hiking in mountains (49.2%) (Fig. 4). Paramedics statistically more often than pilots chose cross-country skiing (9.2% *vs.* 0%, $p = 0.012$).

Analyzing the results of study on the reasons for undertaking physical activity among subjects, it was noted that paramedics statistically significant more often than pilots indicated answers: it gives me pleasure (63.1% *vs.* 40.9%, $p = 0.0110$), an opportunity to check myself (26.2% *vs.* 7.6%, $p = 0.0040$), spending time with friends (21.5% *vs.* 9.1%, $p = 0.0480$) and learning about a new hobby (7.7% *vs.* 0.0 %, $p = 0.0216$) as motives for undertaking physical activity (Fig. 6). For pilots, the main motive for undertaking physical activity was maintaining or improving health (47%).

Table 1. General anthropometric characteristics of HEMS members.

Variables	All respondents			Paramedics			Pilots			
	N	X	SD	N	X	SD	N	X	SD	p
Age [years]	131	42.73	9.58	65	36.23	6.64	66	49.12	7.52	<0.0001
Height [cm]	131	178.36	5.86	65	179.23	6.09	66	177.50	5.53	0.0712
Body weight [kg]	131	86.17	14.78	65	83.10	11.81	66	89.20	16.75	0.0478
BMI [kg/m^2]	131	27.07	4.32	65	25.84	3.17	66	28.27	4.95	0.0023

N – number of respondents, X – mean, SD – standard deviation, p – U Mann-Whitney test result, BMI (Body Mass Index)

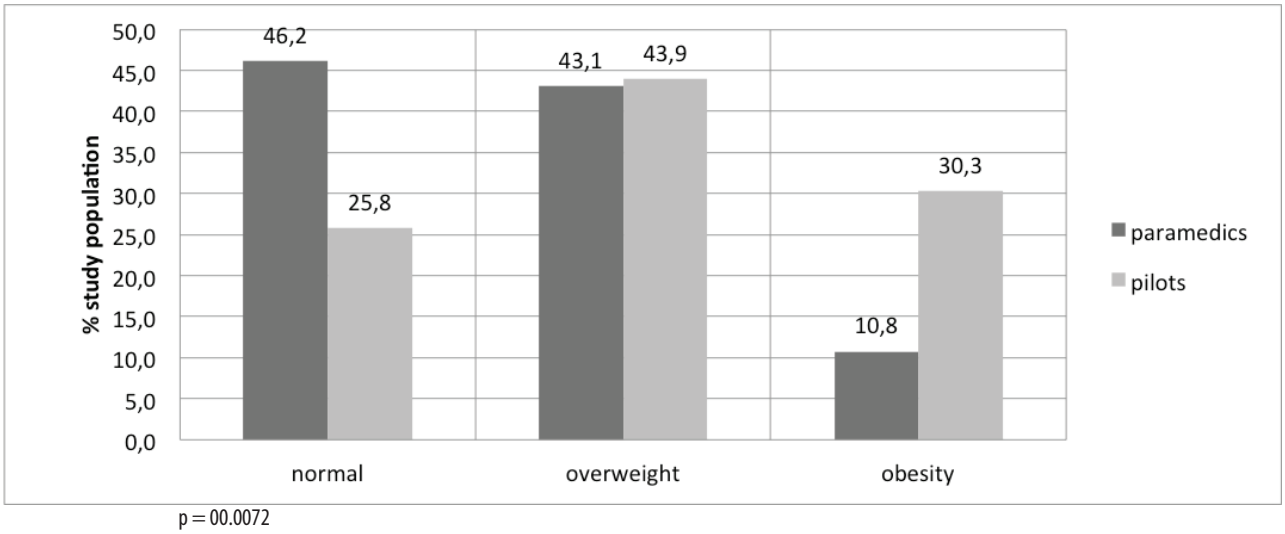

Fig. 1. Nutrition status of the respondents according to the BMI index and the occupation.

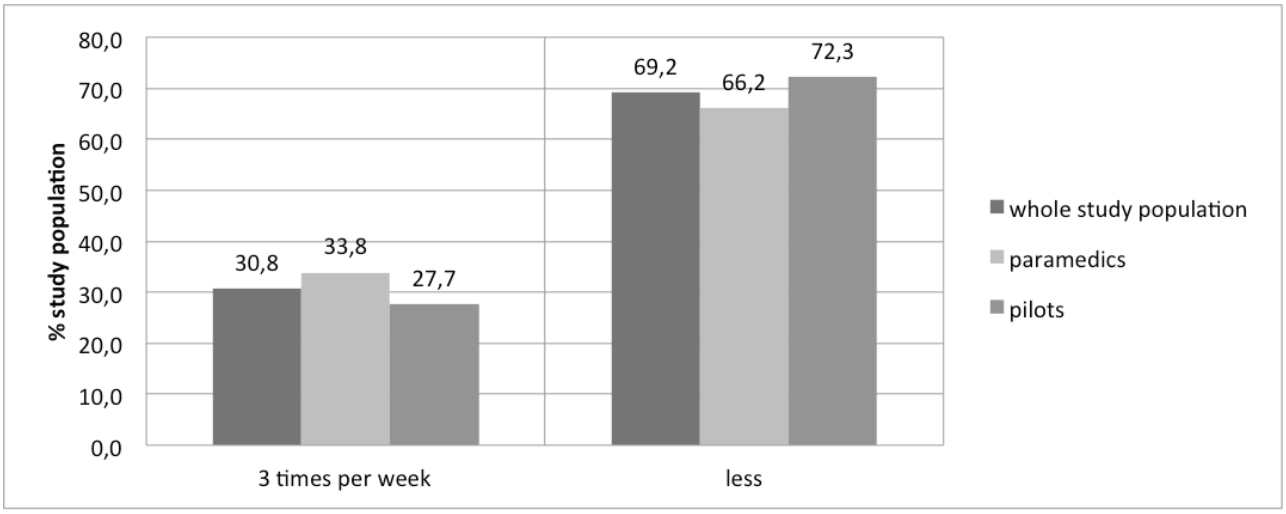

Fig. 2. The frequency of undertaking any form of physical activity by the HEMS crew.

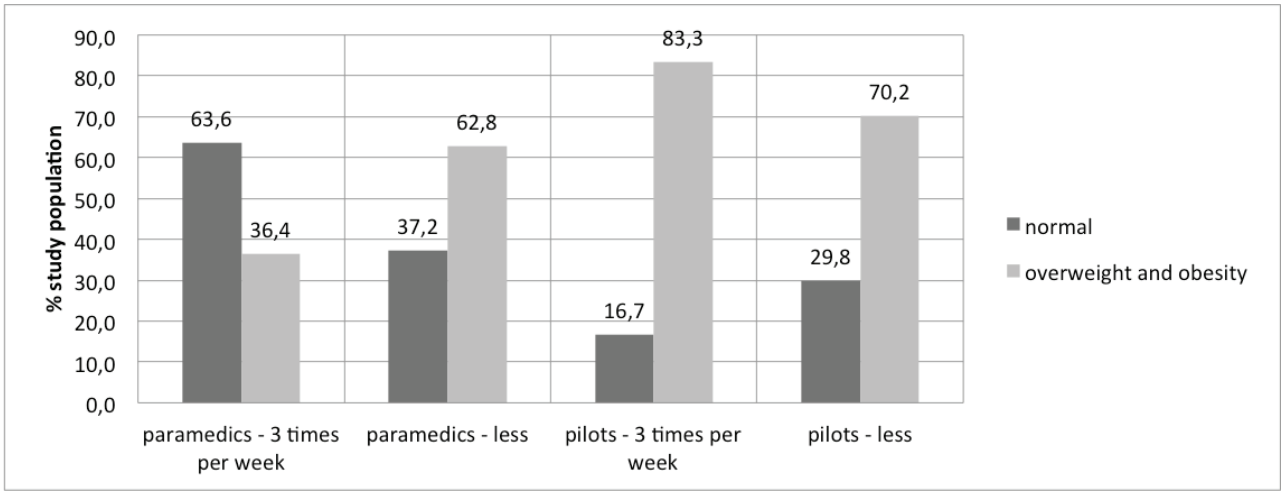

Fig. 3. Relationship between the frequency of physical activity and BMI in the studied groups of HEMS crew members.

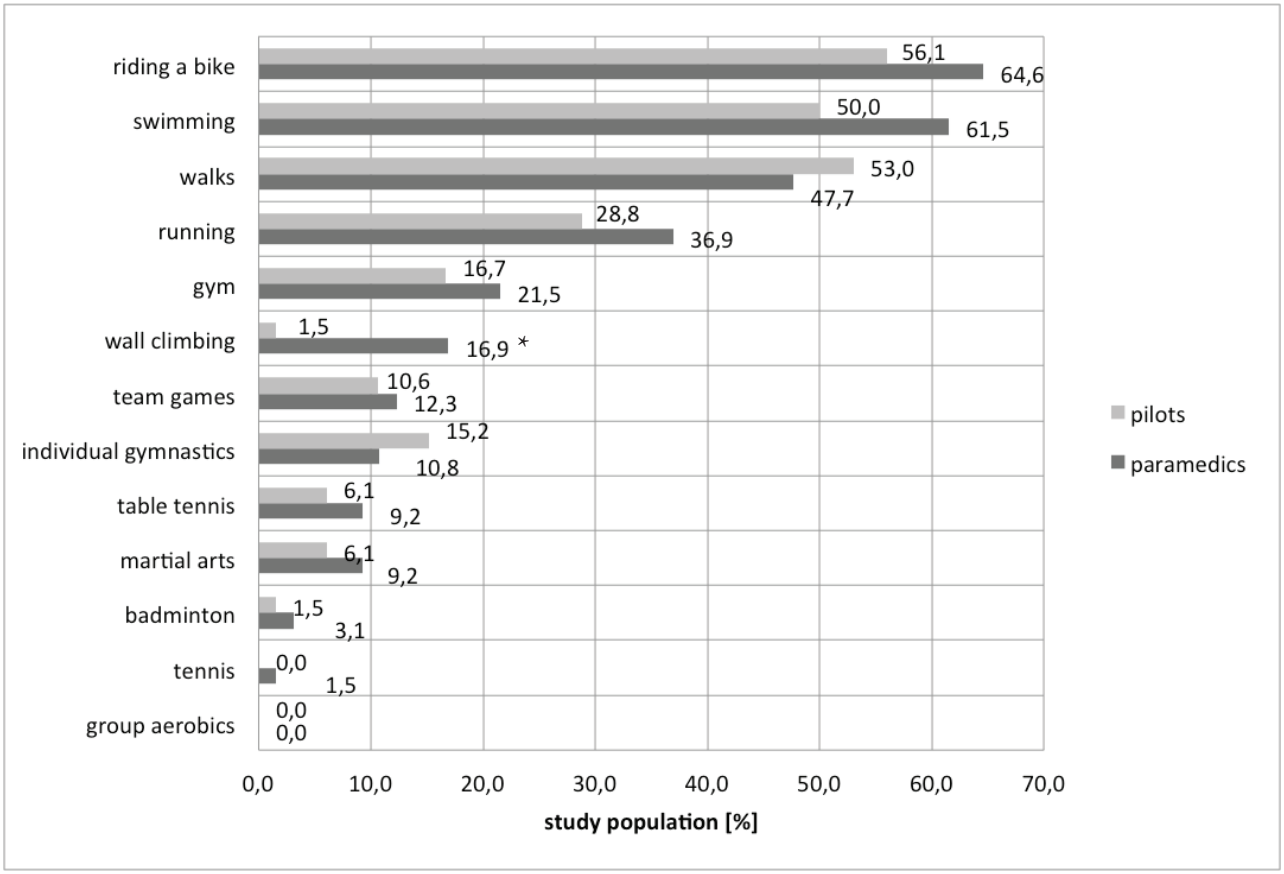

Fig. 4. Forms of activity undertaken by HEMS pilots and paramedics.

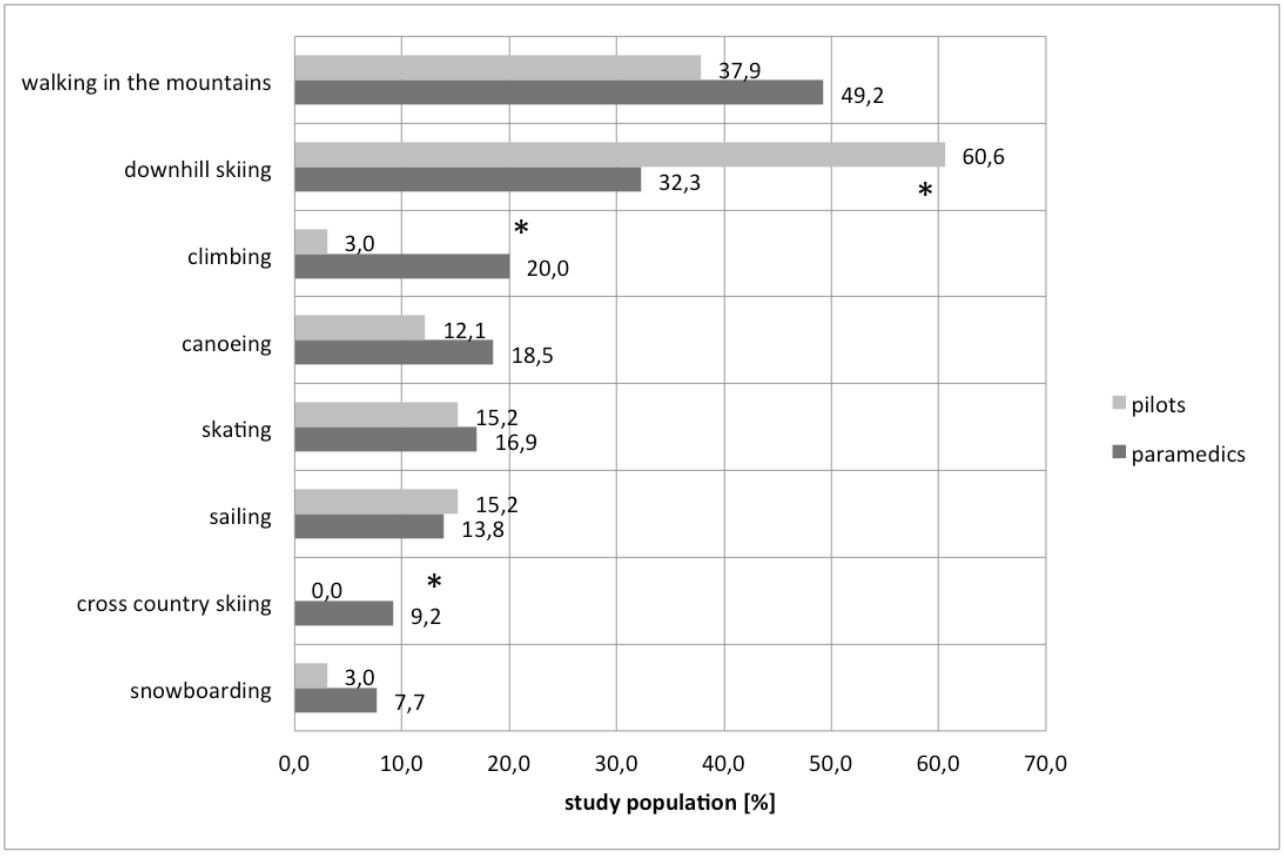

Fig. 5. Forms of seasonal activity undertaken by HEMS pilots and paramedics in summer or winter.

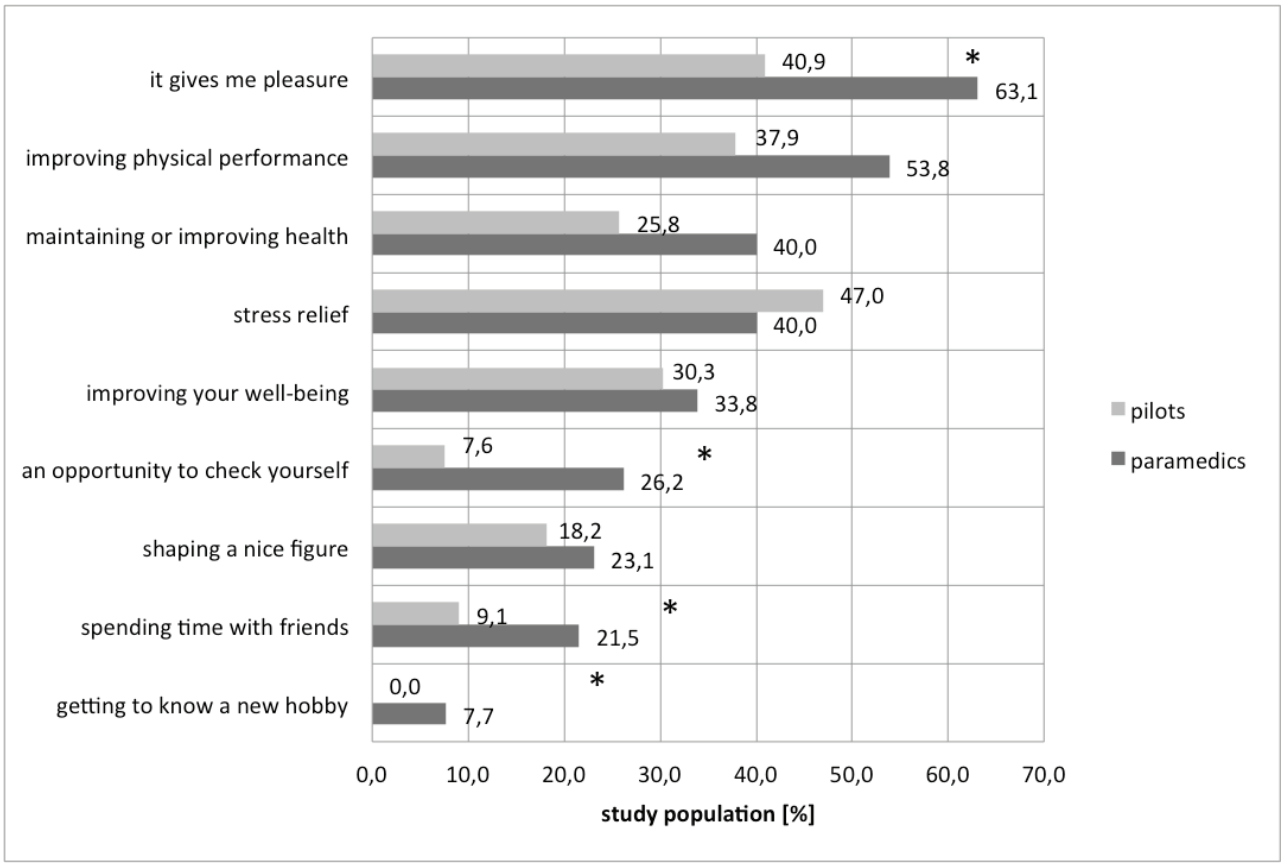

Fig. 6. Motives for undertaking physical activity by HEMS crew.

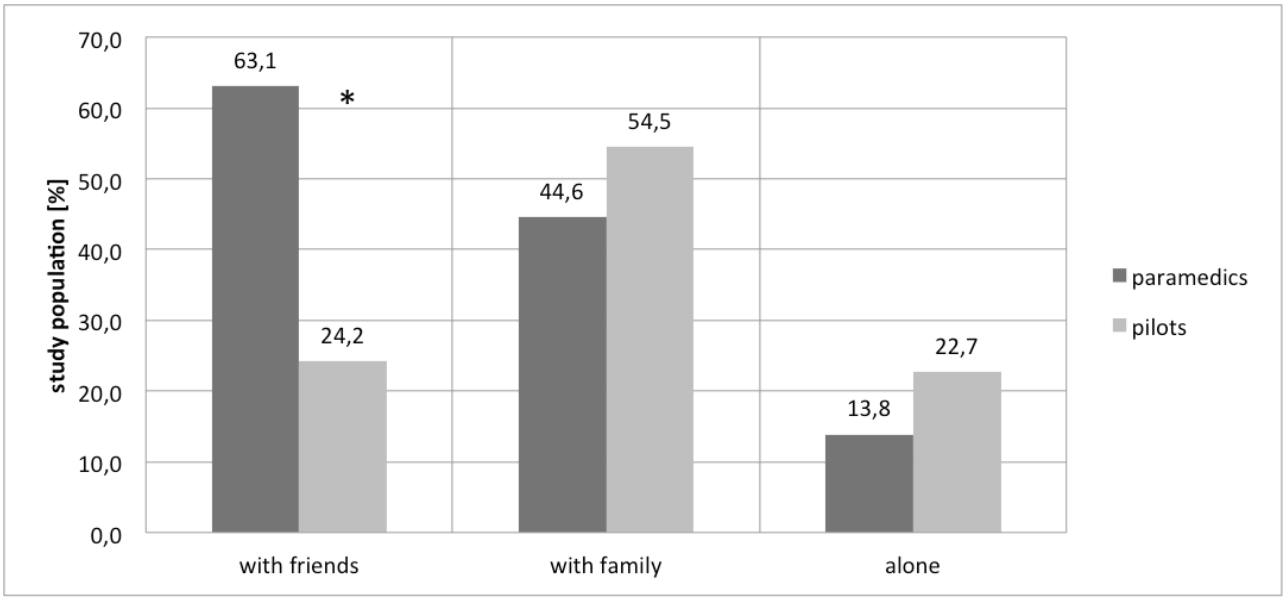

Fig. 7. Percentage of HEMS pilots and paramedics answering the question: *With whom do you most often practice selected forms of physical activity?*.

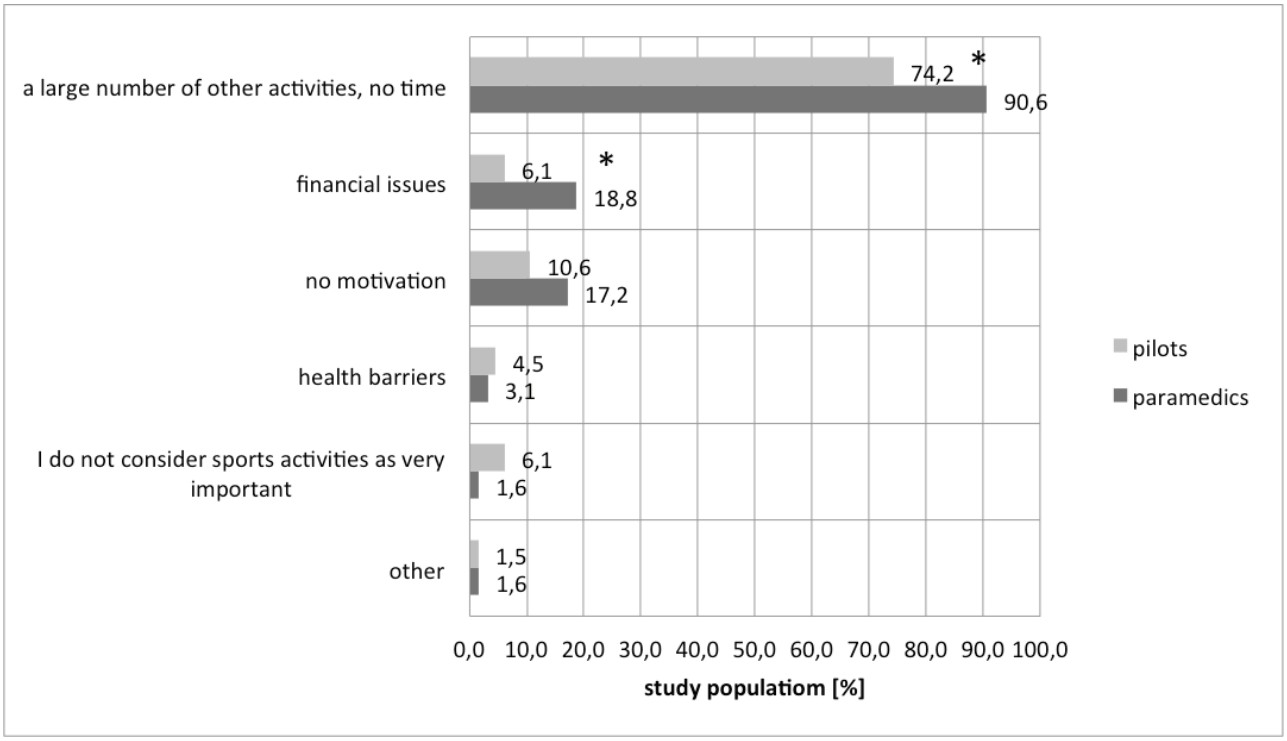

Fig. 8. Barriers in undertaking physical activity declared by HEMS crew members.

Paramedics statistically significant more often than pilots were more likely to engage in physical activity with friends (63.1 *vs.* 24.2%, p <0.0001). Over half of the surveyed pilots declared that they most often play sports with their families (Fig. 7).

90% of subjects answered "yes" to the question "Would you like to spend more time on sports activities?". Paramedics were statistically more likely than HEMS pilots to disclose a large number of other activities (90.6 *vs.* 74.2%, p = 0.0140) and financial issues (18.8 *vs.* 6.1%, p = 0.0240) as barriers that prevent more involvement in sports activities (Fig. 8).

DISCUSSION

This paper raises the issue of undertaking physical activity of a selected professional group, namely HEMS crew members. The professional activity of this group is a very mentally burdensome work. Research shows that high physical activity has a positive effect on the proper functioning of the mind, reduces anxiety, and improves the quality of sleep, even in an organism under stress [8]. In the research by Rasmus et al. physical activity, conversations with family and friends, and meetings with friends were the methods of coping with stress most frequently chosen by employees of the State EMS system [9].

According to current recommendations, adults should exercise at least 150 minutes to 300 minutes a week with moderate intensity, or 75 minutes to 150 minutes a week with high intensity, or an equivalent combination of aerobic activity of moderate and high intensity. They should also do muscle strengthening exercises for 2 or more days a week [10]. The respondents were asked about the frequency of undertaking physical activity. Optimal physical activity was disclosed by less than a third of respondents (30.8%).

In Gacka's study it was shown that doctors undertook recreational physical activity usually once a week [11]. Insufficient physical activity in free time was also described in earlier studies of another group of doctors and nurses [12]. Other results were obtained by Jasik, where 44% of health care workers performed physical activity several times a week [13]. In the studies of doctors from Poznań and Bydgoszcz, a satisfactory frequency of participation in sports and recreation classes (69.5%) was also shown [14].

According to CBOS, the most popular form of physical activity of Poles, like five years ago, is cycling [15]. Over the past year, more than two-fifths of respondents (44%) declared that they rode a bicycle. Swimming (20%) was in the second place in terms of popularity, and in the third place – hiking, walking in the mountains and hiking on tourist routes (14%). They were also the most preferred forms of physical activity selected by the studied HEMS crew members. Cycling was also the most popular way of spending free time by medical students. 40.5% of respondents declared such an answer [16]. Team games (27.1%), walking the dog (27.1%) as well as group exercises (21.2%) were also high in the aforementioned group of students, which was not confirmed by our research.

Among activities practiced seasonally, downhill skiing and walking in the mountains were the most popular among the studied HEMS crew members. According to CBOS surveys, only every thirteenth respondent did winter sports over the past year (8%) [15]. Studied pilots and HEMS paramedics declared definitely less frequently that they practiced water sports (about 15% of respondents), which was also confirmed by CBOS (5%) [15].

The authors were also interested in motivations related to the practice of sport by the HEMS crew members. The motives for choosing different forms of physical effort for pilots were, first and foremost, maintaining or improving health (47%), while the most important for paramedics was well-being (63%). This is confirmed by CBOS research where sport is practiced for health by 69% of Poles, secondly for pleasure (55%), and thirdly for better well-being and stress relief (44%) [15]. For roughly a quarter of Poles engaging in physical activity (27%), sport is primarily a way of spending time together with friends, family and friends (25%). In their own research, the respondents also most willingly practiced various forms of activity with friends and family, much less often they did it themselves. Psychophysical well-being was also the most frequently mentioned motive for undertaking physical activity by medical students (51.1%) [16]. Caring for health was also important in this study group. This was also confirmed by the research of Dróżdż and Olszewski-Strzyżowski conducted among the inhabitants of Elbląg [17].

In considerations of physical activity, one cannot ignore obstacles that stand in the way making it difficult or even impossible to participate in active leisure. Recognizing barriers allows, on the one hand, to realize how important it is to face human behavior change, and on the other hand to make us aware of the actions to be taken to eliminate them.

According to the respondents, the biggest barriers for undertaking physical activity was the lack of time. 90.6% of paramedics and 74.2% of HEMS pilots responded in this way. 90% of respondents declared willingness to spend more time on physical activity. This was confirmed by the research of Chinna et al. In a group of well-educated people who, apart from the lack of free time, also recognized a lack of motivation as a significant barrier in undertaking physical activity [18].

CONCLUSIONS

1. The frequency of physical activity undertaken by members of the Helicopter Emergency Medical Service is insufficient.
2. The limited participation of HEMS members in physical recreation adversely affects their nutritional status.
3. It is necessary to take initiatives to promote physical activity in this professional group.

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DOI: 10.36740/EmeMS202002104 **ORIGINAL ARTICLE**

CHANGES IN THE VISITS TO EMERGENCY DEPARTMENT OF NON-INFECTIOUS HOSPITAL DURING THE EARLY COVID-19 STATE OF EPIDEMIC

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Abstract

Introduction: The epidemiology of Emergency Department (ED) visits provides important data regarding demand for the medical resources.
The aim: To present changes in the visits to ED of University Hospital during the early stage of Covid-19 state of epidemic.
Matrial and Methods: All ED visits during the 3 periods each lasting one weeks in 2018, 2019, and 2020 respectively were analysed. The data related to patients 'visits in the emergency department were gathered.
Results: The percentage of patients admitted between 23-29.03 in 2020 year was 23.7% of the study group and constituted a significantly lower percentage than those admitted in 2028 who constituted 37.2% and 2019 who constituted 39.1% $p<0.001$. There was no significant differences between percentages of patients admitted to ED and brought by EMS among studied periods. The percentage of patients admitted to other ward of the hospital was higher in 2020 than in 2018 and 2019.
Conclusions: 1. During early stage of COVID-19 epidemic state the number of ED significantly decreased both patients brought by EMS and non EMS pathway. 2. Patients admitted to ED are more often admitted to other ward of the hospital. 3. The mortality during ED stay is similar than in similar periods in previous years.

Key words

emergency department, COVID-19

INTRODUCTION

The epidemiology of Emergency Department (ED) visits provides important data regarding demand for the medical resources. It has been reported the different epidemic changes pattern of ED visits [1-5]. COVID-19 (from Coronavirus Disease 2019) is an acute respiratory disease caused by SARS-CoV-2 infection. It was first recognized and described in November 2019 in central China in Hubei Province, Wuhan City. WHO recognized the COVID-19 a pandemic [6]. In Poland state of epidemic threat was announced on March, 13 2020 [7] and on March 20 2020 government has introduced state of epidemic [8].

During Covid-19 rapid changes in ED attendance rates and causes may occur.

The aim of the study was to present changes in the visits to ED of University Hospital during the early stage of Covid-19 state of epidemic.

MATERIAL AND METHODS

Retrospective analysis of the medical recordings of the patients admitted to Emergency Department of University Hospital in Wroclaw during 3 periods lasting 7 days between 23.03 and 29.03 in 2018, 2019, and 2020.

From the medical recording the following data were gathered: triage color, a method of coming to the ED (brought by EMS or other), the ICD-10 code at discharge, the place where the patient was discharged (admitted to another ward of the University

Hospital, discharged from University Hospital, died during stay at ED).

University Hospital in Wrocław is a non-infectious hospital which is intended to treat patients without COVID-19 infection.

STATISTICAL ANALYSIS

The continuous variables were presented as means and standard deviations and compared with ANOVA. The discrete variables were presented as numbers and percentages and compared with chi2 test. P less than 0.05 was considered as significant.

RESULTS

A total of 1807 patients were admitted to ED during the study period. The percentage of patients admitted between 23-29.03 in 2020 year was 23.7% and constituted a significantly lower percentage than those admitted in 2018 who constituted 37.2% and 2019 who constituted 39.1% p<0.001. The was no difference between the percentage of patients admitted in 2018 and 2019 (p=0.47). In the table1 the number of patients admitted to ED according to the triage colour was presented.

Table 1. Number of patients admitted to the Emergency Department (ED) according to the triage colour.

Triage colour	2018.03.23-29 N=673	2019.03.23-29 N=706	2020.03.23-29 N=428
Red n (%)	28 (4.2)	26 (3.7)	14 (3.3)
Orange n (%)	0 (0)	0 (0)	13 (3.0)
Yellow n (%)	204 (30.3)	186 (26.4)	67 (15.7)
Green n (%)	398 (59.1)	463 (65.6)	237 (55.4)
Blue n (%)	38 (5.7)	29 (4.1)	87 (20.3)
Not noticed n (%)	5 (0.7)	2 (0.3)	10 (2.4)

Table 2. The pathway of coming of the patients to Emergency Department as brought by Emergency Medical Services (EMS) and non EMS (other).

There was no significant differences between percentages of patients admitted to ED who were brought by EMS among studied periods.

In all studied periods there were significantly lower percentage patients admitted from EMS than admitted through pathway not involving EMS (p<0.001). In the table 3 the discharge of the patients from ED was presented. The percentage of patients admitted to another ward of the hospital was significantly higher in 2020.03.23-29 than in corresponding periods in 2019 and 2018.

	2018.03.23-29 N=673	2019.03.23-29 N=706	2020.03.23-29 N=428
EMS n (%)	217 (32.2)	232 (32.9)	162 (37.9)
Other n (%)	456 (67.8)	474 (67.1)	266 (62.2)
	P<0.001	<0.001	<0.001

Table 3. The discharge of the patients who were admitted to Emergency Department (ED) during studied periods.

	2018.03.23-29 N=673	2019.03.23-29 N=706	2020.03.23-29 N=428
Admitted to other ward of the hospital (%)	170 (25.3)	169 (23.9)	140 (32.7)*
Discharged from ED (%)	501 (74.4)	535 (75.8)	287 (67.1)*
Died n (%)	2 (0.3)	2 (0.3)	1 (0.2)

Table 4. ICD-10 codes of diagnoses at discharge of the patients admitted to ED during studied periods

First digit of an ICD-10 code	2018.03.23-29 N=673 n (%)	2019.03.23-29 N=706 n (%)	2020.03.23-29 N=428 n (%)
A+B	2 (0.3).	0 (0)	1 (0.2)
C+D	8 (1.2)	5 (0.7)	3 (0.7)
E	4 (0.6)	3 (0.4)	6 (1.4)
F	6 (0.9)	1 (0.1)	1 (0.2)
G	11 (1.6)	15 (2.1)	10 (2.3)
H	73 (10.8)	85 (12.0)	24 (5.6)*
I	63 (9.4)	85 (12.0)	62 (14.5)$
J	18 (2.7)	22 (3.1)	14 (3.3)
K	20 (3.)	20 (2.8)	11 (2.6)
L	7 (1.0)	4 (0.6)	8 (1.9)
M	17 (2.5)	25 (3.5)	6 (1.4)
N	21 (3.1)	25 (3.5)	21 (4.9)
P	1 (0.1)	1 (0.1)	0 (0)
R	144 (21.4)	136 (19.3)	71 (16.6)*
S	150 (22.3)	122 (17.3)	114 (26.6)#
T	39 (5.8)	41 (5.8)	35 (8.2)
Z	89(13.2)	116 (16.4)	41 (9.6)#

* - p<0.01 *vs.* 2018.03.23-29 and 2019.03.23-29
\# - p<0.01 *vs.* 2019.03.23-29
$ - p<0.01 *vs.* 2018.03.23-29

In the table 4 ICD-10 codes at discharge were presented. The frequency of group H codes was significantly lower in 2020.03.23-29 than in 2019.03.23-29 and 2018.03.23-29. The frequency of I group codes was significantly lower in2018.03.23-29 than in 2020.03.23-29. The frequency of R group codes was significantly higher in 2018.03.23-29 and 2019.03.23-29 than in 2020.03.23-29. The frequency of S group codes was significantly higher in 2020.03.23-29 than in 2019.03.23-29.

DISCUSSION

The main finding of the study is that in the early period of COVID-19 state of epidemic the number of ED visits in general hospital which is not intended to treat infections is lower than in corresponding periods of the previous years.

The patients are afraid to attend ED and it was even supposed that they more often have myocardial infarction home because would like to omit hospitals and decrease the risk of SARS-CoV-2 infection [9]. The outcome of such behaviour is not known, but the healthcare providers should be attentive because many patients who otherwise would call for ambulance could call their family doctor.

The second finding is that the percentage of the patients with blue colour significantly increased what indicates the lack of other possibilities to obtain medical help.

The mortality during early phase of COVID-19 state of epidemic in a hospital which is not intended to treat infections is similar than in corresponding periods in previous years. The presented findings are related with a recent observations therefore it is difficult to compare them with other studies.

The low number pf patients in ED in the early stage of COVID-19 epidemia may resemble a receding sea before the tsunami. Therefore, this time should be used to train ED teams to prepare for the epidemic surge.

CONCLUSIONS

1. During early stage of COVID-19 state of epidemic the number of ED significantly decreased both patients brought by EMS and non EMS pathway.
2. Patients admitted to ED are more often admitted to other ward of the hospital.
3. The mortality during ED stay is similar than in similar periods in previous years
4. The structure of admission to ED changes and less people are admitted with ophthalmologic and ear-nose-throat diseases whereas the percentage of traumatic injuries is higher.
5. Significant increase in patients admitted with blue colour is found during the early stage of COVID-19 state of epidemic what indicates the difficulties in obtaining the medical help.

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DIAGNOSES MADE BY LEADERS OF EMERGENCY MEDICAL SERVICES TEAMS WITHIN THE OPERATION AREA OF THE EMERGENCY MEDICAL SERVICES STATION IN MINSK MAZOWIECKI IN 2013-2017

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Abstract

Introduction: The activities of the Emergency Medical Services (EMS) Station in Minsk Mazowiecki are based on the provision of medical aid to persons in a state of emergency.

The aim: Analysis of interventions of EMS teams operating in the structure of the EMS Station in Minsk Mazowiecki, including diagnoses made by team leaders based on the International Classification of Diseases.

Material and methods: The study was retrospective. The analysis covered 39,027 dispatches of EMS teams in Minsk Mazowiecki in the period from January 1, 2013 to December 31, 2017. The study was conducted on the basis of medical data collected in SP ZOZ RM-MEDITRANS computer systems in Siedlce.

Results: The results indicated an increase in the number of interventions performed by EMS teams working in the EMS Station in Minsk Mazowiecki (by 30.80%) in the period from 2013 to 2017. In that period, interventions in code 2 (69.12%) dominated. The EMS teams reached the event site much faster in code 1 than in code 2. The mean time needed to reach the event site was noticeable. Most interventions took place in the patient's home (73.14%). The leaders of EMS teams made diagnoses mainly on the basis of a group of ICD-10 codes regarding symptoms and disease features (37.39%), followed by injuries, poisoning, external factors (20.58%) and cardiovascular diseases (15.64%). Of all interventions, 68.60% of patients were transported to hospitals, and 23.97% remained at the place of call.

Conclusions: The analysis of interventions of EMS teams in Minsk Mazowiecki indicated an increase in the society's demand for services in the field of EMS, while the optimization of their use and verification of the legitimacy of their interventions is warranted. In addition, EMS team leaders made diagnoses mainly on the basis of a group of ICD-10 codes regarding symptoms and disease features.

Key words

emergency medical services team, diagnosis, ICD-10

INTRODUCTION

Emergency Medical Services (EMS) Station in Minsk Mazowiecki is a part of the organizational structure of the Independent Public Health Care Center RM-MEDITRANS EMS Station and Sanitary Transport in Siedlce.

The main task of EMS Station in Minsk Mazowiecki is to provide medical rescue activities in accordance with the contract with the National Health Fund. The basic purpose of EMS teams working in the Station is to provide services in states of sudden health emergency by performing medical emergency activities at the place of the incident as a part of the State EMS System.

EMS Station in Minsk Mazowiecki has in its organizational structure EMS teams placed in Minsk Mazowiecki: a specialist team W04-81 (until October 1, 2015 04-81) and a basic team W04-82 (until

October 1, 2015 04-86), in Kaluszyn: a basic team W04-84 (until October 1, 2015 04-87) and formed on February 1, 2017 a basic team W04-92 in Latowicz.

The main operation area of EMS teams working in EMS Station in Minsk Mazowiecki is the Minsk district, from which the city of Sulejowek and the rural-urban commune Halinow were excluded based on the Provincial Action Plan of the State EMS System [1, 2]. In 2013, this area was inhabited by 115,516 people [3], and in 2017 this number increased by 1.59% and amounted to 117,356 people [4]. The operation area of the EMS Station in Minsk Mazowiecki together with the following districts: garwolinski, losicki, Siedlce (city and rural), sokolowski, wegrowski, as well as the communes of Jadow and Strachowka from the wolominski district belongs to the operational area 14-04, for which protection in the field of EMS is the responsibility of SP ZOZ RM-MEDITRANS in Siedlce [1, 2].

The area of EMS Station activity in Minsk Mazowiecki is not limited to the boundaries set in the Provincial Action Plan of the State EMS System (operational area 14-04). EMS teams subordinate to EMS Station in Minsk Mazowiecki are available when the time of reaching the victim is shorter than the time of reaching by other EMS teams.

THE AIM

Analysis of EMS team interventions in Minsk Mazowiecki, with particular emphasis on diagnoses made by EMS team leaders based on the International Classification of Diseases – ICD-10.

MATERIAL AND METHODS

39,027 interventions of EMS teams subordinate to EMS Station in Minsk Mazowiecki were analyzed. The examination was retrospective and was carried out on the basis of applicable medical documentation – Departure Order Cards and Medical Emergency Activities Cards for the period from January 1, 2013 to December 31, 2017.

The study was conducted using the computer systems of the Independent Public Health Care Station of the Ambulance and Sanitary Transport Station RM-MEDITRANS in Siedlce: Kamsoft – the Basic Program of the Service Provider (KS-PPS), Asseco Medical Management Solutions (AMMS) and the State Emergency Medical Support System – module Analytics (SWD PRM – Analytics module). The data collected in them related to the intervention information such as: town, commune and district call, name and type of EMS team, call times, urgency code of the call, patient management, and diagnosis according to the International Classification of Diseases ICD-10 (International Classification of Diseases). The obtained data was collected in the Microsoft Excel MS Office 2010 database for Windows 10.

Individual data from individual EMS team interventions in the study were quantified depending on a single EMS team, a type of an EMS team – specialist and basic teams, an urgency code in the analyzed period – immediate code 1 (EMS team dispatch within a maximum of 1 minute after notification), an urgent code 2 (EMS team dispatch within a maximum of 2 minutes after notification), a place of call – home, public place, street and road traffic, work, or outpatient clinic. Currently, the EMS team departure in code 2 must take place in a maximum of 3 minutes [5]. The mean arrival time of an EMS team to the place of incident was analyzed.

In addition, the study examined diagnoses made by EMS team leaders based on the International Classification of Diseases (ICD-10).

EMS team proceedings with the patient was analyzed in terms of transport to healthcare facilities, leaving the patient at the place of call or handing over to the Police, City Guard, and Air Ambulance Service.

The study aimed to analyze the factors affecting the activities of EMS teams operating within EMS Station in Minsk Mazowiecki.

Table 1. The mean number of interventions of individual EMS teams per day in 2013-2017.

EMS	2013	2014	2015	2016	2017
W04-81	5.3	5.8	6.1	6.2	5.4
W04-82	8.7	9.1	9.6	9.7	9.9
W04-84	4.7	5.3	5.9	5.8	5.5
W04-92					4.0
ALL	18.7	20.2	21.6	21.8	24.4

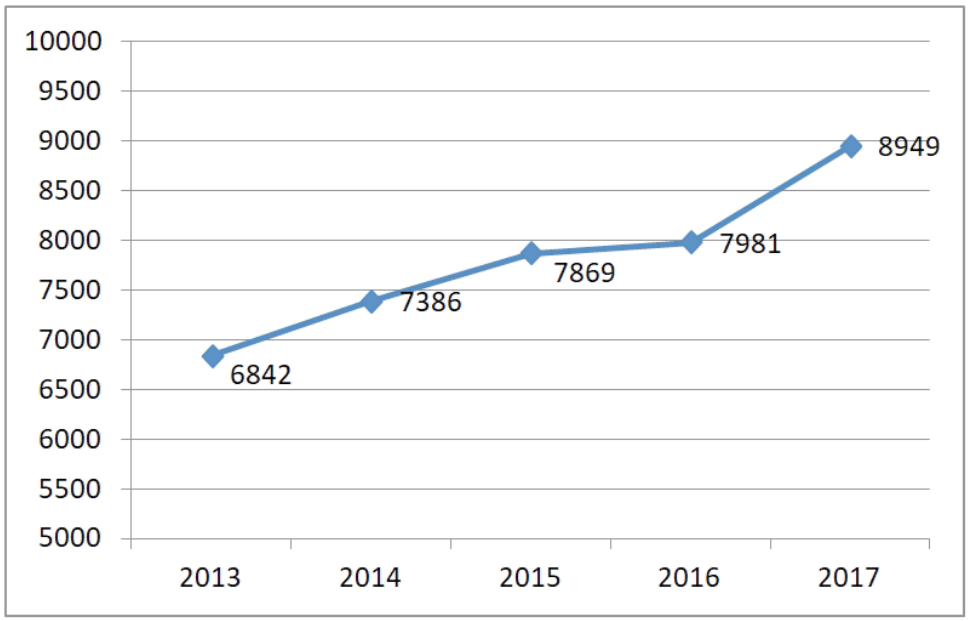

Fig. 1. The number of interventions medical emergency teams in 2013-2017.

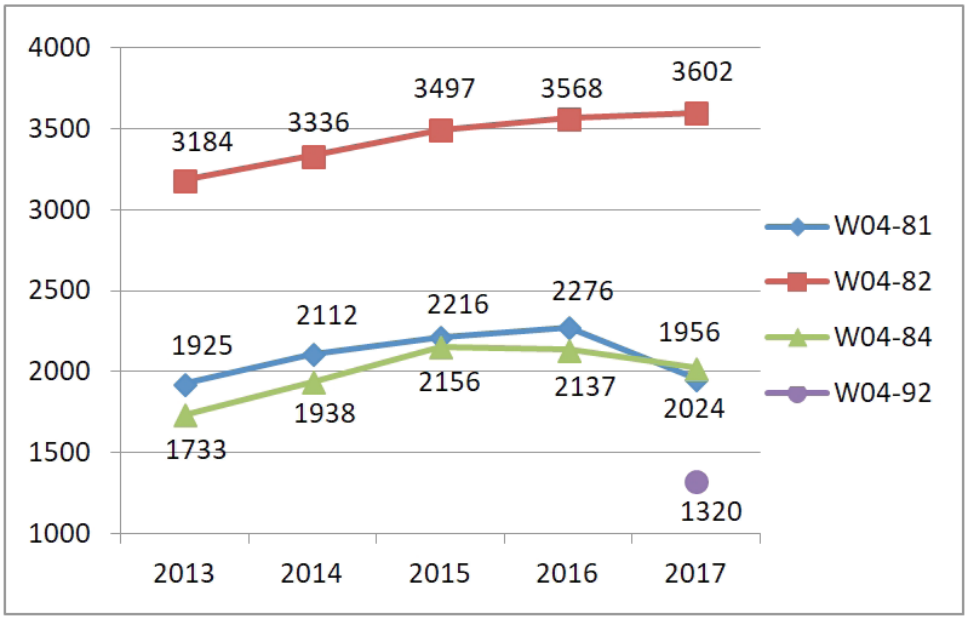

Fig. 2. The number of interventions of individual medical emergency teams in 2013-2017.

RESULTS

From January 1, 2013 to December 31, 2017, EMS teams of EMS Station in Minsk Mazowiecki were dispatched for medical events 39,027 times (Fig. 1). EMS teams showed an annual, steady increase in the number of interventions. The number of which in 2017 was higher by as much as 30.80% (n = 2107) compared to 2013 (Fig. 1).

The analysis showed that the basic EMS team – W04-82 (in Minsk Mazowiecki) was the most burdened in terms of the number of interventions compared to the other EMS teams of EMS Station in Minsk Mazowiecki. The basic EMS team W04-84 (in Kałuszyn), after increasing the number of interventions to 2015, in the years 2016-2017 recorded a gradual, slight decrease. In the case of the specialist EMS team W04-81 (in Mińsk Mazowiecki), we observed an increase in the number of interventions, and then in 2017 their decrease to the level from 2013. The decrease in interventions by teams W04-81 and

Table 2. EMS interventions according to the urgency code with the mean arrival time in 2014-2017.

Year	EMS	Urgency code 1			2			3		
		No of interventions	[%] interventions	Mean arrival time	No of interventions	[%] interventions	Mean arrival time	No of interventions	[%] interventions	Mean arrival time
2013	04-81	980	50.91%	00:08:44	933	48.47%	00:09:51	12	0.62%	00:15:06
	04-82	535	16.80%	00:09:08	2465	77.42%	00:11:40	184	5.78%	00:21:57
	04-84	459	26.49%	00:12:13	1219	70.34%	00:17:37	55	3.17%	00:23:52
	all	1974	28.85%	00:09:50	4617	67.48%	00:14:15	251	3.67%	00:22:21
2014	04-81	1046	49.53%	00:08:35	1043	49.38%	00:09:08	23	1.09%	00:25:24
	04-82	640	19.18%	00:08:39	2562	76.80%	00:12:02	134	4.02%	00:23:03
	04-84	567	29.26%	00:12:45	1323	68.27%	00:17:59	48	2.48%	00:27:11
	all	2253	30.50%	00:09:39	4928	66.72%	00:13:01	205	2.78%	00:24:19
2015	04-81	1108	50.00%	00:09:21	1108	50.00%	00:11:13			
	04-82	611	17.47%	00:11:05	2886	82.53%	00:13:46			
	04-84	616	28.57%	00:14:18	1540	71.43%	00:18:28			
	all	2335	29.67%	00:11:07	5534	70.33%	00:14:33			
2016	04-81	1184	52.02%	00:09:34	1092	47.98%	00:11:13			
	04-82	666	18.67%	00:09:48	2902	81.33%	00:13:53			
	04-84	585	27.37%	00:13:29	1552	72.63%	00:18:42			
	all	2435	30.51%	00:10:35	5546	69.49%	00:14:42			
2017	04-81	1030	52.66%	00:11:15	926	47.34%	00:12:33			
	04-82	676	18.77%	00:10:41	2926	81.23%	00:14:28			
	04-84	548	27.08%	00:13:10	1476	72.92%	00:18:34			
	04-92	337	25.53%	00:15:28	983	74.47%	00:19:05			
	04-D-86	8	17.02%	00:09:15	39	82.98%	00:16:26			
	all	2599	29.04%	00:12:03	6350	70.96%	00:15:52			

W04-84 could probably be associated with the formation of the basic group W04-92 in 2017 with the waiting place in Latowicz (Fig. 2, Table 1).

Noteworthy is the creation of an additional basic EMS team W04-D-86, which stationed in Minsk Mazowiecki during the holiday season from midnight 24 to midnight December 31, 2017, during the period in which the intensification of medical interventions was noted. That translated into 47 interventions of this team.

In total, for all interventions of both the specialist EMS team and the basic EMS teams in individual years (2013-2017), interventions in code 1 accounted for about 30%. The specialist EMS team carried out most of such interventions (51.01%). Compared to basic EMS teams, the specialist EMS team was primarily sent for urgent medical interventions (sudden cardiac arrest, loss of consciousness, traffic accidents, etc.) due to the presence of a doctor and an increased number of specialist drugs and equipment (Table 2).

In case of basic EMS teams, interventions in code 1 accounted for 22.78% of all their interventions. One must remember that basic EMS teams from Kaluszyn (28.07% interventions in code 1 and

Table 3. EMS interventions according to the location of the call in 2013-2017.

	All		2013		2014		2015		2016		2017	
	No of interventions	[%] interventions	No of interventions	[%] interventions	No of interventions	[%] interventions	No of interventions	[%] interventions	No of interventions	[%] interventions	No of interventions	% interventions
Home	**28544**	**73.14%**	5019	73.36%	5388	72.95%	5801	73.72%	5777	72.38%	6559	73.29%
Public place	**4908**	**12.58%**	845	12.35%	946	12.81%	993	12.62%	1046	13.11%	1078	12.05%
Traffic	**1942**	**4.98%**	339	4.95%	369	5.00%	367	4.66%	414	5.19%	453	5.06%
Nursing home	**1259**	**3.23%**	196	2.86%	215	2.91%	222	2.82%	281	3.52%	345	3.86%
Outpatient clinic	**974**	**2.50%**	188	2.75%	197	2.67%	223	2.83%	189	2.37%	177	1.98%
School	**560**	**1.43%**	87	1.27%	107	1.45%	96	1.22%	121	1.52%	149	1.66%
Work	**266**	**0.68%**	35	0.51%	41	0.56%	54	0.69%	54	0.68%	82	0.92%
Police station	**296**	**0.76%**	64	0.94%	67	0.91%	54	0.69%	53	0.66%	58	0.65%
After hours medical center	**101**	**0.26%**	20	0.29%	10	0.14%	26	0.33%	21	0.26%	24	0.27%
Home – a doctor call	**138**	**0.35%**	48	0.70%	40	0.54%	27	0.34%	16	0.20%	7	0.08%
In agriculture	**28**	**0.07%**	1	0.01%	4	0.05%	3	0.04%	6	0.08%	14	0.16%
Others	**11**	**0.03%**	0	0.00%	2	0.03%	3	0.04%	3	0.04%	3	0.03%
All	**39027**	**100.0%**	**6842**	100.0%	**7386**	100.0%	**7869**	100.0%	**7981**	100.0%	**8949**	100.0%

71.93% in code 2) and Latowicz (code 1 – 25.53%, code 2 – 74.47%) were always sent for a call located in its proximity, regardless of the urgency code assigned. However, in the case of Minsk Mazowiecki, the medical dispatcher based on the collected medical history, having the choice of a specialist and basic team usually for the event in code 1 sent the EMS team with a doctor. This translated into 18.54% of calls in code 1 and 81.46% in code 2 made by the Minsk basic EMS team W04-82 (Table 2).

In years 2013 – 2014, the urgency code 3 was in force. This code was given to interventions in which urgent intervention of the EMS team was not required, but for various reasons the patient could not get proper medical help on his own. Interventions in this code accounted for a small percentage of all interventions, while in case of the W04-82 team, such interventions accounted for about 5% of all dispatches (Table 2).

As it results from the presented data, the mean arrival time to the patient in code 1, for each team, was definitely shorter than in code 2 (Table 2). This resulted from code 1 nature: EMS team departure within a minute and absolute use of light and sound signals. In case of code 3, the mean arrival time was clearly longer than in code 1 and 2 (Table 2). In the discussed period (2013-2017), arrival times were gradually lengthened, which was probably the result of an increase in the number of interventions and thus a reduced availability of EMS teams. In 2013, the mean time to reach the patient was 12 minutes and 17 seconds, while in 2017 it was already 14 minutes and 46 seconds. It is clear that even the formation of the EMS team W04-92 in Latowicz failed to reverse this trend. In addition, this team, compared to others, had significantly longer arrival times, which was the result of the extent of the operation area (Table 2).

The vast majority of interventions to which EMS teams subordinate to EMS Station in Minsk Mazowiecki were called took place at the patient's home – 73.14%, followed by public places – 12.58% and street and road traffic – 4.98% (Table 3).

EMS team leaders making diagnoses for individual patients presented a high degree of caution resulting from small diagnostic possibilities. In the discussed period (2013-2017), among all interventions (n = 39,027), diagnoses were made in case of 37,672 EMS team interventions, in the remaining 1,355 interventions no diagnoses were made, which resulted from the cancellation of the call, a false call, no patient or the patient refused the help. For most interventions, team leaders made diagnoses based on a group of ICD-10 codes regarding symptoms and disease features – 37.39% (Table 4). In this group,

Table 4. Diagnoses (ICD-10) made by EMS team leaders in 2013-2017.

ICD10 code	Name			[%]
A-B	Infectious and parasitic diseases			0.82%
C-D	Neoplasms and blood diseases			0.75%
E	Endocrine, nutritional and metabolic diseases			2.67%
	E10-E15	Diabetes	0.32%	
F	Mental and behavioral disorders			3.97%
G	Diseases of the nervous system			3.34%
	G40-G41	Epilepsy and status epilepticus	2.69%	
H	Diseases of the eye and adnexa, the ear and mastoid process			0.04%
I	Diseases of the circulatory system			15.64%
	I00-I09, I26-I52	Heart diseases	6.09%	
	I10-I15	Arterial hypertension	4.75%	
	I20, I23-I25	Ischemic heart disease	0.59%	
	I21-I22	Acute myocardial infarction	0.70%	
	I60-I69	Cerebrovascular diseases	3.02%	
J	Diseases of the respiratory system			2.63%
K	Diseases of the digestive system			1.00%
L	Diseases of the skin and subcutaneous tissue			0.17%
M	Diseases of the musculoskeletal system			0.76%
N	Diseases of the genitourinary system			0.83%
O-P	Pregnancy, delivery and puerperium			0.36%
Q	Congenital malformations, deformations and chromosomal abnormalities			0.00%
R	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified			37.39%
	R06	Abnormalities of breathing	3.47%	
	R07	Throat and chest pain	5.58%	
	R55	Syncope and collapse	7.69%	
	R56	Convulsions, not elsewhere classified	1.54%	
S-T	Injury, poisoning and certain other consequences of external causes			20.58%
V-Y	External causes of morbidity and mortality			5.31%
Z	Factors influencing health status and contact with health services			4.47%
U	Codes for special purposes			0.00%

the largest number was the diagnosis of R55 – Syncope and collapse (20.57%), constituting 7.69% of all EMS interventions where the diagnosis was made. Subsequently, the ICD-10 diagnosis groups included injuries, intoxications, effects of external factors – 20.58% and cardiovascular diseases – 15.64% (Table 4). For diagnoses based on the group of ICD-10 codes regarding symptoms and disease features,

Table 5. The place of patient's transfer/end of the dispatch.

	All		2013		2014		2015		2016		2017	
	No of interventions	[%] interventions	No of interventions	[%] interventions	No of interventions	[%] interventions	No of interventions	[%] interventions	No of interventions	[%] interventions	No of interventions	% interventions
Emergency department	**24302**	**62.27%**	4349	63.56%	4578	61.98%	4984	63.34%	4976	62.35%	5415	60.51%
Left at the place of call	**9355**	**23.97%**	1586	23.18%	1822	24.67%	1816	23.08%	1933	24.22%	2198	24.56%
Admission room	**1020**	**2.61%**	155	2.27%	164	2.22%	193	2.45%	219	2.74%	289	3.23%
Death	**1046**	**2.68%**	201	2.94%	183	2.48%	205	2.61%	213	2.67%	244	2.73%
Psychiatric admission room	**936**	**2.40%**	149	2.18%	181	2.45%	202	2.57%	179	2.24%	225	2.51%
Cancellation of the call	**777**	**1.99%**	106	1.55%	151	2.04%	152	1.93%	147	1.84%	221	2.47%
Cath lab	**506**	**1.30%**	107	1.56%	94	1.27%	122	1.55%	93	1.17%	90	1.01%
No patient	**478**	**1.22%**	90	1.32%	88	1.19%	84	1.07%	87	1.09%	129	1.44%
Police	**280**	**0.72%**	44	0.64%	67	0.91%	54	0.69%	71	0.89%	44	0.49%
Help refusal	**137**	**0.35%**	11	0.16%	17	0.23%	31	0.39%	26	0.33%	52	0.58%
Air EMS	**82**	**0.21%**	14	0.20%	23	0.31%	14	0.18%	17	0.21%	14	0.16%
Another EMS team	**77**	**0.20%**	24	0.35%	12	0.16%	7	0.09%	14	0.18%	20	0.22%
False call	**10**	**0.03%**	4	0.06%	3	0.04%	1	0.01%	1	0.01%	1	0.01%
City Guard	**13**	**0.03%**	2	0.03%	3	0.04%	3	0.04%	1	0.01%	4	0.04%
Trauma center	**8**	**0.02%**	0	0.00%	0	0.00%	1	0.01%	4	0.05%	3	0.03%
all	**39027**	**100.0%**	**6842**	100.0%	**7386**	100.0%	**7869**	100.0%	**7981**	100.0%	**8949**	100.0%

this group included a number of diseases from other categories. And so in the case of diagnosis of R07-Pain in the throat and chest (5.58% of all diagnoses and 14.92% of diagnoses in the group of symptoms and disease features), as many as 23.98% (n = 504) of patients underwent electrocardiogram teletransmission to one of the nearby invasive cardiology centers, which might suggest a serious illness. 5.33% (n = 112) of these patients were transported directly from the place of the event to the cath lab due to acute coronary syndrome. This cautious approach of EMS team leaders, far from making unequivocal diagnoses, probably resulted from the limited diagnostic possibilities that could be performed on board of the ambulance.

A large group of patients who called EMS teams were people under the influence of alcohol. Only on the basis of the ICD-10 code (T51-Toxic effect of alcohol) interventions in people under the influence of alcohol accounted for 1.57% (n = 593) of all interventions ended with diagnosis. In the case of code Y91-Symptoms of alcohol action depending on the concentration, it was 3.40% (n = 1,279) of calls in which the diagnosis was made. Only on this basis can it be assumed that in the case of every 20th EMS intervention, the main reason for calling was alcohol consumption, constituting 4.80% of all interventions (n = 39,027) and 4.97% of EMS interventions in which the diagnosis was made (n = 37,672).

As a result of interventions for which the EMS teams were dispatched, 68.60% of patients were transported to hospitals (Table 3), and 23.97% remained at the place of call, which was due to the lack of health risk, the lack of consent to transport to hospital, or improvement of state of health, as in the case of e.g. hypoglycemia, epilepsy, etc. Other

interventions included deaths (2.68%), canceled calls (1.99%), no patient at the place of call (1.22%), refusal of help (0.35%), etc (Table 5).

Most people were transported by EMS teams to Emergency Departments (ED) (62.3% of all interventions) (Table 5). Of all patients transported to hospitals (n = 26772), as much as 86.00% (n = 23023) were sent to the ED in Minsk Mazowiecki. Other hospitals to which Minsk EMS teams transported patients included hospitals in: Siedlce (n = 1100), Pruszkow (n = 519), Miedzylesie (n = 429), and Anin (n = 357). 14.00% (n = 3728) of transports to hospitals outside the Minsk district was caused by the state of health of patients and the possibility of medical help only in specialist medical facilities. This applied to people with acute coronary syndrome, stroke, mental disorders (n = 936, 2.40% of- all transports to hospitals) or injuries to children.

DISCUSSION

As in the whole Poland, in EMS Station in Minsk Mazowiecki there is a noticeable increase in the number of EMS team interventions, which in the period from 01 January 2013 to 31 December 2017 increased by as much as 30.80% (Fig. 1). Already in 2012-2015 Szpakowski and Pilip observed an increase in the number of EMS interventions in the operational area 14-04 [6].

Out of all interventions carried out by EMS teams from EMS Station in Minsk Mazowiecki, interventions in code 2 dominated and constituted 69.12% of all interventions (Table 2). Different results were obtained by Andrzejewski et al. [7] analyzing the medical documentation of the Falck Medycyna substation – Lodz region, where interventions in code 1 constituted 67%, and in code 2 – 33% of interventions. In contrast, in the study of Białczak et al. [8] covering the northern part of Mazovia in the period from 2013 to 2016, EMS interventions in code 1 accounted for 34.42%, and in code 2 – for 64.11% of all interventions. In case of Minsk basic EMS teams, interventions in code 1 constituted 22.68% of their all interventions, and in case of a specialist EMS team it was already 51.01% of their interventions (Table 2). Guła et al. [9] came to similar conclusions when analyzing 21,896 interventions of EMS in the second half of 2013, where in case of specialist EMS teams code 1 constituted 53.2% calls and code 2 – 44.8%, in basic EMS teams it was 15.9% and 73.0%, respectively. In 2012, in the Provincial EMS Station in Rzeszow 90.6% EMS interventions were in code 1, and 9.4% – in code 2 [10].

Based on the data analysis carried out, it can be clearly stated that in the analyzed period EMS reached the place of the event much faster in code 1 than in code 2. The increase in the mean arrival time of the ambulance to the place of the event is also noticeable (Table 2). This resulted from the increase in the number of interventions and the extent of the operation area.

Most interventions of teams from EMS Station in Minsk Mazowiecki took place in the patient's home 73.14%, then in a public place 12.58%, while incidents in street and road traffic accounted for 4.98% of all interventions (Table 3). In case of Rzeszow EMS Station, calls to the patient's home accounted for 62.7% of interventions, and street and road traffic incidents – 13.26% [10].

In the entire operational area 14-04, in 2012-2015, interventions to traffic accidents accounted for 22%, while for health hazards of internal origin or non-traffic injuries 78% [6].

In case of EMS teams from Minsk, their leaders made diagnoses mainly on the basis of a group of ICD-10 codes regarding symptoms and disease features – 37.39%. Further among the ICD10 diagnoses were injuries, intoxication and effects of external factors (20.58%) and cardiovascular diseases (15.64%) (Table 4). Białczak et al. [8] indicated the following most common causes for calling EMS teams in the north-eastern part of the Mazowieckie Voivodeship: cardiovascular diseases (36.07%), injuries (20.08%), disorders of the digestive system (11.91%), respiratory (11.27%), nervous (10.38%) and mental disorders (10.08%). Dobosz K. et al. [11] based on data from the Voivodship EMS Station in Bydgoszcz and Konin from 2010 stated that IDC-10 codes regarding symptoms and disease features in Bydgoszcz constituted 37.61% of interventions, and in Konin – 23.91%, whereas injuries, intoxication and effects of external factors accounted for 21.90% and 18.77%, respectively, and cardiovascular diseases – for 15.34% (Bydgoszcz) and 23.81% (Konin). Whereas in the study of Aftyka and Rudnicka-Drożak [12], based on the analysis of documentation of the Provincial EMS in Lublin from the Śródmieście and Garbów substations, 76.5% of cases were diseases, the rest were poisoning and injuries (23.5%). On the other hand, Andrzejewski et al. [7], based on the medical documentation of the EMS of the Falk Medycyna substation in Łask and in Widawa, indicated that 85.2% of diagnoses were diseases (with 24% being cardiovascular, 14.8% – respiratory), and 14.8% of diagnoses were injuries and poisonings. The causes of EMS intervention in Rzeszów district in 2012 were classified by Filip D. et al. differently [10], indicating the following most common reasons for EMS intervention: cardiovascular disorders (25.95%), hypertension (15.67%), abdomi-

nal pain (15.13%), and fainting (12.25%). In case of patients over 65, Timler et al. [13] indicated that in the Otwock district in 2009, interventions due to cardiovascular diseases accounted for 19%, injuries – 18%, and respiratory diseases – 8%.

Out of all interventions of EMS in Minsk, 68.60% of patients were transferred to hospitals and 23.97% remained at the place of call (Table 5). In the EMS Station in Rzeszów in 2012, 68.55% of patients were transported to the Emergency Department, 6.38% to a specialized hospital unit, 3.05% to the trauma center, and 18.75% of patients remained at the place of call [10]. On the other hand, Andrzejewski et al. [7] reported that in the period from 1 January to 30 April 2015 in case of interventions of EMS Falk Medycyna substation in Łask and in Widawa 27.8% of patients were transported to the ED, 33.9% to admission rooms, and the lack of indications or consent for hospitalization accounted for 38.4% of all interventions. Guła P. et al. [9] reported that in the second half of 2013 in case of specialist EMS teams 25.7% of patients remained at the scene of the event, and in case of intervention of the basic EMS teams – 30.7%.

CONCLUSIONS

An analysis of interventions of EMS teams subordinate to EMS Station in Minsk Mazowiecki for the period from January 1, 2013 to December 31, 2017 indicated:

1. The increase in the total number of interventions in the operation area of EMS Station in Minsk Mazowiecki.
2. The constant level of interventions in code 1.
3. A faster arrival time of EMS teams to the place of call when in code 1 than in code 2.
4. The prolonged mean arrival time to the patient.
5. Definitely a higher number of EMS interventions in the patient's home.
6. For most interventions, EMS team leaders made a diagnosis based on a group of ICD-10 codes regarding symptoms and disease features.
7. Alcohol consumption was the main reason for the arrival of EMS teams in a significant number of calls.
8. In the vast majority of calls, EMS team leaders decided to transport the patient to the hospital.

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CONFLICT OF INTEREST

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ORIGINAL ARTICLE

EVALUATION OF SELECTED ITEMS OF EMERGENCY MEDICAL SYSTEM IN POLAND BY PRACTITIONERS

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Abstract

Introduction: The State Emergency Medical System (PRM) exists to provide assistance to every person in state of sudden threat to their health or life, operates 24 hours a day, 7 days a week, all year round. The units of the system are hospital emergency departments (SOR) and emergency medical teams, including aviation emergency medical teams. The obvious purpose of the PRM System, which is to save life of human, as any complex activity, is sometimes put to the proof. Appearing and publicised by media cases of late medical attention, calls ignored by a dispatcher or sending emergency medical teams from hospital to hospital seriously undermine the reputation of healthcare service in Poland.
The aim: Evaluation of organization of the PRM System in Poland by practitioners – medical staff of Hospital Emergency Departments, ambulance personnel and medical students.
Material and methods: The material included a group of 138 interviewees from 768 participants of the 11th Emergency Medicine Conference Kopernik 2018. The research tool was the author's survey consisting of 12 thematic questions, including one open question, and the part collecting sociodemographic data. The collected empirical material was given descriptive and statistical analysis using Microsoft Excel. The results were presented by calculating the arithmetic mean, median, dominant, standard deviation, coefficient of variation and% of responses respectively.
Results: In the majority of respondents' opinion the organization of the PRM system in Poland is average. The vast majority of respondents (64%) consider the two-people "P" teams to be insufficient. Problems the most often reported by the respondents were lack/or insufficient number of trainings, underfunding of the system, large salaries disparities, shortages of staff, hampered cooperation with other services.
Conclusions: The analysis of selected items of the organization of the State Emergency Medical Service in Poland in opinion of practitioners points out the need to implement organizational changes which could improve the system.

Key words

Emergency Medical System (EMS), Emergency Department (ED), Trauma Centre, organization, healthcare system

INTRODUCTION

The World Health Organization (WHO) defines the Emergency Medical Service system (EMS) as such a deployment of personnel, devices and equipment which ensures effective and coordinated operation of the system in the area of prevention and risk management that can be consequence of sudden events, catastrophes or natural disasters [1]. In accordance with provisions of the State Emergency Medical Services Act of September 8, 2006. system exists to provide assistance to every person in a state of sudden threat to their health or life, operates 24 hours a day, 7 days a week, all year round [6]. The units of the system are hospital emergency departments (SOR) and emergency medical squads (ZRM), including aviation emergency medical squads (LZRM) under contract with the National Health Fund [2−5].

The PRM system cooperates with trauma centers and hospital departments specializing in the treatment of emergency health and life-threatening cases, such as multi-organ injuries, heart attacks or strokes. Apart from hospitals, help is provided by emergency medical squads, sent to patients by medical dispatchers after receiving a call on emergency numbers 112 or 999 [7, 8].

The PRM system also cooperates with other rescue services, such as Police, Fire Brigade, Mountain, Tatra and Water Volunteer Ambulance Service. Each voivode is required to have a plan which describes in detail the way of providing rescue services in a given voivodship. The plans must contain information on: 1. possible threats, 2. the number and distribution of emergency medical squads, hospitals and medical dispatch centers, 3. the way of cooperating in this respect with other voivodships [5, 9].

The entire PRM system is under the direct supervision of the Ministry of Health.

As part of the supervisory function, the minister approves voivodship plans of system operation and is authorized to carry out inspections of individual units

of the system. Voivodship plans of system operation are published in the Public Information Bulletin and on the website of the voivodship office.

The need for an efficiently and effectively functioning system which is responsible for providing fast help to people in a state of sudden threat to their health, is confirmed by the fact that in Poland in 2018 emergency medical squads provided health services at the scene of incident to almost 3.2 million people. In emergency rooms or hospital emergency departments, over 4.6 million people benefited from emergency medical assistance on an outpatient basis. In hospital emergency departments, 1.3 million people were treated during one day, and 66 thousand people in stationary mode [10]. In Poland mortality after injuries amounts to 75/100 thousand per year – by half more than in the USA and Western Europe [11].

The PRM system, as any complex activity, is sometimes put to the proof. Appearing and publicised by media cases of late medical attention, calls ignored by dispatchers or sending emergency medical teams from hospital to hospital seriously undermine the reputation of healthcare service in Poland. If you add to this the diagnosed problems in functioning of hospital emergency departments, shortage of qualified medical staff, the lack of pay rise and low salaries of paramedics, the lack of doctors in type S ambulances or restrictions on the 24-hour availability of specialist examinations, the picture of the whole is not presented in the best light [12].

THE AIM

The aim of the study was to assess the organization of the PRM system in Poland by practitioners – medical staff of Hospital Emergency Departments, ambulance personnel and medical students. The most important results and conclusions are presented in this article.

MATERIAL AND METHODS

The survey was carried out in the fourth quarter of 2018 among the participants of the 11th Emergency Medicine Conference "Kopernik 2018" in Łódź. 138 people took part in the survey. Most respondents in the group were working people with an average job seniority of 15 years. In relation to their profession, 104 participants declared to perform a medical profession and 8 participants were medical students.

The research tool was the author's survey questionnaire consisting of 12 thematic questions, including one open question and a part collecting sociodemographic data. A five-grade rating scale was used from 5 – very good to 1 – very bad, in questions about the facts – yes/no/no opinion and the percentage determination of the degree of substitution of the third member of the ZRM crew by a chest compression device.

The collected empirical material was given descriptive and statistical analysis using Statistica 13.0 (prod. StatSoft, Poland). The results were presented by calculating the arithmetic mean, median, dominant, standard deviation, coefficient of variation and % of responses respectively. Figures 1-3 show data of respondents.

RESULTS

All answers received in the survey were analyzed. No answer was excluded from the survey.

The evaluation of individual thematic areas is for the predominant part only satisfactory (below "4"), it concerns:

- evaluation of the organization of the State Emergency Medical System (3),
- evaluation of the organization of the PRM system in a given voivodship from which the respondents came (3),
- evaluation of the cooperation of Medical Rescue Squads with the city guard (3),
- evaluation of cooperation between Medical Rescue Squads and SOR/Emergency Room (3 – median, 4 – dominant),
- evaluation of the exchange of medical equipment between Emergency Medical Squads and health care units (3),
- evaluation of security and transfer of patient records between Emergency Medical Squads and health care units (3 – median, 4 – dominant).

The grade"4" was only for:

- evaluation of cooperation between Medical Rescue Squads and the police,
- evaluation of cooperation between Medical Rescue Squads and the fire brigade.

The vast majority of respondents (64%) consider the two-people "P" Teams to be insufficient, with nearly 40% lack of the chest compression device in the ambulance equipment and over 60% assessment of substitution the third crew member by it (very large differentiation in the coefficient of variation). This is also reflected in the comments and change proposals submitted by participants of the study, which will be referred to later in this article.

Moderate differentiation in the coefficient of variation was recorded only for the evaluation of cooperation with the fire brigade (18.52%), the other examined areas indicate similarly large differentiation in the coefficient of variation (between 20 and 30%), which means a significant diversity of the examined

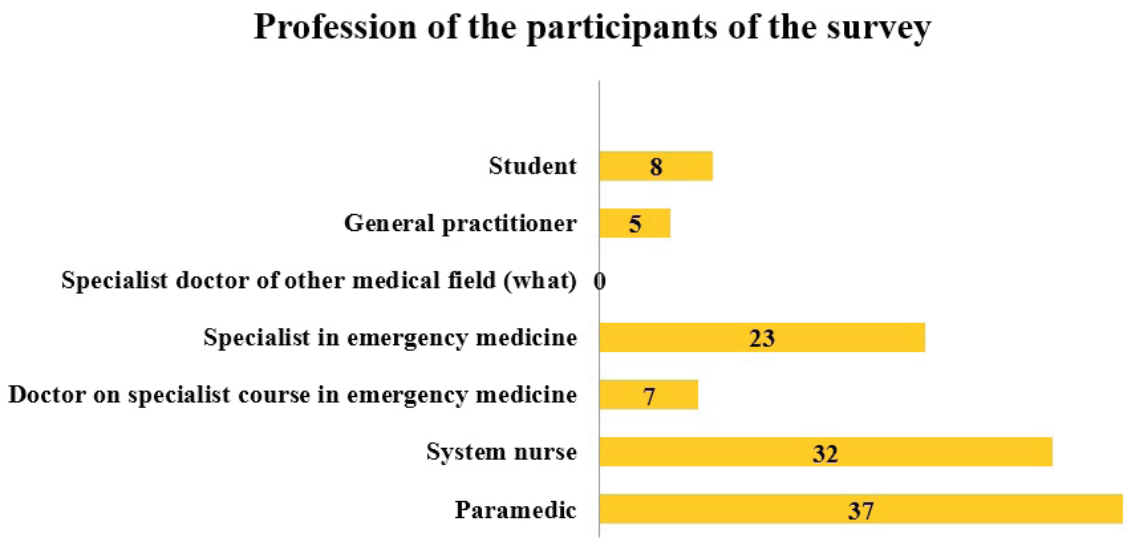

Fig. 1. Structure of the studied group. Own study.

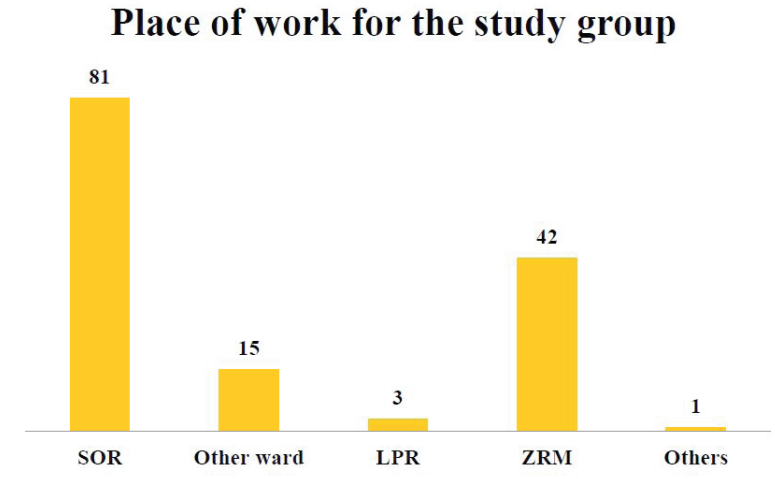

Fig. 2. Place of work for the study group.

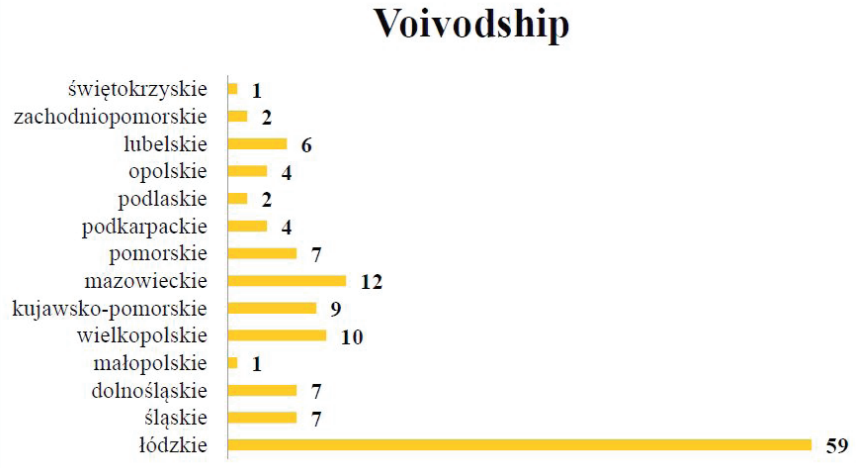

Fig. 3. Distribution of the study group in terms of place of residence.

Table 1. Detailed results of the survey on the System and ZRM.

Survey Question	average	median	dominant	standard deviation	coefficient of variation
a. How do you assess the organization of the State Emergency Medical System (PRM) in Poland?	3.06	3	3	0.89	28.97%
b. How do you assess the PRM organization in your voivodship?	3.06	3	3	0.90	29.34%
c. Do you accept the two-people "P" teams system as sufficient?					
YES – 37 (28,9%)		**NO – 82 (64,0%)**		NO OPINION – 9 (7%)	
d. Does your workplace equipment contain a chest compression device?					
YES – 81 (60,4%)			**NO – 53 (39,5%)**		
e. To what extent do you think the chest compression device replaces the third member of the Medical Rescue Squad?	62.3%	60	50	27.31	43.82%
f. How do you assess the cooperation of Medical Rescue Squads with the police?	3.5	4	4	0.81	22.99%
g. How do you assess the cooperation of Medical Rescue Squads with the fire service?	3.9	4	4	0.73	18.52%
h. How do you assess the cooperation of Medical Rescue Squads with the city guard?	2.9	3	3	1.06	35.75%
i. How do you assess the cooperation of Medical Rescue Squads with SOR/ Emergency Room?	3.3	3	4	0.97	29.47%
j. How do you assess the exchange of equipment between Emergency Medical Squads and health care units?	3.1	3	3	0.97	30.43%
k. How do you assess the protection and transfer of patient documentation between Emergency Medical Squads and health care units?	3.3	3	4	0.98	29.72%

group in terms of the areas studied. Detailed results are shown in Table 1.

In the present survey, the authors used an open question regarding comments and proposals for changes in the organization of PRM system. Answers from respondents were divided into four areas. The obtained data is described below:

1. Human resources:
   - staff shortages, lack of specialized medical staff,
   - organizing of 3-people P teams and 4-people S teams,
   - low salaries, large payment disparities: doctor – nurse – paramedic,
   - the need to increase free specialist training for staff, including those related to work with the patient (empathy/communication), coping with difficult situations (stress/aggression), also based on modern training methods, such as e-learning on the basis of Evidence Based Medicine EBM,
   - discrimination against system nurses,
   - raising the prestige of the paramedic profession, forming a paramedic self-government.
2. Infrastructure and medical equipment:
   - increase in the number of ambulances in the system,
   - improvement of tablet software (Command Support System for the State Emergency Medical System SWD PRM) – currently the equipment hinders and extends the work by the time of submitting documentation in the SRD, it can be easily damaged and the software crashes, liquidation or replacement for new equipment,
   - providing a chest compression device, breathalyzer and CO2 Lifepack module to all teams,
   - equipping and periodic replacement of equipment in the emergency medical system units (orthopedic boards, orthopedic collars, etc.) and joint tenders (unification of used equipment and medicines) or so-called "adapters" between incompatible equipment, such as Quick Combo defibrillators and electrodes,
   - the need to follow the rules of asepsis.
3. Documentation:
   - modification of the pattern of the Medical Rescue Operation Card (KMCR), including complement to information about the place

and reason for calling ZRM, from where the patient is being carried,
- integration of the SWD PRM system with SOR and IP, ensuring data teletransmission,
- less paper documentation (currently is very often filled in cursorily, containing curt expressions, without a full description of the certain event and the patient's condition).

4. Organization of work:
   - implemented changes in emergency medical service are unprepared, lack of proper organization of work, insufficient funding,
   - the need to develop and implement standards of proceedings all over the country, including unification of TRIAGE, shortening the time of patient transfer in SOR, legitimizing the work of medical dispatchers – a list of diseases and events to which ZRM should be sent/ cooperation with POZ/NPL/SOR (currently, emergency medical service in the vast majority replaces primary health care – numerous redirections ZRM to completely unjustified cases),
   - searching the nearest ZRM should be done on the basis of the map / the approach road of the given team, and not in a straight line – as it is at present, the dispatcher sends ZRM without checking that on the way there is a water reservoir or other natural obstacle,
   - - improving the organization and coordination of the system by dispatchers, currently directing many teams to the same place at the same time, indicating the nearest SOR without taking into account the needs of a given patient – completed treatments/complications/free place in the required ward – according to the type of illness or injury of the patient/availability of specialist diagnostics, e.g. CT or MR, which often causes the need to transport the patient again to the center providing this type of service,
   - decentralization of medical dispatch centers,
   - improving relations and cooperation with other services,
   - transportation of alcohol-intoxicated people to sobering stations by police service, even from SOR,
   - introduction of the rendezvous system.

DISCUSSION

The duty of public administration in Poland is to have system solutions adequate to each type of threat. This proceeds from the state's obligation to guarantee citizens medical service, including emergency medical service [13]. The necessity, or even the obligation to create system solutions adequate to each type of threat, raises no doubt.

The health care system in Poland has undergone lots of reforms and is practically still in the phase of numerous organizational and system transformations also in the field of emergency medical service. The Act on Emergency Medical Service of 2006 [6] introduced key changes. The Act indicates the creation of the unified emergency medical system, showing the same standards, both personal and equipment. In accordance with the provisions of the Act, teams are divided into: 1. "S" team – a specialist team consisting of at least three people eligible to perform medical emergency operations, ie: a system doctor and a system nurse or a paramedic; 2. "P" team – a basic team consisting of two people qualified to perform medical rescue operations [14]. For economic reasons, one of the two rescuers is also a driver [14−16]. According to the opinions obtained from respondents, such way of organizing individual teams is considered inappropriate and certainly insufficient, especially in the situation of a large number of cases and the lack of a chest compression device in the ambulance. The results confirm the conclusions of other authors, according to which in the current system of division of teams, the qualifications of system physicians are not optimally used [17].

The qualitative analysis of the obtained results showed that the largest objections regarding the organization of the system result from an insufficient system of training paramedics. The problem is especially important because the competences of the rescuers transfer directly to patient safety. A recurring problem was also insufficient financing of the system. Only security of proper resources can guarantee technological modernization as well as ensure an appropriate level of salaries for employees. The results obtained in that study fully confirm the conclusions of the study carried out by Cichońska et al. among paramedics working in the PRM system in Poland [18]. Issues of underfinancing of the system were also indicated in the audit recommendations of NIK [19], which showed that at the current level of financing the majority of administrators of rescue units generate losses. In addition, in the respondents' opinion, the problem of financing trauma centers could be also noticed – it seems reasonable to separate payments for alert to provide health benefits from payments for emergency medicine procedures [20].

Participants of the study also paid attention to a numerous elements related to noticeable problems in

terms of human resources, such as insufficient number of professional staff, low salaries and large pay disparities between doctors, nurses and paramedics, as well as underestimation of the role of a nurse or a paramedic in the system. All these elements have great importance for the level of satisfaction and staff motivation to work, so when planning next changes in the future, we should view these areas with special care and involvement, and plan and implement appropriate tools and improving actions. This is especially important because PRM system employees are the professional group which is exposed to frequent stressful situations. Research of Rasmus et al. show that patient aggression, dangerous working conditions and helplessness experienced during rescue operations may contribute to increased irritability, tendency to depression and anxiety disorders and have an impact on low interest in work and daily duties and passions [21]. Only proper organization of the system and employment of a psychologist in the workplace can limit the negative casus of professional burnout.

With regard to infrastructure and medical equipment in vehicles, respondents paid special attention to the poor condition and malfunctioning of tablets being a part of the SWD PRM system, as well as to the need to standardize used equipment or medicines to ensure consistency and continuity of performed rescue operations.

In conclusion, the PRM system still requires the aim to take many organizational actions to ensure its full effectiveness, which requires a deeper look at the activities within the system and is also associated with the need to create a multiannual emergency medical operation plan which will be consistently implemented [22]. Only the adequate organization of the whole system will affect the saving of life at the scene of the accident, the proper evacuation and transportation as well as effective further treatment of the injured in specialist centers corresponding to individual health indications.

CONCLUSIONS

The analysis of selected elements of the organization of the State Emergency Medical Service in Poland from the point of view of practitioners indicates the need for organizational changes which could improve the system. It is also the most effective method of developing the best system solutions and a chance to observe functioning good organizational practices to be used in building global security of the country.

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CONFLICT OF INTEREST

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SIMPLE EMERGENCY TRIAGE (SET) – THE NEW PERSPECTIVE ON MASS CASUALTY INCIDENT TRIAGE

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Abstract

The aim: Incidents with large number of casualties present a major challenge for the emergency services. Incident witnesses are always the first on scene. Authors aim at giving them an algorithm arranging the widely known first aid rules in such way, that the number of potential fatalities before the services' arrival may be decreased.
Material and methods: The authors' main aim was creating an algorithm for mass casualty incident action, comprising elements not exceeding first aid skill level. Proceedings have been systematized, which led to creation of mass casualty incident algorithm. The analysis was based on the subject matter literature, legal acts and regulations, statistical data and author's personal experience.
Results: The analysis and synthesis of data from various sources allowed for the creation of Simple Emergency Triage (SET) algorithm. It has been proven – on theoretical level – that introducing an organized way of proceeding in mass casualty incident on the first aid level is justified.
Conclusions: The SET algorithm presented in the article is of an implemental character. It may be a supplement to basic first aid skills. Algorithm may also be the starting point for further empirical research aimed at verifying its effectiveness.

Key words

triage,
mass casualty incidents,
first aid,
medical education,
cardiopulmonary resuscitation

INTRODUCTION

Action schemes used by the emergency services during a mass casualty incident significantly differ from procedures used in situations where all the necessary forces and resources are available at once. This concerns in particular the early phase of action, during which the medical segregation takes place. Giving therapeutic and transport priorities is based on one of many available triage algorithms. Legally accepted median of emergency medical team arrival on scene in Poland is 8 minutes within the city with over 10000 inhabitants and 15 minutes elsewhere [1]. In case of mechanism inflicting potentially lethal injuries, many victims will have no chance of survival after such time. This can be changed only by rapid reaction of witnesses present on scene before rescuers and emergency medical teams arrive. Current legal state in Poland does not impose the use of any particular triage system on all emergency services. The situation is most explicit among the National Firefighting Rescue System units. These are bound by the document regulating the rules of organizing emergency medical rescue within the NFRS („Zasady organizacji ratownictwa medycznego w KSRG") acknowledged by the national chief fire officer in July 2013. This document defines the initial and secondary segregation, and imposes the use of START / Jump-START system for the initial segregation [2]. One should take no more than 30 seconds to assess a casualty, during this time it is advised to give priority, place in a position securing airway patency and control massive external bleeding [2]. START / Jump-START is also the algorithm most widely known among the emergency medical teams of the state emergency medical system. These however are not obliged by any regulation to use this particular algorithm. START / Jump-START system was created in the 1983 in Hoag Hospital System and Newport Beach (CA) Fire Department [3]. One of its arguable presuppositions was it being useful for the individuals with no medical background (despite the proper assessment of radial pulse necessary for completing the procedure).

In 2015 the guidelines concerning mass casualty incident procedures were published by the national consultant in emergency medicine („Zalecenia konsultanta krajowego w dziedzinie medycyny ratunkowej dotyczące procedur postępowania na wypadek wystąpienia zdarzenia mnogiego/masowego"). This document does not impose any particular triage sys-

tem on the members of emergency medical teams. It does however repeatedly refer to giving casualties one of four priorities, compliant with START / Jump-START algorithm [4]. The widely accepted use of this system makes it easier to cooperate between EMS and NFRS units, both while training and during actual rescue action.

American experience led to the publication of Model Uniform Core Criteria for Mass Casualty Incident Triage (MUCC) guidelines in December 2017. These are the criteria which have to be met by any medical segregation system to be used during a mass casualty incident. Among the 24 criteria, there are requirements for the triage system to be: effective regardless of patient's age and the mechanism of injury, easy to memorize, adaptable to variable conditions and leading to assigning casualty to one of 5 priority categories [5].

These criteria are met by the SALT system. It is by far more versatile than START / Jump-START system. On the other hand it leaves much space for the individual decision about the patient's chance of survival made by the rescuer. Such decision is frequently to be made rapidly and in adverse conditions. This makes medical background and experience seem necessary, which in Polish system makes SALT of no use for rescuers of the qualified first aid level. The main difficulty results from the introduction of the fifth category (not present in START system) – the expectant casualty, marked by the gray color band. This is a category for the individuals with vital functions present, but still assessed by the rescuer as impossible to save within given conditions at current level of rescue action.

During the qualified first aid course it takes 24 hours to teach skills useful during the mass casualty incident (2h – shock, 2h – proceeding with an unconscious person, 11h – mechanical trauma, 3h – thermal trauma, 6h – mass casualty incident action tactics) [6]. By the rule, first aid training does not cover the subject of incidents with large number of victims.

THE AIM

The aim of the research is to create a simple triage tool based on basic life support and first aid rules in order to increase casualty survival rate within the initial minutes following the incident.

MATERIAL AND METHODS

During research, current first aid proceedings have been systematized, which led to creation of mass casualty incident algorithm. The analysis was based on the subject matter literature, legal acts and regulations, statistical data and author's personal experience. The idea is inspired by the concept of employing witnesses, by the algorithm proposed by the British charity organization CitizenAID [7] and by European Resuscitation Council guidelines.

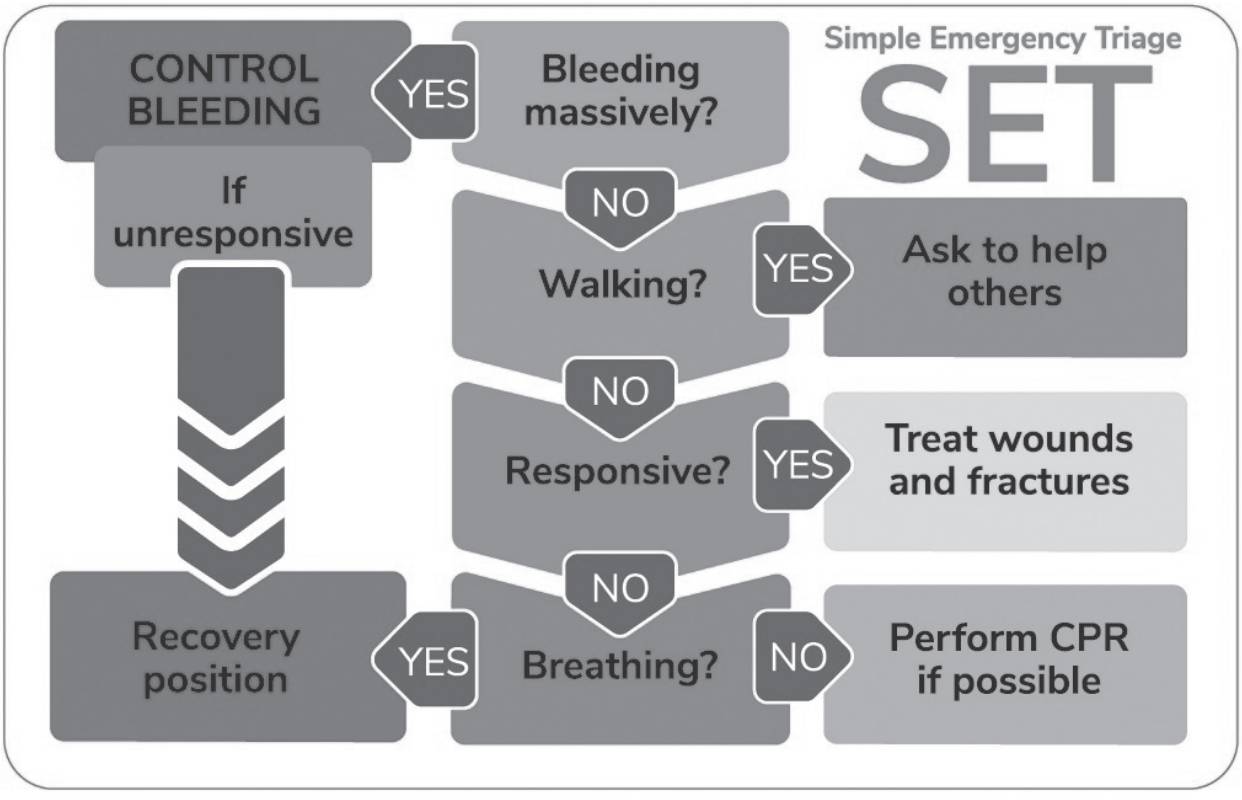

Fig. 1. Simple Emergency Triage (SET) algorithm.

RESULTS

Regardless of triage system used by the emergency services, many simple procedures making further segregation easier and increasing survival chance may be implemented by the witnesses. In order to fully use their potential, authors have created the Simple Emergency Triage (SET) algorithm (Fig. 1). Elements of the SET system do not exceed first aid skills, which is a significant advantage compared to the abovementioned systems. The SET algorithm may turn out priceless for people with no medical background, who will find themselves on the scene of an incident with many casualties. No specialist equipment is needed, and implementing the algorithm does not influence further proceedings of the emergency services. On the first aid level the algorithm is to be treated as a systematized way of stopping the process of dying. There is no need to physically mark the casualties with the use of color-coded bands.

DISCUSSION

Before initiating the use of Simple Emergency Triage algorithm is necessary to check for safety. It is of crucial importance in case of mass casualty incident resulting from terrorist attack, the presence of firearms, hazardous substance or other environmental danger.

SET system elements are the following:

- Bleeding control – massive blood loss is among most frequent causes of traumatic death. In the US hemorrhage is the leading death cause of Americans from one to 46 years of age [8]. Tourniquets may prevent exsanguination in the civilian setting for patients suffering either blunt or penetrating trauma to the extremity [9]. After the Boston Marathon bombing on April 15th, 2013 hospitals admitted 29 victims with amputations or severe extremity injuries. 27 of those had had the tourniquets applied (none of which was a factory tourniquet, all were improvised solutions). All 27 victims survived the incident, and only every third tourniquet is known to have been applied by the medical personnel or emergency services [10]. SET algorithm recommends controlling bleeding in any effective manner. In case of broad injuries or the lack of possibility to localize the wound clearly it is advised to place the tourniquet proximally. In any case seizure of bleeding confirms proper application. MUCC guidelines define critical interventions as the ones executable in under one minute and not requiring staying by the victim [5]. On the level of implementing the SET algorithm it is justified to use the assistance of anyone available in applying direct pressure until an improvised tourniquet is placed or the emergency services arrive.
- Recovery position – unconscious victims (after controlling bleeding if necessary) need to be placed in a position securing airway patency. People trained in first aid should understand this by using the traditional recovery position. Potential spinal injury may make it justified to consider the H.A.I.N.E.S. (High Arm IN Endangered Spine) position. The technique of rolling the victim's head over the arm stretched upwards, which limits the uncontrolled movement of the cervical spine. According to the European Resuscitation Council guidelines, the advantages of using the H.A.I.N.E.S. position are not significant enough to recommend its use [11], while the American Heart Association guidelines do not consider restraining cervical spine motion an element necessary for first aid training [9]. In case of sufficient number of rescuers or lack of possibility to use lateral position it is advised to manually support airway patency, without moving the casualty.
- Cardiopulmonary resuscitation – while assessing breathing it is crucial to focus mainly on chest movement, as it is the most clear indication especially within the chaos of mass casualty incident. It is advised to perform cardiopulmonary resuscitation (CPR). Incident witnesses are not a part of forces and resources at direct and formal disposal of emergency services. They may therefore perform CPR even for patients classified as expectant by the services, as long as it is safe. If emergency services quickly turn out to be sufficient, there is a chance of resuscitation effort being taken over.
- Treating other wounds and injuries – if there is sufficient number of witnesses, they can treat potential causes of death other than bleeding or airway patency pathology. It is worth mentioning that current ERC guidelines recommend leaving the open chest pneumothorax without sealing dressing [11]. In case of mass casualty incident this allows for saving time and assisting further victims, while minimizing the risk of tension pneumothorax onset (which may lead to patient's condition deterioration after applying chest seal) [12].

The SET algorithm proposed may increase the survival rate of mass casualty victims. This may also make it easier for emergency services to perform professional medical segregation, as they will find some casualties already treated in terms of critical

interventions. The SET algorithm is also a simple, coherent and clear answer for frequent question – "How should first aid be administered when there are more than one accident victim?"

CONCLUSIONS

The character of modern era mass casualty incidents taking place in densely populated city centers brings many people on scene, who are capable of administering aid in an organized manner. First aid requires the introduction of a simple tool assisting making decisions based on priorities and systematizing helping large number of victims. Simple Emergency Triage (SET) is a concept of such algorithm. In authors' opinion SET algorithm should be integral part of elementary first aid course. Field for further consideration and research is the use of this system on the qualified first aid level.

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PRIMARY CARE WORK ORGANIZATION DURING CORONAVIRUS DISEASE PANDEMIC FROM FAMILY DOCTOR PERSPECTIVE

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Abstract

COVID-19, the disease caused by coronavirus SARS CoV-2, is the newest and the best known disease, which changed our reality in just a few weeks. It caused many changes in healthsystem. The purpose of the work was to collect and systematize the changes in primary healthcare facilities before the peak of the COVID-19 disease in Poland from the perspective of the doctor running one of these facilities.

Key words

Primary Care, COVID-19, coronavirus, SARS CoV-2, organization

INTRODUCTION

Action schemes used by the emergency services durAt the end of 2019, when China informed the World Health Organisation (WHO) about new cases of pneumonia with unidentifiable cause in Wuhan, ambulatory work in primary care on polish grounds was conducted in accordance with norms, focusing mainly on civilisation diseases problems and their prophylactics. Even at the beginning of current year, while the new coronavirus was isolated on 07/01/2020 and the new cases of the disease were skyrocketing in China, neither the staff, nor the patients of basic healthcare in Poland assumed that it was the end of the era, in which healthcare was open to everybody, easily accessible and trustworthy. Even in February 2020, although the COVID-19 cases were rising, nothing was happening in our ambulatories.

Data from Chancellery of the Prime Minister (KPRM) testify about this process dynamics:

- First note about coronavirus on webpages of KPRM appeared on 24/02/2020
- 04/03/2020 first confirmed coronavirus case in Zielona Gora
- 13/03/2020 Government decided to induce state of epidemic danger
- 20/03/2020 State of Epidemic induced in Poland.

The tremendous velocity of changes in health care organisation is confirmed by enormous quantity of legal documents, that appeared in the last few weeks, such as the legislation from 2/03/2020 about particular measurements undertaken towards preventing, counteracting and fighting COVID-19, other infectious diseases and crisis triggered by them and new decrees created by minister of health on 7th of march: about the list of diseases causing the need of obligatory hospitalisation. Especially now, during the SARS CoV-2 pandemic and while the access to specialist treatment is greatly limited, the planned procedures are suspended, rehabilitation is not working, the ambulatory, primary health care that is responsible for consistency and keeping millions of Polish people feeling safe, has undergone a massive reorganisation.

In the last three weeks, fundamental changes to functioning of our practices have taken place, directed mainly at prevention and limiting the risk of contagion.

Abbreviation

COVID-19 – a disease caused by coronavirus SARS CoV-2
KPRM – Chancellery of the Prime Minister
NFZ – National health Fund
POZ – primary care
PPE – personal protective equipment
WHO – World Health Organisation

REVIEW AND CONCLUSIONS

CHANGE OF PATIENTS ADMISSION

To limit direct contacts, the doors to the ambulatories had been „locked" – patient can only enter ambulatory after previous phone agreement and only in essential situation e.g. after the physician had appointed the visit. Telephone line is being operated by registration workers, who represent the first contact for the patient. Worker, after patient verification, conducting initial qualification survey in the direction of coronavirus contagion and recognition of the problem proceeds according to the scheme:

- Provides information,
- Can accept the need for chronically used medication,
- May schedule a phonecall between patient and physician.

Thanks to the possibility of conducting interview with a patient via teleinformatic systems the physician, after verification of the identity of the patient or his representative, can give advice, write E-prescriptions, orders for medical crafted articles or schedule a visit in the ambulatory. Patients admitted in ambulatory are scheduled for a particular time and grouped in regard to their admission cause. Patients admitted due to infection, so called „infectious" are examined in a separate room, which is located near the entrance to the ambulatory. It is recommended that there is as little furniture in that room as possible. The advised examination time should be slim, while wearing protective equipment. The history is collected earlier, via phone call and the prescription is sent via internet. The medical documentation is created without the patients presence. The changes also affect the realisation of house visits, executed by physicians, nurses, obstetricians.

For the time of the epidemics vaccinations and balance sheets have been suspended. We also aborted functioning of laboratory collect stand, which was in our procedure room on scheduled days and hours.

CHANGE OF ADMISSION PLACE

In the ambulatories all of redundant stuff, like kids ground or leaflets, was removed. Only the essential tools were left on the desks. Aiming to reduce risk of contact with the virus in many ambulatories physical barriers like glass or plastic windows were created, as well as more disinfectant dispensers appeared. Special „isolation" places were created for patients who would be awaiting transport.

Special training for staff in:

- basic information concerning COVID-19,
- washing and disinfecting techniques, of hands, stethoscopes, keyboards, computers, flat surfaces and other articles,
- appropriate clothing – it is forbidden to wear watches or jewelry,
- correct using of personal protective equipment (PPE),
- realisation of deals with National health Fund,
- schemes to follow with patients incoming due to contagion concerns and other groups of patients,
- organisational issues.

Assurance of resources vital to realisation of foregoing changes:

- computers, laptops, programmes and additional phones had been bought,
- thermometers,
- physical barriers.

Disinfecting agents, additional dispensers, disposable cloths, mop endings:

- individual safety equipment PPE (gloves, filtrating masks, surgical masks, googles, visors, long-sleeved coats, jumpsuits) together with optimalising access to individual protection gear.

CHANGE OF PATIENTS' NEEDS

Right now the main problems for our patients are lack of access to medical procedures, shock, fear, loss of jobs and depression.

OVERCOMING BARRIERS

From which the most important and the hardest is awareness of new legal legislations and adjusting our ambulatories to them. In the current moment, correct communication based on undisputed and simple guidelines is the key to success. It concerns mainly the Staff, as well as communication with institutions with which we have to cooperate eg. Sanitary-Epidemiologic Station, voivode, health minister. Rising prices and limited access to vital resources is the biggest problem we have to deal with now. We are also observing the feeling of threat among Staff and the consequences of this stress.

At the time of writing this article (30/03/2020) the number of confirmed COVID-19 cases globally was 679,096 and there were 31,777 deaths. In Poland 1,984 COVID-19 cases were confirmed and 26 deaths had happened.

Currently, in Poland, we are just at the beginning of epidemic. We are doing whatever we can to prepare ourselves to tackle COVID-19, we are aware of the necessity to continue treatment for all patients, but are we prepared to fight longsighted consequences that the epidemic brings? What changes

introduced in epidemics period will work in time right after it finishes? Will the current epidemics influence the placement of primary care in post-epidemical healthcare system in Poland? There are more questions like that. As for now we are trying to exchange information with other countries, which are also dealing with this problem. The article of Li DKT. Entitled „Challenges and responsibilities of family doctors in the new global coronavirus outbreak" is an example of that.

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DOI: 10.36740/EmeMS202002109 **REVIEW ARTICLE**

PATHOPHYSIOLOGY AND CLINICAL SYMPTOMS OF ACUTE RADIATION SYNDROME

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Abstract

Introduction: The use of radiation sources in various areas of life generates the risk of accidents and radiation disasters. The increase in terrorist threats as well as the risk of an outbreak of new armed conflicts carries the risk of using radioactive materials by terrorist groups and the military. Exposure to high doses of radiation and absorbing above-threshold doses by victims may cause acute radiation syndrome (ARS), as well as some distant effects. Personnel of the State Emergency Medical System (EMS) will be the first professional medical team in the process of providing assistance to such victims. The effects of further medical treatment in the hospital will depend on EMS's first response, radiological triage and initial interventions taken.

The aim: To present pathophysiology and clinical symptoms of acute radiation syndrome in the context of the medical practice of the EMS.

Material and methods: For the purpose of this publication, an analysis of literature on the subject of the mechanism of ionizing radiation and its effects on the human body was performed. The work is focused on the interpretation of research results and their presentation from the EMS's perspective.

Results: The publication presents the impact of ionizing radiation on the body, the mechanism of damage to cellular structures and its consequences for individual organs and systems. ARS's clinical (hematopoietic, intestinal, cerebrovascular) syndromes were discussed in detail, paying attention to radiation doses, the sensitivity of individual systems and organs, the dynamics of individual phases, as well as the ability to recognize and assess the severity of their progression by EMS personnel.

Conclusions: The knowledge of pathophysiology, and ARS's symptoms and dynamics is important to respond correctly to radiation incidents. This knowledge allows for efficient organization and emergency management during rescue operations. The increase in the risk of radiation incidents and radiation disasters generates the need for appropriate preparation of emergency rescuers, in particular, of the medical personnel of the State Emergency Medical Services.

Key words

ionizing radiation, deterministic effects, acute radiation syndrome

INTRODUCTION

Radiation is the form of energy in the event of which different physical phenomena occur. Ionising radiation is one of many kinds of radiation. The ionisation is created when the radiation is absorbed by matter. There are 5 basic forms of ionising radiation: alpha radiation, beta radiation, gamma radiation, X-radiation and neutron radiation [1]. Each of the radiation type manifests its individual characteristics and properties. Tissue exposure to the same dose of different radiation measured in Gy units (grey) has dramatically different biological effects. Thus, it was necessary to introduce a term of an equivalent dose which is measured in Sv (sievert). $Sv = W_R \times Gy$ where W_R represents the quality factor of a radiation type which is characteristic for each radiation type. The factor W_R equals more than 1 for gamma radiation and up to 20 for alpha radiation [2]. The authors use Sv and Gy units interchangeably assuming that the biological effect of the described doses is equipotent.

Ionising radiation is present in the environment and its source is cosmic radiation and radioisotopes produced in the Earth's crust (background radiation). The natural ionising radiation (background radiation, cosmic radiation) averages to 2.4 mSv per annum [3]. Humans give off radiation as well due to radioactive potassium present in the body. Taking advantage of radiation brings the risk of accidents and catastro-

phes. Over the years several incidents causing severe impact on health occurred. The Chernobyl disaster in Ukraine in 1986, a radiation incident in Mexico City in 1962 , the Goiânii incident in Brazil in 1987 and the Fukushima Daiichi nuclear disaster started by the tsunami in Japan in 2011 [4−6]. Radioactive materials are also used for the military and terrorist purposes. The polonium-210 was used to poison Alexander Litvinenko - a Russian dissident and a former officer of the Russian Federal Security Service (FSB) and KGB [7]. Radioisotopes and various devices emitting radiation such as X-ray devices, CT scanners commonly used for medical purposes may pose some risks of exposing patients to high doses of radiation. For instance, in Białystok five women undergoing radiotherapy to treat breast cancer were given higher doses than intended as the device was not functioning properly [8].

THE AIM

The authors show the pathophysiology and clinical signs and symptoms of the Acute Radiation Syndrome (ARS) in order to discuss and draw attention to the difficulty of providing medical help to patients.

REVIEW

PATHOPHYSIOLOGY OF ARS

Clinical symptoms are divided into early and late deterministic effects (dose related) and stochastic ones (not dose related). Non-stochastic effects are either local esp. Cutaneous Radiation Syndrome (CRS) or systemic esp. Acute Radiation Syndrome (ARS). The authors aim to discuss ARS.

Acute Radiation Syndrome is caused by irradiation of the whole body or a significant portion of it with a penetrating dose greater than 1Gy [9, 10]. ARS is characterised by signs and symptoms that are manifestations of tissue damages to the organs and organ systems. The mechanism of radiation damage to the tissue varies. Not only can radiation have a damaging effect on a genetic material but also on a cytoplasmic membrane and active sites of enzymes (catalase, peroxidase). Time of ionising radiation penetrating a mammalian cell is 10-14 of a second while a DNA molecule is 10-18 . The exposure of 1 Gy causes ionisation of 105 in every cell of 10 μm in diameter. Consequently, 1-2 Gy dose of ionising radiation causes about 1000 DNA single-strand breaks and around 40 DNA double-strand breaks [10]. There is a direct and indirect effect of ionising radiation on a cell. Water radiolysis is an indirect process which results in the production of a hydrogen ion H+ and a hydroxide ion OH-, which further produce free radicals (H_2O_2, O_{2^-}). These particles cause damages to the genetic material of a cell. Radiation has an indirect effect on DNA as a result of Compton Effect /Compton Scatter and photoelectric effect. [11]. If the damage to the DNA is beyond repair with high doses of ionising radiation, it can induce the cell death or its lysis. If the damage cannot be repaired and the suppressor genes and oncogenic genes are exposed to the ionising radiation, the neoplastic transformation can be started [12]. Irradiation damages to the DNA are as follows: double-strand breaks, single-strand breaks, damages to cellular proteins, cell membrane lipids and enzymes. During the mitotic phase cells were shown to be highly sensitive to the ionising radiation in G2 phase and M phase of a cell cycle. The radiation induces mitotic delays and slows down transition from G2-->M phase and G1-->S phase [2]. It is due to p21 protein that is produced in the CDKN1A gene expression [13]. Those delays allow the cell to repair DNA damages induced in the course of radiation. The expression of GADD45 gene being a marker of various physiological and environmental stressors was observed. The expression of this gene results in the production of protein which affects p21 protein that halts the cell cycle at the checkpoints in order to repair damages incurred in the genetic material.

As mentioned above, irradiation indirectly results in the production of free radicals (H_2O_2, O_{2^-}). Free radicals affect the genetic material and their products can cause changes in DNA chain and distort its structure that may result in mutations. One of those products is 8-Oxo-2'-deoxyguanosine (8-oxo-dG) that manifests highest mutagenic potential. It is also a diagnostic tool to assess the radiation risk and a reliable oxidative marker of DNA damages. A urine test may allow to assess the risk of mutation of the genetic material after radiation exposure [14, 15].

Radiation may also change chromosomal structures. The frequency of chromosomal aberrations is one of the most reliable markers of DNA damages being a result of ionising radiation [16]. Aberrations may be divided into chromosomal and chromatid ones. The above mutations are the result of ionising radiation and are irreversible. The radiation induces translocation mutations in which segments of chromosomes get mutually rearranged and dicentric mutations in which segments of chromosomes get rearranged and result in the production of 2 chromosomes; one of 2 with two centromeres and the other lacks a centromere. Translocations are mutations passed on to children while dicentric ones are non-inherited. Thus, their significance is decreasing as the cell proliferation occurs [17]. High instability of

karyotype (changes within the structure of chromatids or chromosomes) has been observed in cell colonies that survived the X radiation exposure to 2Gy or more than that [18].

Ionising radiation may cause damages to lipids and proteins. Free radicals especially a hydroxide ion interact with fatty acids causing the peroxidation of membranes. Consequently, the membrane of lipids and proteins stops functioning and loses its integrity. Malondialdehyde (MDA) is the marker of polyunsaturated acids peroxidation in the cells, and the MDA concentration in blood platelets has showed a significant increase after the exposure to ionising radiation [19].

By exposing cellular proteins to radiation, free radicals make the protein chains break where proline occurs. Consequently, no functional protein in produced [20]. The level of a peripheral protein and messenger RNA (mRNA) of an intercellular adhesion molecule 1 (ICAM-1) exposed to ionising radiation has been tested. It was shown that the exposition of ICAM-1 on the surface has grown by 0,125 and 0,25 Gy. The findings suggest that low doses of radiation affect post-transcriptional regulation of mRNA ICAM-1 which causes exposure to ICAM-1 protein [21]. It may serve as a diagnostic tool to assess the risk of the patient exposed to low doses of radiation.

Radioresponses of tissue are dependant on types of tissue exposed to radiation. There are two models of tissue organisation: Flexible (F-type) model and Hierarchical (H-type) model. According to the law of Bergonie and Triondeau "tissues appear to be more radiosensitive if their cells are less-well differentiated, have a greater proliferative capacity, and divide more rapidly." The main characteristic of H-type model is high proliferation rate which suggests a high level of stem cells. Three compartments can be distinguished in H-type model. The first one is the stem cell compartment consisting of stem cells capable of proliferation and self-renewal to maintain their number. Stem cells of the intestinal epithelium, stem cells in the basal layer of the epidermis and bone marrow stem cells are examples of the stem cell compartment. The next type is amplification compartment, in which cells mature, replicate and differentiate. Cells of the basal layer of the epidermis and erythroblasts are examples of the second type. Another group is called post-mitotic compartment consisting of fully differentiated cells such as the cells in the surface layers of epidermis, cells at the top of villi of intestinal mucosa and mature circulating blood cells.

Flexible model (F-type model) consists of identical cells with tissue-specific function and have capacity for cell renewal. Connective tissue, nervous tissue are liver parenchyma are some examples of F-type model [22]. Table 1 presents differences between two models of tissue. For better understanding of the impact of irradiation on F-type model certain terms have been used: W_T - the tissue weighting factor for tissue or organ and the effective dose. W_T accounts for variable radiosensitivity of organs and tissues to radiation. The radiation weighting factor (W_R) is used to determine differences in biological effects depending on different radiation types exposed to a human body. The absorbed dose (Gy) is equivalent to the absorption of one Joule (J) of energy per kilogram (kg) of material [23]. W_T, W_R and the average absorbed dose allows to calculate the equivalent absorbed dose (Sv) that leads to the effective dose. The effective dose is a sum of all equivalent doses absorbed by tissues and organs from both internal and external exposure. It represents health risk to the whole body even if only particular parts of a body were exposed to irradiation [24]. The unit of measurement for effective dose is the sievert Sv.

The term critical organs was introduced due to different organ sensitivity to irradiation. The term refers to the organs most vulnerable to a given isotope or type of radiation. When external exposure to radiation in the form of gamma or X-rays occurs, the critical organs are bone marrow, gonads and lens of the eye. When alpha-radioactive isotopes are administered orally, the critical organ is intestines and the intestinal mucosa where isotopes are accumulated [20]. An absorbed isotope of iodine accumulates in thyroid which is the critical organ. Other isotopes such as polonium, strontium or radium accumulate in bones and bone marrow. Similarly, isotopes taken into the body via inhalation of radioactive fallout particles were observed to accumulate in liver, spleen and bone marrow [25].

The term of a tissue tolerance dose represents the radiation dose an organ can receive without adverse effects. The tissue tolerance dose may differ for different tissues and organs depending on a radiation type. The tissue tolerance dose refers to late effects of radioactive exposure [26]. The tolerance dose TD5/5 represents the radiation dose that would result in less than 5% risk of severe damages within 5 years after irradiation [27].

CLINICAL PICTURE OF ARS

Acute Radiation Syndrome is subdivided into 3 subsyndromes: the hematopoietic syndrome, the gastrointestinal syndrome and the neurovascular syndrome. Each subsyndrome is comprised of four clinical phases: prodromal, latent, manifest illness,

final one. The signs and symptoms of the prodromal phase appear within 1-3 days after the exposure and are characterised by vomiting, nausea, fever, headache and early skin erythema. The onset of vomiting is also related with the absorbed dose and can be observed within few minutes after a high dose exposure. The prodromal phase has been presented in Table 2. The second phase of ARS is a latent phase depending on individual patient's sensitivity and the absorbed dose and may occur from 2-20 days following the exposure [28]. It is a delusive phase characterised by improvement of symptoms. The paramount indicator of ongoing changes is the changing level of lymphocytes and granulocytes in peripheral blood. Those changes depending on the absorbed dose are presented in Table 4. The most sensitive marker of radiation exposure is the change of a lymphocyte level which is used to triage the casualties of radiation incidents. The third phase (a critical phase) occurs within 21-60 days following radiation exposure and its symptoms are characteristic for each syndrome [28]. The final phase is either recovery or death depending on the absorbed dose, the dose rate and the heterogeneity of exposure (how much and which part of the body has been exposed) and individual patient's sensitivity to radiation.

THE HEMATOPOIETIC SYNDROME

The hematopoietic syndrome results from the exposure to doses of 2-3 Gy [29]. The initial predominant symptom of doses less than 10 Gy is lymphopenia within 6-24 h [30]. An absolute lymphocyte count that remains within 50% of normal during the first week following exposure suggests an exposure of less than 1 Gy and a survival rate is above 90% [9]. It is believed that a dose of 0.95 Gy reduces the population of stem cells to 37%. For this reason, the hematopoietic syndrome may be developed with radiation exposures below 1 Gy [31]. The onset of signs and symptoms depend on the physiological cellular loss rate of cells and the dose-dependent reduced supply of cells from the depleted proliferating compartments. [34] Genotoxic and other specific toxic mechanisms, leading to aplasia, cell apoptosis or necrosis are involved in radiation hematoxicity. The clinical signs and symptoms of the hematopoietic syndrome are the result of reticulocytopenia, anemia, granulocytopenia, monocytopenia, and thrombocytopenia [32]. There is a subpopulation of stem cells that displays more resistance to irradiation than other cells and are crucial to restore morphotic elements after exposure to doses up to 6 Gy [34]. Initially, laboratory tests show a decline in the number of lymphocytes and transient increase in the number of granulocytes [34]. After their lifespan of about 7-24 h, granulocytes disappear from the blood. The higher the dose, the earlier the disappearance of granulocytes [29]. There has been observed a gradual reduction in the number of circulating leukocytes, platelets, erythrocytes over time. The onset of signs and symptoms that appear in the hematopoietic syndrome depends on the physiological cellular loss rate of circulating cells [34]. In the hematopoietic syndrome bone marrow failure leads to death. [34].

THE GASTROINTESTINAL SYNDROME

The onset of early and mild symptoms of the gastrointestinal syndrome such as nausea and vomiting occur at doses below 1,5 Gy [35]. More severe symptoms develop at doses of 5-12 Gy due to the radiation damage to stem cells leading to apoptosis within 3-6 h after the exposure [36]. Damaged cells are replaced with other stem cells provided not all stem cells are damaged, otherwise the crypt dies. The substantial loss of crypts leads to villous atrophy followed by the ulceration within 3-9 days after the exposure which is the time needed for the restoration of villi. Radiation-induced enterocyte damage leads to its reduction. It has been observed that lower doses cause nucleus and chromatin swelling while higher doses lead to changes in biochemistry of cytoplasm and impair cell membranes. It has a negative effect on intercellular junctions and enterocytes as it inhibits cell division and disturbs cell membranes. These changes cause disorders of absorption and increased intestinal secretion. Irradiation disturbs intercellular integrity and causes disorders of intestinal mucus production as a result of a reduced number of goblet cells. Consequently, impaired barrier function of the gastrointestinal tract results in the passage of bacteria through the intestinal wall into the bloodstream. The gastrointestinal signs and symptoms usually start 48 hrs after exposure but that depends on the radiation dose. The signs and symptoms include nausea, vomiting and headaches that are followed by fever over time. In the symptomatic phase there are the following symptoms: appetite disorder, the feeling of fullness of upper abdomen, salivary gland swelling, ileus (resulting from ulceration and necrosis of the bowel wall leading to stenosis), bloody stools, dehydration, electrolyte imbalance and sepsis. All the symptoms may lead to multisystem organ failure and death [37].

THE CEREBROVASCULAR SYNDROME

The cerebrovascular syndrome occurs with doses greater than 10 Gy [9]. Due to radiation exposure, radiation neurotoxins are produced. Radiation Toxins of CV ARS are defined as glycoproteins with the molecu-

lar weight of RT toxins ranges from 200-250 kDa and with high enzymatic activity. Neurotoxins cause damages to endothelial cells that leads to their increased permeability. Furthermore, the disruption of a blood-brain barrier and the disorder of cerebral circulation occur. Most likely neurotoxins act on the receptors NMDA, AMPA, 5HT1, 5HT2, 5H3 that leads to their overactivation and trigger the death cell mechanism [32]. Apart from cellular damages caused by irradiation, brain tissue is also affected. There has been noticed a decrease in the population of oligodendrocyte progenitors which leads to the reduction of mature oligodendrocytes and consequently demyelination of myelin sheath around nerves. Moreover, the process of apoptosis of oligodendrocytes has been noticed to be activated. Irradiation leads to the proliferation of astrocytes and and microglial cells [38]. Neurological deficits such as reduced deep tendon reflexes, ataxia and corneal reflexes have been observed [9,10]. These symptoms are followed by cerebral edema, impaired consciousness resulting from disturbances of cerebral blood microcirculation. The consequence of brain edema is an increase in intracranial pressure. Progressive respiratory distress along with hypotension resulting from impaired cerebral blood supply and neural conduction in brainstem leads to patient's death within 2 days after exposure [10].

DISCUSSION

As a result of the Chernobyl accident the diagnosis of ARS was initially considered for 237 persons based on symptoms and the diagnosis of ARS was confirmed in 134 persons. The persons were exposed to radiation doses of 0,8-16 Gy. There were 28 short term deaths of which 95% occurred at whole body doses in excess of 6.5 Gy. After the Fukushima accident no ARS level of radiation was observed [40, 41]. It was found that the radiation incident in Mexico City in 1962 was caused by cobalt-60 that had been found unprotected in the garbage dump and brought home. Four people died from exposure to radiation [42]. In Goiânia in 1967 a capsule with radioactive isotope of caesium-137 was stolen from the abandoned hospital. As a result, 46 persons were radiated, 4 persons died and 28 required skin graft or amputations [43].

Each and all radioactive contamination accidents and disasters are a great source of information about the influence of ionising radiation on a human body. Studies have shown that radiation sensitivity is not the same for the general population. Men are more vulnerable to radiation effects than women [44]. Children, elderly people and people with hereditary diseases are the most vulnerable. Children's higher sensitivity to radiation is due to a higher mitotic activity and dynamic increase in cell number. Owing to the fast growth, there is less time for radiation-induced DNA damages to be repaired [45]. Higher sensitivity to radiation has been observed due to the higher proliferation activity and less cellular differentiation [46]. Persons (over 60) have increased radiation sensitivity than adults (below 60). The increased radiation sensitivity of aging cells may be the consequence of already dysfunctional systems dealing with radiation-induced damages. There are changes in elderly persons' bodies that enable radiation-induced damages. One of them is the oxidative stress arising from aging that causes an increase in number of free radicals and induces DNA, protein and lipid damages. Another one is telomeres shortening in aging cells which leads to genome instability caused by disruption of the cell cycle checkpoints. Moreover, DNA repair-deficiency has been observed. Telomere dysfunction, DNA damage and persistent response to radiation induce cell aging process as the cycle is stopped irreversibly [47]. Studies showed that 18 genetic disorders have radiation hypersensitivity. Patients with such hereditary disorders as Ataxia-Telangiectasia Syndrome, Nijmegen Breakage Syndrome, LIG4 Syndrome (Ligase IV Syndrome), Seckel Syndrome, Werner Syndrome and Fanconi Anaemia show the highest radiosensitivity. The most common radiation effect on patients with the above disorders are DNA double-strand breaks [48].

Exposure to ionising radiation at doses above threshold values lead to different subsyndromes of ARS. The absorbed dose is not the only marker of patient's damages and patient's survival rate. Whether a patient will suffer from ARS depends on patient's individual radiosensitivity, age, general health condition, extent and length of radiation exposure. It is crucial for survival to stop radiation exposure and perform radiation triage. Absorbed doses above 1 Gy will probably lead to ARS and assessing absorbed doses allows to predict type of ARS and induce proper medical response management.

CONCLUSIONS

Proper EMS responses followed by hospital treatment substantially increases patients' survival rates. The understanding of ARS pathophysiology and all clinical manifestations of every ARS sybsyndrome improves effectiveness and accuracy of medical responses provided and allows for better hospital treatment of radiation incidents' casualties.

Table 1. Differences between H-type and F-type models of normal tissues.

Properties	H-type model	F-type model
Examples	Bone marrow, skin epidermis, gastrointestinal and urinary tract epithelium, testicular epithelium	Connective tissue, nervous tissue, liver parenchyma, liver parenchyma
Proliferative capacity of functional cells	None	Infinite
Time of functional damage	Dose-independent	Dose-dependent
Time-scale of expression of radiation injury	Early	Late

Source: Own study based on [10,18,34].

Table 2. Signs and symptoms of ARS prodromal phase.

Signs and symptoms	Mild (1-2Gy)	Moderate (2-4Gy)	Severe (4-6Gy)	Very severe (6-8Gy)	Lethal (>8Gy)
Vomiting	>2h after exposure	1-2h after exposure	<1h after exposure	<30 min after expose	<10 min after exposure
Diarrhea	-	-	Mild (3-8h after exposure)	Heavy (1-3h after exposure)	Heavy (within min after exposure)
Headache	Slight	Mild	Moderate (4-24h after exposure)	Severe (3-4h after exposure)	Severe (1-2h after exposure)
Consciousness	Unaffected	Unaffected	Unaffected	May be affected	Unconsciousness
Body temperature	Normal	Increased (1-3h after exposure)	Fever (1-2h after exposure)	High fever (<1h after exposure)	High fever (<1h after exposure)

Source: Own study based on [49].

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CONFLICT OF INTEREST

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TREATMENT OF PAIN DURING EMERGENCY MEDICAL SERVICES

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Abstract

Introduction: Pain, while undertaking medical rescue operations, is a common complication of injuries or a symptom of disease entities of internal medicine. Equipping emergency medical teams with painkillers from various groups, gives broad opportunities to fight pain at the pre-hospital stage. The manner of using medicines is regulated by law in the form of an executive regulation to the Act on State Emergency Medical Services, which specifies the type and route of their administration. When undertaking analgesic treatment, one should be aware of the contraindications to the use of individual medications, possible complications of their use, and methods of combining analgesics and co-analgesics as part of multimodal analgesia. The consequence of using medicines may be their impact on the work of the circulatory and respiratory systems, hence it is necessary to observe the patient's cardiopulmonary stability during medical emergency operations at the call site, during transport and in the Hospital Emergency Department.

The aim: This article aims to systematize the knowledge of painkillers available to the paramedic and methods of assessing pain intensity according to the following scales: numerical, verbal, visual-analog and picture for pediatric patients with whom it is possible to make logical contact.

Conclusions: 1. Basic emergency teams are equipped with drugs from the following groups: nonsteroidal anti-inflammatory drugs, non-opioid analgesics and opioid analgesics. Thanks to them, it is possible to effectively and noticeably reduce pain at the stage of providing medical emergency services. 2. Despite properly undertaken pain therapy with available means and methods, it may not be possible to completely eliminate pain and clearly determine its etiology at the pre-hospital stage. 3. Available scales allow proper assessment of pain intensity in both pediatric and adult patients. 4. In complex cases, pain should not go away, it is necessary to use multimodal analgesia by combining analgesics of different groups, or to include in analgesic therapy co-analgesics, which, due to the weakening of the impact of a potential cause of pain, may determine the effectiveness of therapy. 5. Establishing the etiology of pain due to the numerous potential pathologies that cause it requires careful assessment of the patient at the stage of providing medical emergency services and the implementation of a full and properly conducted physical examination.

Key words

pain,
Emergency Medical Services,
analgesia,
receptors,
drugs

INTRODUCTION

Pain is one of the most common reasons for intervention of emergency medical teams. The availability of a wide range of pharmacological agents with analgesic effects along with co-analgesics gives great possibilities of pain treatment at any intensity. According to the analysis of data on traumatic diagnoses according to ICD 10 classification carried out by the Ministry of Health (MZ), including thermal and chemical burns, in the period from November 1, 2017 to April 30, 2018, in adults, pain relievers were given in 25, 23% of cases, and in children (<18 years) in 16.58% of cases. 547 interventions of emergency medical teams were subjected to statistical analysis [1]. The above infamous results caused the introduction of the so-called good pain management practices.

THE AIM

The authors of this publication would like to draw attention to the possibility of using analgesic treatment using available pharmacological and non-pharmacological agents, which has a real impact on safer and more efficient care of a suffering patient due to pain of various causes.

REVIEW AND DISSCUSION

ETHOLOGY OF PAIN

Pain is a subjectively unpleasant and unambiguously negative sensory and emotional impression, arising under the influence of stimuli that damage the tissue or threaten its damage or described in terms of such damage – such a definition of pain in the 1870s was formulated by a group of experts from the International Society for the Study of Pain. The definition is still valid today and due to the fact that each person has an individual range of pain tolerance, determination of its intensity is often subjective. The gradual intensity of the sensory stimulus that a person perceives as pain defines the threshold of pain sensation, while the maximum intensity of pain that a person is able to tolerate is the threshold of pain tolerance [2]. The pain sensing threshold is often a constant value for every person and depends mainly on somatic factors, in contrast to the pain tolerance threshold which is variable and depends on many psychological factors. Physiologically, pain arises as a result of irritation or hyper-responsiveness of specific pain receptors to an ordinary stimulus [3]. Chronic pain can be talked about when it ceases to be a warning signal and becomes a factor that causes suffering and significantly reduces the quality of life. This condition continues despite the healing of the tissues after injury or surgery, accompanies a chronic disease such as cancer or osteoarthritis. More often it appears as a non-receptor, lasting over three months [4]. Chronic pain is described as "pain that goes beyond the normal expected recovery time" and is also often considered a disease in itself that requires treatment. People suffering from chronic pain experience physiological, psychological and social disorders. This is due to the duration of the pain and the severity, not the cause of the pain. Depressive mood, nervousness, outbursts of anger, isolation from the world, eating disorders are characteristic symptoms observed in patients with chronic pain [5]. Many family, personal, social and environmental factors contribute to the perception of chronic pain that accompanies the final stage of a chronic disease (e.g. cancer). That is why this pain is described as total and overwhelming. An example of such a situation are young people with terminal cancer who suffer not only from pain, but also from a lack of sense of control over their lives and isolation from the environment. Acute pain is considered to have a warning function in the body, lasts up to three months and is accompanied by tissue damage. It is a symptom of a cured disease that ceases to give any pain. Strong emotional states such as anxiety and stress can cause analgesia, and pain can only appear when the emotions subside. The most common acute pains include post-traumatic, postoperative and burn injuries, and their intensity is usually proportional to the acquired damage [6]. In most cases, the pain disappears after a few or a dozen days after the implementation of analgesic treatment and the natural process of tissue healing. It should be noted that the treatment of acute pain and its causes prevents chronic pain. As a result of trauma to the structures of the central or peripheral nervous system, neuropathic pain occurs. It has a scalding and burning character, usually after a few days or weeks after the injury. Therapeutic management differs from that in the case of pain syndromes accompanying injuries of somatic or visceral structures [7]. One of the basic elements of effective post-traumatic pain relief is the assessment of its intensity at rest and in dynamic conditions (movement, coughing). The most common assessment method is the Numerical Rating Scale (NRS). In patients with acute non-traumatic abdominal pain, the use of opioid analgesics does not change the symptoms, but only reduces the severity of pain. It also does not increase the risk of establishing an incorrect diagnosis and undertaking improper treatment [8].

LOCATION OF PAIN AND ITS POSSIBLE CAUSE

Headache

Sudden and severe headache can be caused by serious vascular pathologies. The most serious disease entities include: subarachnoid haemorrhage, dynamically dissecting carotid or vertebral artery, cerebral venous thrombosis or a sudden increase in blood pressure to life-threatening values. The non-vascular cause that, if left untreated, can cause serious defects within the Central Nervous System (CNS) in the short term is most often Cerebrospinal Meningitis. The third group of pain includes primary headaches. They include: migraine, trigeminal autonomic headaches, headache associated with sexual activity and headache due to coughing or exertion.Among the abovementioned, a sudden health threat as a result of not taking timely treatment may be vascular and non-vascular causes being a sudden symptom of severe pain. In turn, the primary causes of pain can be unpleasant and long-lasting causes of headache of a lesser

intensity. An exception to the reasons described above may be the traumatic causes of the headache. However, they should not be classified in terms of the severity of the pain, because often a trivial injury from the patient's point of view can cause serious damage within the CNS. Patients may also underestimate the head injury they experience as a result of a traffic accident because there may have been disturbances of consciousness at the time of the injury. In this case, the patient often does not realize what kinetic energy accompanied the event. Only the image of a damaged vehicle observed by the emergency services can be a premise for the patient's limited trust in the matter of the course of the event [9-12].

Pain in the chest

ZRM interventions due to chest pain are an important part of all events undertaken as part of the State Emergency Medical System. According to the analysis of 10513 Emergency Medical Services Cards (KMCR), about 26% of all trips occur on the occasion, accompanying ICD codes from the I44 – I49 range [13]. Among the possible pain sensations within the chest, the following nature of pain can be distinguished: creasing, burning, squeezing, stinging, excruciating, sharp, blunt, variable. Considering the life-threatening condition, which are, among others: acute coronary syndrome (ACS), unstable angina, aortic dissection, oesophageal rupture, when interviewing patients, it can be expected to describe the pain with the adjectives listed above. The occurrence of such pain sensations requires effective and safe treatment that will not expose the patient to iatrogenic consequences of pain reduction in pre-hospital or early hospital care. The effects of drugs on cardiovascular fitness, possible bleeding complications and the effectiveness of pain treatment with the lowest effective doses should be taken into account using correlation within multimodal analgesia. Other possible causes of chest pain which in the course of the development of the disease which is indirectly a life-threatening condition are, among others:

- stable angina pectoris (retrosternal cramping, burning or squeezing pain transient after cessation of physical exertion or dose of nitro-glycerine),
- pericarditis (retrosternal pain of varying intensity depending on inhalation, body position or cough; stinging in the chest is possible),
- pleural pain (unilateral pain, may radiate to the back; it can be caused by inflammatory infiltration in the pleura, lung infarction or pneumothorax),
- neuralgia (i.e. neuralgia (Greek: algos – 'pain')) is a stinging pain that occurs in the area of innervation of a given nerve without signs of damage, usually paroxysmal, often spontaneous or provoked by various stimuli, e.g. palpation or movement may increase it within the thorax. Located quite clearly in the intercostal space. It is recognized on the basis of anamnesis, and the cause is usually unknown,
- astroesophageal reflux (burning or smoking pain, the patient reports belching with acid stomach contents, often heartburn, palpation).

Cholelithiasis

Cholelithiasis (chest pain of increasing dynamics and then constant intensity may be caused by an increase in gallbladder pressure after eating fatty meals and blocking the outflow of increased food with more bile through gallstones)

·stomach ulcer (chest pain due to perforation of the ulcer, often of a blunt nature due to damage to the gastric or duodenal mucosa)

·neurotic pain (chest pain, often called it erroneously as a result of hyperventilation, palpitations; most often it does not require analgesic treatment, but sedation and normopnoe return)

·traumatic causes of chest pain (diffuse pain, the nature of the pain varies depending on the patient's position, the scale of pain may correlate with the extent of the injury, however, chest pain after excluding the life-threatening condition due to the injury is long lasting for 6-8 weeks, well undergoes analgesic treatment).

The multitude of causes of chest pain require careful diagnostics, above all, thorough medical history, physical examination and additional tests available at the pre-hospital stage (ECG, BP measurement, saturation or temperature) [14-18].

Stomach ache

Abdominal pain should be classified by their location. The abdominal cavity should be divided into the following areas: right upper quadrant, upper abdomen, left upper quadrant, right abdomen, left abdomen, umbilical region, lower right quadrant, lower abdomen, lower left quadrant. If pain covers many of these areas or cannot be located accurately, classify the condition as diffuse pain. The following are sudden conditions that manifest themselves as pain in a given area and may pose a sudden health risk:

within the upper right quadrant:

inflammation of the gallbladder or bile ducts and biliary colic – caused by obstruction of the bile duct due to urolithiasis, pancreatitis, gastric and duodenal

ulcer disease with ulcer perforation, intestinal obstruction, appendicitis

within the upper abdomen:
gastric and duodenal ulcer with ulcer perforation, acute hepatitis, acute pancreatitis, intestinal ischemia, abdominal aortic aneurysm, acute coronary syndrome

within the upper left quadrant:
splenic rupture or infarction, colon splenic flexion ischemia

in the right and left abdomen:
kidney infarction, intestinal obstruction, hernia

within the umbilical region:
appendicitis (at an early stage), intestinal obstruction, intestinal ischemia, pancreatitis, abdominal aortic aneurysm, hernia

within the lower right quadrant:
appendicitis, intestinal obstruction, ovarian torsion, ovarian rupture, ectopic pregnancy, hernia

in the lower abdomen:
appendicitis, intestinal obstruction, hernia

within the lower left quadrant:
intussusception, ovarian cyst, ovarian torsion, ovarian rupture, ectopic pregnancy

diffuse pain:
intestinal obstruction, peritonitis

other causes of abdominal pain in various locations, which are not usually a state of emergency, causing significant pain:
hepatitis, esophagitis, inflammatory bowel disease, renal colic, pyelonephritis, functional abscess, dyspepsia, gastroesophageal reflux disease, drug-induced gastric and duodenal mucosal damage, adnexitis, abscess (pelvic, lumbar), diverticulitis, cystitis urinary tract, pelvic abscess, infectious diseases, infectious and non-infectious gastroenteritis, urinary tract infection

Abdominal pain with specific symptoms requires the implementation of basic diagnostics in the conditions of the Admission Room (IP) or the Hospital Emergency Department (SOR). These symptoms include: persistent vomiting, abrupt retention of the stool, gastrointestinal bleeding (upper section – dusty vomiting, lower section – tarry stool). Basic laboratory tests should be performed to determine: morphology, sodium and potassium levels, glucose, urinalysis as well as abdominal panel of laboratory tests together with exclusion of acute coronary syndrome (symptoms may often be false in the abdominal cavity during coronary artery ischemia). These studies include the concentration of: amylase, bilirubin, creatine kinase (CK-MB), cardiac troponin and the activity of: aspartate aminotransferase (AST), alanine aminotransferase (ALT), gamma-glutamyltranspeptidase (GGTP) and alkaline phosphatase (ALP), optionally stool for blood. Imaging tests in the abdominal cavity performed in connection with pain for the purpose of further diagnostics include: ultrasound, a review x-ray or computed tomography (CT) [19-23].

PAIN ASSESSMENT SCALE

Pain assessment scales are used by medical staff as an indicator, thanks to which the patient will receive the right medicine that will help with the ailment. In the case of such a method of measuring the severity of pain, this is only a subjective assessment of the patient. It is therefore necessary to explain the patient thoroughly and to illustrate the principles of scale. The most common scale is numerical, visual – analogue, verbal or pictorial. These methods are applicable to conscious people. However, in the case of unconscious people, facial grimaces, body position or vital signs are observed [24, 25].

Numerical Rating Scale (NRS)

The most popular and reliable scale with 11 points – from 0 (no pain) to 10 (the worst pain in life) (Fig. 1). It is understandable for patients and is used to treat both acute and chronic pain. The NRS scale is not recommended for children under 9 years of age.

Verbal Rating Scale (VRS)

When assessing pain on this scale, the patient describes his pain in words. Here, the patient is presented with a 5-point Likert scale, where the degree of pain intensity is added to each digit (Fig. 2). This scale is imprecise because patients have difficulty adjusting their pain sensation to the description given to them [26].

Visual AnalogueScale (VAS)

It is a ruler-shaped scale, like the NRS scale, it has an 11-degree scale (from 0 to 10) (Fig. 3). In addition, at the beginning and end it contains face drawings – smiling and sad. Sometimes, individual numbers are also described by terms of pain. The effectiveness of analgesic treatment is determined by using the cyclically used VAS scale [27].

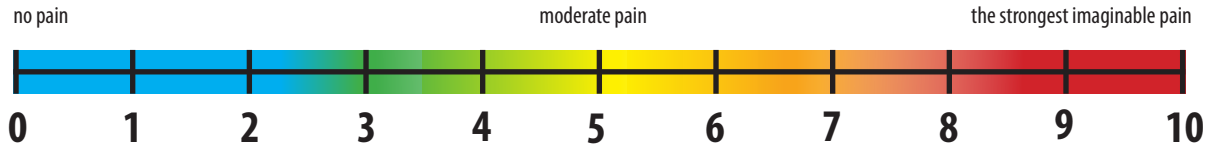

Fig. 1. Numerical pain assessment scale.

Fig. 2.Verbal scale of pain assessment.

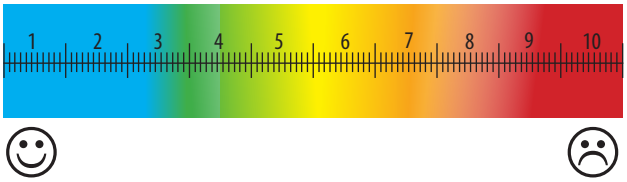

Fig. 3. Visual-analogue pain assessment scale.

Fig. 4. Pain assessment scale among paediatric patients.

Pain assessment scale among paediatric patients

Among younger children, pain can be assessed at the beginning of medical rescue operations by implementing the PAT (Paediatric Assessment Triangle) analysis (Fig. 4). This triangle includes general appearance (muscle tone, reaction to stimuli, sedation, eye contact and conversation / crying), respiratory effort (abnormal voice effects, abnormal breathing position, retraction, movement of the wings of the nose), skin (pale, marbled, cyanosis).

Among patients who are already in an age that allows understandable communication, it is worth using pictorial scales to assess pain, where the child compares his pain sensation to a smiley face or face in the picture of the face [27].

PAINKILLERS AVAILABLE IN BASIC MEDICAL RESCUE TEAMS

There is a wide range of painkillers to choose from in emergency medical teams that can be used depending on the time and nature of the event. They should be divided into three groups:

- Nonsteroidal anti-inflammatory drugs (NSAIDs)
- Non-opioid analgesics
- Opioid analgesics

Nonsteroidal anti-inflammatory drugs (NSAIDs) and non-opioid analgesics are groups of drugs that have moderate analgesic effects, but have a number of other benefits. The action of NSAIDs is to inhibit the enzyme cyclooxygenase, which is necessary for the synthesis of prostaglandins, which in turn are responsible for the sensation of pain. In addition, NSAIDs have anti-inflammatory and antipyretic effects. Non-opioid analgesics do not have anti-inflammatory components. Each drug individually has different characteristics and each should be treated separately from the perspective of precautions and side effects. In Basic Medical Rescue Teams (pl. ZRM P), several types of NSAIDs and non-opioid analgesics are available with different routes of administration [28].

Opioid analgesics are a family of drugs that are agonists of μ opioid receptors found in both the central and central nervous system, they are responsible for

the sensation of pain and adaptation to environmental changes. Physiologically, they are stimulated with endogenous opioids. In addition to pain relief, drugs also cause euphoric states, which makes opioids one of the highly addictive drugs [29, 30].

Non-opioid analgesics (1st degree analgesic ladder according to the World Health Organization (WHO)

Paracetamol /Perfalgan, Panadol, Codipar, Apap/. The active metabolite of phenacetin with analgesic and antipyretic effects without anti-inflammatory component. It does not damage the gastric mucosa, does not inhibit platelet aggregation and coagulation. Its side effect is hepatotoxicity when the safe dose is exceeded. It can be safely used in children, pregnant women and during breastfeeding. Allergic reactions are relatively rare among the population. It can be given orally, intravenously and often rectally in feverish children [31, 32].

Metamizole, /Pyralgin/

It has analgesic, antipyretic and spasmolytic effects, which makes it effective in the treatment of pain of various origins, including visceral. Can be used in children> 1 y.o. in the case of severe life-threatening fever, when other medicines are ineffective. There may be a local burning sensation after administration, and in the case of hypersensitivity to metamizole, there is a likelihood of aspirin asthma, dyspnoea, urticaria, angioedema or acute renal and hepatic failure. It should not be used during pregnancy and while breastfeeding. At Emergency Medical Teams, there is a possibility of intravenous, intramuscular and oral delivery. When i.v. the drug should be diluted in 0.9% NaCl solution or Ringer's solution in a ratio of 1:10 (2 ml of the preparation in 20 ml / 5 ml of the preparation in 50 ml) [33].

Nonsteroidal anti-inflammatory drugs (1st degree analgesic ladder according to WHO)

Acetylsalicylic acid (ASA) /Aspirin, Polopiryna S, Etopiryna, Acard/

Antipyretic, analgesic and anti-inflammatory drug. In children under 12 years of age acetylsalicylic acid is not given due to the potential for Reye syndrome. In adults, the supply of ASA is contraindicated, among others, in the presence of active gastric or duodenal ulcer and aspirin asthma. In the case of pregnant women in the first and second trimester, the drug should be used only when clearly necessary, in the third trimester, contraindicated administration. Acetylsalicylic acid has antiaggregatory properties and is used in the presence of ACS with ST segment elevation (STEMI), without ST segment elevation (NSTEMI) or unstable angina. At present, ZRM is recommended to be administered only by the oral route [34, 35].

Ibuprofen/Ibufen,Ibum, Nurofen, Ibuprom/

A propionic acid derivative with NSAID-specific activity. Has anti-aggregation properties (works less and shorter than ASA). Symptomatic treatment of pain of various etiologies of low and medium severity. Reduces the swelling zone in inflamed tissues. Used to treat rheumatoid arthritis (RA), osteoarthritis and rheumatic diseases. Contraindications similar to those in ASA. In Poland in medical emergency medicine administered orally [36].

Ketoprofen/Ketonal/

The last of the representatives of the NSAID group – a propionic acid derivative with strong analgesic, antipyretic and anti-inflammatory effects. Has anti-aggregation properties such as Ibuprofen. It works well in post-traumatic, postoperative and menstrual pain relief as well as in the chronic treatment of osteoarthritis and RA. In adults, the supply of ketoprofen is contraindicated, among others, in the presence of active gastric or duodenal ulcer and allergic reactions after NSAID administration. In the case of pregnant women in the first and second trimester, the drug should be used only when clearly necessary, in the third trimester, contraindicated administration. Do not use in persons under 15 years of age. The drug increases the risk of gastrointestinal bleeding, it should not be taken with other NSAIDs. At Medical Rescue Teams, the possibility of intramuscular supply and, according to the manufacturer's recommendations, supply i.v. only in hospital conditions. When i.v. the drug should be diluted in 0.9% NaCl solution (drip infusion) and remember to wrap the infusion bottle in black paper or aluminum foil, as ketoprofen is sensitive to light [37].

OPIOID ANALGESICS (III DEGREE ANALGESIC LADDER ACCORDING TO WHO)

Morphine Sulfate /MorphiniSulfas/

A potent analgesic, opioid receptor agonist μ. Strengthens smooth muscle tone, may lower blood pressure due to histamine release. It depresses the respiratory and coughing centers, reduces shortness of breath in patients with pulmonary edema, euphorizes, narrows the pupils. Action of the drug after i.v. injection occurs after 2-3 minutes, but complete saturation occurs after about 30 minutes. – remember to titrate the medicine. Morphine is indicated for very severe post-traumatic, cancer or ACS pains. In addition to

the analgesic effect, morphine is used in patients with dyspnoea in the course of pulmonary edema. Contraindications include: head injuries with increased intracranial pressure, convulsions or hepatic colic. In pregnant women, morphine should be considered when the benefit outweighs the risk. It is not recommended to use during childbirth because of the possibility of neonatal respiratory failure. Can be successfully used in children. Metoclopramide should be considered ancillary in the event of nausea [38].

Fentanyl /Fentanyl/

A potent synthetic painkiller, opioid receptor agonist μ. about 100 times stronger than morphine which results from better fat solubility and easier penetration through the blood-brain barrier. Action of the drug after i.v. injection occurs after about 2 minutes, complete saturation occurs after about 3-5 minutes. The main indications are: abolition of pain and hemodynamic response to intubation, maintenance of analgesic effect, analgosedation, ACS STEMI pain, post-traumatic pain. The list of contraindications is slightly shorter than that of morphine, it mainly lists the depressive effect on the respiratory center. Routine use during labor and delivery is not recommended, it should not be used during breastfeeding and pregnancy unless the benefit outweighs the risk. After recalculating the dose, it can be safely used in children [39].

Good practices for the treatment of pain in adults and in children are presented in Tables 1-2.

Table 1. Good practices for the treatment of pain in adults in basic medical rescue teams and air medical rescue teams.

PAIN RATE (NRS)	PAIN OF NON-TRAUMATIC ETIOLOGY			PAIN OF TRAUMATIC ETIOLOGY
	headache	**chest pain**	**abdominal pain**	**injuries, burns**
mild pain 1-4 points	Ibuprofen 800 mg p.o. and/or paracetamol 1000 mg p.o. paracetamol 1000 mg p.o.(1)	metamizole 2.5 g i.v./i.m.	metamizole 2,5 g i.v./i.m. + drotaverine 80mg i.v./i.m.(3)	
moderate pain 5-7 points	ibuprofen800 mg p.o. and/or metamizole 2.5 g i.v. or ketoprofen100 mg i.v.(8) fentanyl 0.5-1.0 μg/kg bw i.v./i.o.(1)	morphine 0.1-0.2 mg/kg bw i.v./i.o.(2) and/or metamizole 2.5 g i.v.	metamizole 2,5 g i.v. + drotaverine 80mg i.v.(3)	fentanyl 1,0 μg/kg bw i.v./i.o.(5),(6) or morphine 0,1-0,2 mg/kg bw i.v./i.o.(2)(4) + non-pharmacological treatment (7)
severe / extreme pain 8-10 points	fentanyl 0.5-1.0 μg/kg bw i.v./i.o.	morphine 0.1-0.2 mg/kg m.c. i.v./i.o.(2) and/or metamizole 2.5 g i.v.	morphine 0,1-0,2 mg/kg bw i.v./i.o.(2),(4) or fentanyl 0,5-1,0 μg/kg bw i.v./i.o.	

(1) In case of suspected features of CNS bleeding or contraindications to NSAIDs and / or metamizole.
(2) In the case of ineffective pain control, the dose may be repeated every 5 minutes until significant pain reduction, sedation or qualitative disturbance of consciousness is achieved.
(3) Drotaverine only in the presence of spastic states of smooth muscle of the digestive tract, urinary tract.
(4) In the absence of contraindications.
(5) In the case of ineffective pain control, the dose may be repeated every 15 minutes until significant pain reduction, sedation or qualitative disturbance of consciousness is achieved.
(6) Caution is recommended in chest injuries.
(7) Non-pharmacological treatment: sterile hydrogel dressings, elevation of the limb, stabilization of the limb in the axis, etc..
(8) Ketoprofen – make up to 100 ml with 0.9% sodium chloride and administer within 1 to 1 hours.
Source: [https://www.gov.pl/web/zdrowie/dobre-praktyki-leczenia-bolu]

NOTE: Intramuscular and rectal analgesics are not recommended in medical rescue teams.
Drugs given in this way are characterized by a long latency period (the time that passes between the administration of the drug and the onset of its analgesic effect); the concentration of drugs in the target compartments shows fluctuations, which in practice means that analgesic treatment may be ineffective.

Table 2. Good practices in pain management in children in basic emergency rescue teams.

PAIN INTENSITY	PAIN OF NON-TRAUMATIC ETIOLOGY		PAIN OF TRAUMATIC ETIOLOGY
	age		injuries, burns
	0-12 years	> 12 years	
mild pain	paracetamol 15 mg/kg bw i.v./i.o	paracetamol 15 mg/kg bw i.v./i.o	morphine 0,1 mg kg/bw i.v/i.o. or fentanyl 1-3 µg/kg bw i.v./i.o. + non-pharmacological treatment (3)
	ibuprofen10 mg/kg bw p.o.(1)	ibuprofen10 mg/kg bw p.o.	
moderate pain	paracetamol 15 mg/kg bw i.v./i.o	paracetamol 15 mg/kg bw i.v./i.o.	
	ibuprofen10 mg/kg bw p.o.(1) or morphine 0,1 mg kg/bw i.v/i.o.	ibuprofen10 mg/kg bw p.o. or Ketoprofen 50-100 mg i.v./i.o.(2)(5) or morphine 0.1 mg kg/bw i.v/i.o.	
severe/extreme pain	morphine 0,1 mg kg/bw i.v/i.o.	morphine 0.1 mg kg/bw i.v/i.o. or fentanyl 1-3 µg/kg bw i.v/i.o.	

(1) Applies to patients over 3 months of age.
(2) Applies to patients over 15 years of age.
(3) Non-pharmacological treatment: sterile hydrogel dressings, elevation of the limb, stabilization of the limb in the axis, etc.
(4) **In systolic pains located in the abdominal cavity, it is recommended to administer drotaverine at a dose depending on the child's weight and age. Dosage: 0-6 years 40-120 mg / 24h, over 6 years 40-240 mg / 24h.**
(5) Ketoprofen – make up to 100 ml with 0.9% sodium chloride and administer within 1 to 1 hours.
Source: [https://www.gov.pl/web/zdrowie/dobre-praktyki-leczenia-bolu]

NOTE: Intramuscular analgesics are not recommended in medical rescue teams

Multimodal analgezion

Multimodal pain treatment involves combining two or more groups of analgesic drugs to improve pain relief and reduce the incidence of side effects [40]. The above method of pain management assumes that drugs acting in various mechanisms may show a synergistic analgesic effect during their simultaneous supply. Very often multimodal therapy is supported by complementary drugs – co-analgesics or non-pharmacological methods [41].

There are two ways to give medicines:

- by the same route, e.g. intravenous opioid + intravenous metamizole
- by different routes e.g. intravenous opioid + NSAIDs or oral paracetamol.

It should be emphasized that the combined administration of two NSAIDs is a mistake, because it is doubtful to obtain greater therapeutic efficacy, while we increase the risk of side effects, therefore, in the case of too weak analgesic effect, NSAIDs should be combined with paracetamol / metamizole and / or opioid [42].

Paracetamol reduces the needed dose of opioid drugs, especially morphine, reducing its consumption by an average of 30%, hence the combination of paracetamol with opioid drugs is strongly recommended [43].

Coanalgesics, or complementary drugs, are used in the treatment of pain, to increase the analgesic effect and supplement their action with additional pharmacodynamic mechanisms [42]. The most commonly used supportive drugs include:

- tricyclic antidepressants (TLPD) – treatment of neuropathic pain, enhance the morphine analgesic effect [44]
- local anesthetics and antiarrhythmics (lignocaine) – treatment of acute neuropathic pain
- spasmolytic drugs (droterna, papaverine) – reduction of smooth muscle tone in the gastrointestinal tract and urinary tract
- glucocorticosteroids (dexamethasone, corhydron) – reduction of the outbreak of inflammatory mediators
- benzodiazepines (diazepam) – incidentally in states of increased muscle tone
- drugs affecting the cardiovascular system – relief of coronary pain (nitrates, antihypertensives)

Non-pharmacological methods include activities in the field of psychological support and physical support methods, i.e. proper limb immobilization after injury or the use of cold compresses [45, 46].

CONCLUSIONS

Determining the severity of pain and its treatment in the conditions of EMR in the face of the above solutions should be the task undertaken in every situation of pain occurrence reported by the patient as part of a medical history. Correct pain assessment using

graphic or descriptive scales should be achievable in every situation where Medical Rescue Action is taken at the scene. By the very fact of creating various tools for assessing pain and repeatedly checking these solutions in the course of scientific research undertaken on their usefulness, should encourage Emergency Medical Teams' members to regularly use them. Situations in which Emergency Medical Team personnel do not take painkiller treatment despite having a painkiller palette and clear indications are inexplicable. It should be remembered that reducing pain does not hinder hospital diagnostics and, due to the reduction of patient stress, can be used to improve the general condition faster. Considering the multitude of pain symptoms in various anatomical locations and disease entities that they may indicate, it should be emphasized that a complete medical history and comprehensive physical examination is the basis for success in the further stages of providing medical emergency services, diagnostics and hospital treatment. Postgraduate education should be undertaken regularly, which means that EMT staff will be able to correlate pain with a suspected disease entity. Lack of education, negatively affects the safety of EMT members as a result of incorrect Medical Rescue Action and wrong decisions regarding the patient's location in a hospital with an appropriate profile of activity and reference, especially in a state of immediate threat to life. It should be remembered that knowledge at the appropriate substantive level and proper keeping of medical records may protect EMT members from legal liability for errors in the course of actions taken. In connection with the use of analgesic treatment, there is a need to use the pain scale before and after using the analgesic together with a re-examination of the patient. Combining painkillers from different groups and levels of the analgesic ladder still arouses a lot of negative emotions among members of Emergency Medical Team. Co-analgesics are very valuable, as they help to achieve the right level of analgesia. The experience of the authors of this work indicates frequent errors in analgesia by using monotherapy with low doses of drugs or combining drugs from the same group of NSAIDs, which increases the risk of side effects without achieving a beneficial analgesic effect. To sum up, the availability of a wide range of pharmacologic agents with analgesic effects along with co-analgesics in the conditions of emergency medical services gives great opportunities for multimodal therapy in the treatment of pain of any intensity.

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STUDYING ORGANIZATION DURING CORONAVIRUS DISEASE PANDEMIC FROM ERASMUS+ – MEDICAL STUDENT PERSPECTIVE

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Abstract

Introduction: COVID-19, the disease caused by coronavirus SARS CoV-2, is the newest and the best known disease, which changed our reality in just a few weeks. It caused many changes in education and health system.
The aim: To recount and summarise what is happening in Italian and Polish medical studies right now in the perspective of two students, one of them being a part of the Erasmus+ programme, residing in Italy and studying at Universita degli Studi di Pavia.
Conclusion: Italian and Polish studying organization is similar. Erasmus Students have access to more than one University materials.

Key words

COVID-19, SARS CoV-2, e-learning, quarantine, university students

08/04/2020 – SITUATION IN ITALY FROM STUDENTS PERSPECTIVE

LIVING MEASUREMENTS AND RESTRICTIONS COMPARED TO REALITY

Social distancing, not being allowed to exit your place of residence without a proper reason, police controls and queues outside of the supermarket – those are some of numerous restrictions that the country of Italy had put on their residents [1–3]. Officially you cannot be in groups of more than two, you need to wear masks and gloves while entering supermarkets or pharmacies and only a limited number of people can do it at the same time. All of those things were introduced as measures to prevent the spread of Covid-19, however the cases continue to rise and although the government is doing its part, as students residing in Italy, we would rather say that the people and their change of mentality are the main reason that the disease is expected to drop off [4, 5]. Living on the outskirts of Pavia which has around 70 thousand people population you do not see any police officers around. If you wish to go for a walk, you can do it without any repercussions although the officials state otherwise. While going to the supermarket or a pharmacy there is no police to be seen and of course they have more important things to do but the control is really poor. But the Italian people are saving the situation – they could go out but they choose not to do it, they always wear masks and gloves in supermarkets and practice social distancing effectively. Only occasionally you can notice a person going out with a dog – that means they even had to figure out a way for dogs to defecate at home, as before you could see people with dogs practically everywhere. On the other hand the shops are taking the case seriously and they have trained workers who command the queue in front to follow the measurements. In the big supermarket nearby only 15 people can be inside at the same time.

TRAVEL PROBLEMS

You need a special paper called "autocertificazione" to travel throughout the country – this paper

Abbreviation

COVID-19- a disease caused by coronavirus SARS CoV-2
PPE – personal protective equipment
WHO – World Health Organisation

states for what reason (it has to be an important one) you are travelling in this period of time.

Travelling between borders in Europe right now is a really hard job, with many countries shutting their borders and flights, trains, buses being cancelled. What about travelling inside Italy?

When You want to arrive to Italy from Austria usually the train from Innsbruck to Verona is Your go-to option. Obviously at this moment most of international trains are called off, so there is a big problem to cross the border. However this problem does not originate from controls but from financial reasons. To get to Brenner, which is a small city located on the border between Tirol and Trentino, you need to get a taxi which costs around 70 euro. Once you arrive, the Austrian Police stops the taxi and you need to walk the rest of the distance to the train station on the Italian side of the city. Feeling quite stressed you are slowly strolling towards the station, waiting for the first Italian officers to control Your "autocertificazione" document and let you inside the country. However, that never happens. You get to the train station and take one that goes to Bolzano or Verona without being checked. On the train you look around and notice that it is not empty at all – you have a safes pace for yourself but based on the number of people you could say it is just another regular day. You put on your mask and disinfect your hands again just to make sure you get off the train safely. Then in those places you buy tickets for further trains without being checked – confused you turn your eyes towards officers that check people once they are coming inside the station, but as you are already travelling that means that you had been checked before right? You change your trains a few times, arriving from Verona to Milan and then to Pavia, the city in the center of Lombardy where we study. All of those trains are not empty and they do not make it seem like the massive quarantines and isolations are taking place just around the corner. Once you leave the train in Pavia the military and police officers let you go out of the train station without saying a word. You walk to your place of residence without being checked once – and then you start wondering how is that everybody is saying that Italy is so strict right now.

E-LEARNING

Universities in Italy have opted to move to e-learning, which includes online lectures via Zoom or professors choosing instead to upload their lecture slides and material online. Seeing as most of our professors are doctors, they are working around the clock at the hospital. The vast majority have decided to upload materials. Two professors that we have are teaching online lectures on Zoom. Zoom is an online platform that facilitates large online meetings, and as such can simulate large lectures. Thankfully Zoom can accommodate any style of teaching that Professors have. Luckily the two professors referenced each have their own style of teaching. For instance, 1 professor holds a more traditional lecture, he is able to draw pictures to help visualize the material and recounts information from personal experience. The other professor takes a more discussion based approach where all students can get involved and ask questions at any point in the lecture. Lectures taught online come with their fair share of problems. Usually the online lectures proceed normally, but at times lectures can run into some issues: the occasional student who forgets to mute themselves while they eat, the internet disconnects, mics cut out. For the most part, however, any issues are non-consequential to the overall learning process. Unfortunately, there is a small portion of classes, university-wide, that have not yet sent any material or prepared any online lectures for students.

In Poland we mostly use programs Microsoft TEAMS or Skype. Students use wildly social media (e.g.: WhatsApp, Twitter, Facebook, Instagram, YouTube and Edmodo) to communicate and knowledge sharing [5−8]. We also experience problems with connection, microphone settings or cameras (which not everybody is able to use). Our Professors are also extremely busy regarding the on-going situation, therefore some of them did not release any material or online lectures. However many of them find some time to provide us with live conversations or online slides. A great thing for ERASMUS students is that they can use materials from both universities, Italian and Polish one. Because of restrictive measures, we have plenty of time to study and we can utilize it to the fullest. Students would like to have more opportunity to study some parts with on-line way [7].

CONCLUSION

Italian and Polish studying organization is similar. Erasmus Students have access to more than one University materials.

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