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LATERAL DECUBUTUS POSITION AND eTCO₂ PROCALCITONIN MEASUREMENTS DURING EARLY DIAGNOSIS PROCESS THE SURGICAL PHYSICIAN ASSISTANT PROPOFOL AND PRIAPISM

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THE DELTA INDEX – THE DIFFERENCE BETWEEN END TIDAL CARBON DIOXIDE CONCENTRATION IN RIGHT AND LEFT LATERAL DECUBITUS POSITION – COULD PREDICT PULMONARY EMBOLISM – PRELIMINARY RESULTS

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Abstract

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Abstract	ney words	
Aim: To determine the presence and the importance of a difference in end tidal carbon dioxide between lateral decu-	capnography,	
bitus positions for purmonary emporism prediction.	pullionary embolishi,	
Material and methods: There were 32 patients aged 65.7±14.4 (16M, 16F) with pulmonary embolism and 15 pa-	emergency department	
tients aged 56.7±20.3 (10M, 5F) with excluded pulmonary embolism Capnography was performed in supine, left and		
right lateral decubitus position. The absolute value of the difference in end tidal carbon dioxide concentration between		
left and right decubitus position was called the delta index. Demographics and clinical data were collected.		
Results: The delta index was significantly higher in patients with pulmonary embolism vs those with excluded pul-		
monary embolism: 4 (3-5.5) mmHg vs 1 (1-2) mmHg p<0.001. Area under curve for the delta index was 0.92; 95% Cl		
0.83-1.0 p 3 mmHg to predict PE the sensitivity and specificity was 66% and 100%, respectively.		
Conclusions: The patients with pulmonary embolism had increased variability of end tidal carbon dioxide concentra-		
tion while changing their position.		

INTRODUCTION

Pulmonary embolism (PE) is a life-threatening condition [1]. The clinical symptoms of PE are similar to many other medical conditions. The nonspecific clinical presentation of the diseases challenges its identification. The diagnosis of the PE is difficult and only minority of patients with suspected PE had it confirmed after the diagnostic process [1]. For this reason, further researches are being conducted to improve the diagnostic methods of PE. The non-invasive methods are particularly sought after because they can be used in a larger group of patients and represent a lower risk of complications.

Capnography is a potential diagnostic tool for suspected pulmonary embolism. However, despite many technological improvements measurement of the end-tidal-carbon dioxide concentration ($eTCO_2$) does not allow to rule out PE in suspected patients. Therefore, $eTCO_2$ is not recommended in current guidelines to perform as a diagnostic test in these patients [1].

One of the proposed method to diagnose PE was comparison of eTCO₂ in two lateral decubitus positions [2]. Lying on the one side diminishes its movements and increases the ventilation of the opposite side. In case of dominant one side PE, the eTCO, in the exhaled air from the more involved lung is lower than from the less involved lung, because the increase of the dead space [3, 4]. Therefore, it was supposed that lying on the side of the lung with higher amount of thrombosed arteries increases eTCO₂ in comparison to eTCO, while lying on the healthier lung [2]. Finally, the difference in eTCO, while measured in the both lateral decubitus positions could be observed [2]. However, the proposed model may not occur as expected because of contraction of vessels of unventilated area. The non-perfused area may have decreased production of lung surfactant, which leads to atelectasis of non-perfused areas [5].

THE AIM

The aim of the study was to determine the presence and the importance of a difference in $eTCO_2$ between lateral decubitus positions in patients with suspected PE.

MATERIAL AND METHODS

The study was approved by Bioethical Commission No 583/2019.

The study was designed as retrospective analysis of the medical records of patients admitted to the Emergency Department due to PE suspicion as well their capnography performed during 24 hours after admission.

The patients were suspected to have PE at admission because of chest pain, dyspnoea or syncope as a main complaint. All studied patients had performed computed tomography pulmonary angiography (CTPA).

The studied patients had performed side stream capnography using Emtel monitor with nasal cannula. The $eTCO_2$ in the both lateral decubitus position was assessed during 10 seconds after 30 seconds lying in the given position. The delta index was defined as an absolute value of the difference between $eTCO_2$ in two lateral decubitus positions. The delta index is considered to be a measure of $eTCO_2$ variation. Respiratory rate and $eTCO_2$ were assessed also in supine position.

Table 1. The demographics and clinical data.

	Study group Patients with PE N=32	Control group Patients with- out PE N=15	р
Age, mean±SD	65.7±14.4	56.7±-20.3	0.09
Male gender, n (%)	16 (50.0)	10 (66.7)	0.28
Chronic heart failure, n (%)	5 (15.6)	1 (6.8)	0.70
Previous myocardial infarction, n (%)	5 (15,6)	1 (6.8)	0.70
Diabetes, n (%)	6 (18.8)	2 (13.3)	0.64
Hypertension, n (%)	18 (56.3)	7 (46.7)	0.53
Chronic obstructive pulmonary disease, n (%)	1 (3.1)	0 (0)	0.70
Cancer, n (%)	13 (40.6)	0 (0)	0.01
D dimer, ng, median (IQR)	4.78 (1.93-11.2)	1.50 (0.69-2.24)	<0.001
Creatinine, mg, median (IQR)	0.99 (0.89-1.36)	0.84 (0.79-0.99)	0.008
C-reactive protein, ng, median (IQR)	29.8 (8.8-87.6)	2.39 (0.7-5.58)	<0.001

PE – pulmonary embolism

The following demographic data were collected: age, gender. The concomitant diseases: congestive chronic heart failure, previous myocardial infarction, arterial hypertension, diabetes, chronic obstructive pulmonary disease, cancer were noted.

The result of CTPA was assessed as presence of thrombi in pulmonary arteries, pleural effusion, pneumonia infiltration, and neoplasm. The presence of thrombi in pulmonary arteries was classified as unilateral or bilateral thromboembolism, and by the largest artery involved as main trunk, main right or left artery, lobar, segmental and subsegmental arteries.

From laboratory tests have been reported D-dimer, creatinine, C-reactive protein levels. According to data from EMTEL company the end-tidal CO₂ value was the highest peak CO₂ value of all end of expirations (end of breaths) over the 10 seconds period. If less than two breaths exist in the selected time period, the value will be the maximum eTCO₂ value for the last two breaths.

Table 2. Complaints at admission and computed tomography pulmonary angiography results.

1 5 6	Study group Patients with PE N=32	Control group Patients without PE N=15	P
Chest pain, n (%)	9 (28.1)	2 (13.3)	0.46
Dyspnoe at rest, n (%)	12 (27.5)	1 (7.7)	0.064
Dyspnoe at exercise, n (%)	16 (56.3)	0 (0)	0.002
Syncope, n (%)	7 (21.9)	13 (76.6)	0.001
Pulmonary embolism:		0 (0)	0.001
main trunk, n (%)	7 (21.9)		
main left or right artery, n (%)	6 (18.8)		
lobar artery, n (%)	13 (40.6)		
segmental artery, n (%)	5 (15.6)		
subsegmental artery, n (%)	1 (3.1)		
Bilateral PE, n (%)	20 (62.5)	0 (0)	0.001
Pneumonia infiltrations, n (%)	8 (25)	0 (0)	0.09
Pleural effusion, n (%)	3 (11)	0 (0)	

PE - pulmonary embolism

STATISTICAL ANALYSIS

The continuous variables with normal distribution were presented as means and standard deviations and compared with Student's T test with Yates's correction when necessary The continuous variables with no normal distribution were presented as medians and interquartile ranges and compared with Mann Whitney's U test. The discrete variables were presented as number and percentages and compared with chi² test.

Receiver operating characteristics (ROC) curve analysis was performed to find cut off points to distinguish patients with and without PE on the basis of the eTCO₂, the delta index, and D dimer level.

P less than 0.05 was considered as significant.

RESULTS

A total of 47 patients aged 62.8 ± 12.8 was included into the study. The study group consisted of 32 patients with recognized PE and the control group of 15 patients with excluded PE.

The patients in the study group tended to be older and had significantly more frequently recognized cancer.

The demographics and clinical data were presented in the table 1.

In the table 2 the complaints at admission and findings in the computed tomography pulmonary angiography (CTPA) were presented.

The study group patients had more often dysp-

Table 3. Capnography data: respiratory rate.

	Study group Patients with PE N=32	Control group Patients without PE N=15	Р
eTCO ₂ in supine position (mmHg)	26.9±6.8	31.2±5.0	0.035
Respiratory rate in supine position (1/min)	21.5±8.6	18.9±5.6	0.29
Delta index (mmHg)	4 (3-5.5)	1 (1-2)	0.001
Delta index (mmHg), median (IQR)/ No	7 (21.9)	13 (76.6)	0.001
Main trunk		0 (0)	0.001
main artery	3 (2-4)/7		
lobar artery	5 (4-6)/6		
segmental artery	4 (3-5)/13		
subsegmental artery	5 (2-6)/6		
subsegmental artery, n (%)	3 (3-3)/1		

PE - pulmonary embolism

noea at admission whereas the control group patients more often had syncope.

The control patients had no lung infiltrations and no pleural effusion in their CTPA results.

In the table 3 the delta index (the difference between $eTCO_2$ on the both patient's sides) was presented in the whole groups and in subgroups chosen on the basis of the largest artery with thromboembolism.

In the figure 1 and 2 the ROC analysis results were presented. Area under the curve for eTCO₂ in supine position was 0.32; 95 CI 0.16-0.45) p=0.024 but the point where the Youden index reaches the maximum was undetermined. Area under curve for the delta index was 0.92; 95% CI 0.83-1.0 p<0.001 and the Youden index reaches the maximum when taking the delta index more than 3 mmHg. When using the condition of the delta index > 3 mmHg to predict PE the sensitivity and specificity was 66% and 100%, respectively. Area under curve for D-dimer was 0.83: 95% CI 0.69-0.97 p<0.001 and the Youden index reaches the maximum when taking D-dimer concentration more than 1.6 ng/ml. When using the condition of D-dimer concentration> 1.6 ng/ml to predict PE the sensitivity and specificity was 93% and 60%, respectively. The difference between AUC for the delta index and D-dimer was not significant p=0.19.

DISCUSSION

The first finding of the study was that the eTCO₂ could change while body position is changing which seems to be imporatnt in early phase of PE. This variation could be quantified as the differences between two eTCO₂ values and in this report was called the delta index. In the presented study the delta index above 3 mmHg was related to the PE presence. Robin et al. postulated that ventilation of the non-perfused alveoli results in decrease in the eTCO₂ [3]. Lying on the more affected side causes ventilation mainly of the opposite site what results in eTCO₂ increase. Contrary, lying on the less affected side may result in eTCO₂ decrease. Finally, changing the body position may change the eTCO₂. eTCO₂ is often decreased in PE, however some patients may have this parameter within normal limits [6]. The meta-analysis of 14 trials including 2,291 patients with 20% prevalence of PE revealed that capnography alone was 80% sensitive and 49% specific [7]. Therefore, different modalities were used to improve the usefulness of eTCO, in PE prediction. Volumetric capnography was one of the very promising methods [8]. However, this method requires special dedicated devices and is not easy available [8]. The other method is calculation of the



alveolar dead space fraction which requires arterial blood gas analysis [6].

Capnogram quantification was used to distinguish COPD and chronic heart failure. Airway obstruction in COPD results in a curved, "shark's fin" appearance of the capnogram [9]. Respiration is not only an automatic activity. Respiration can be disturbed by coughing, sneezing, talking and eating, which makes signal analysis difficult [10, 11]. Moreover, exercise increases metabolism and carbon dioxide production as well as blood flow through the apical lungs' segments, which may result in the change in eTCO₂.

Quantitative analysis of the capnogram stress test would enable capnography to be a diagnostic tool. The changing body position may be the simplest stress test for capnography analysis. Although CTPA is supposed to be a golden standard for PE diagnosis, negative CTPA alone or with negative D dimer were observed in patients with confirmed PE. Therefore, adding test representing disturbances in ventilation specific for PE may be of clinical value.

LIMITATIONS

The main limitation of the study is that the control group consisted of patients without significant lung dysfunction. In case of unilateral pneumonia or neoplasm, a higher difference between $eTCO_2$ in two lateral decubitus position can be expected. Therefore, the significance of the obtained results could be applied mainly to the patients with normal chest X-ray.

The second limitation is that in case of symmetrical involvement of the pulmonary arteries the difference would be low. Therefore, this parameter alone is not able to exclude the pulmonary embolism.

CONCLUSIONS

- 1. The patients with pulmonary embolism had increased variability of $eTCO_2$ while changing their position.
- 2. Further studies are needed to assess variability of eTCO₂ while changing position in different groups of patients in whom PE is considered in the differential diagnosis.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest.

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CHARACTERISTICS OF PATIENTS WITH PROCALCITONIN MEASUREMENTS DURING EARLY DIAGNOSIS PROCESS

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Abstract

Aim: To present the population of patients admitted to the Emergency Department in whom their attending physician decided to assess PCT level.

Key words

Material and methods: All data were collected between 01/04/2022 and 30/04/2022. The inclusion criterion was performed PCT measurement at admission to the Emergency Department. The following data were noted: age, gender, temperature, blood pressure, heart rate, SpO₂, respiratory rate, Glasgow Coma Scale, the diagnosis: pneumonia, infection tractus urinary, diabetes, SARS-Cov-2 infection, PCT level, C-reactive protein level, leucocyte level, glomerular filtration rate. PCT upper normal limit was 0.05 µg/L, C- reactive protein upper limit was 5 mg/dL and leucite number was between 4 and 10 G/dL. **Results:** PCT level was increased in 68 (83%) of the studied group. The patients with increased PCT level are older, have

lower blood pressure and more often increased C-reactive protein concentration. These patients tended to have increased in-hospital mortality. **Conclusions:** PCT level was increased in the majority of patients in whom this parameter was assessed by emergency phy-

sicians. Abnormal leucocyte number and the presence of temperature above 37 Celsius degree had no prediction value of presence of increased PCT. Increased PCT level may indicate the increased risk of the in hospital death. Simple guidelines for PCT usage need to be created and implemented in everyday clinical practice.

procalcitonin, clinical laboratory, respiratory tract infection, sepsis

INTRODUCTION

Procalcitonin (PCT) is a peptide precursor of the hormone calcitonin produced by thyroid and neuroendocrine cells of the lung and intestine. PCT is classified as an acute phase reactant. The level of PCT in the human body rises as a response to a pro-inflammatory stimuli, especially of bacterial origin. Serum PCT is also a biomarker with high sensitivity and specificity in identifying patients with sepsis [1]. However many physicians are still uncertain about the test, which acts as a barrier in usage [2]. That's why we decided to control it, to maybe in the future create a straight forward set of guidelines for PCT measurement.

THE AIM

The aim of the study was to present the population of patients admitted to the Emergency Department in whom their attending physician decided to assess PCT level. Furthermore the patients with increased and normal values of PCT were compared.

MATERIAL AND METHODS

The study was designated as retrospective analysis. The study was approved by the local ethics committees (No RNN/116/22/KE). All data were collected from electronic recordings of patients admitted to the Emergency Department of Central Clinical Hospital of Medical University of Łódź, Poland between 01/04/2022 and 30/04/2022. The inclusion criterion was performed PCT measurement at admission to the Emergency Department.

The following data were noted: age, gender, temperature, blood pressure, heart rate, SpO_2 , respiratory rate, Glasgow Coma Scale, the diagnosis: pneumonia, infection tractus urinary, diabetes, SARS-CoV-2 infection, PCT level, C-reactive protein level, leucocyte level, glomerular filtration rate.

PCT upper normal limit was 0.05 μ g/L, C- reactive protein upper limit was 5 mg/dL and leucite number was between 4 and 10 G/dL.

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STATISTICAL ANALYSIS

DISCUSSION

The continuous variables were presented as means and standard deviations and compared with Student's T test or medians and interquartile ranges and compared with U Mann Whitney U test. The discrete variables were presented as numbers and percentages and compared with ch2 test.

p<0.05 was considered as significant.

RESULTS

PCT level was increased in 68 (83%) of the studied group.

In the table 1 the patients with increased and with normal PCT level were compared.

The patients with increased PCT level are older, have lower blood pressure and more often increased C-reactive protein concentration. Moreover, these patients tended to have increased inhospital mortality.

It is a well known fact that serum PCT is a promising biomarker for early detection of bacterial sepsis with a good negative predictive value for bacteraemia [3]. Unfortunately, when a patient presents with some diseases like COVID-19, procalcitonin does not succeed in identifying community-associated bacterial infection [4]. However looking at the data, it lacks positive predictive value for many of the symptoms, mainly just correlating with other biomarkers, such as CRP. The potential advantages of PCT over CRP include a more rapid increase and earlier peak at 24 h following infection and a faster decrease following resolution of infection [5]. In patients presenting with dyspnea, diagnostic accuracy of procalcitonin for pneumonia is only moderate and lower than that of interleukin 6 and CRP [6] - to diagnose invasive bacterial infection and their severity assessment of PCT levels alone may not be enough [7].

Table 1. Clinical characteristics and laboratory findings in patients with and without increased PCT level.

	Procalcitonin level increased N=68	Procalcitonin level within normal limits N=14	р	
Age, years	70.4±17.5	59.6±20.3	0.001	
Female gender n (%)	36 (52.9)	4 (28.6)	0,1	
Systolic blood pressure (mmHg)	125.3±27.6	148.3±15.9	0.004	
Diastolic blood pressure (mmHg)	75.5±17.6	88.3±13.0	0.032	
Heart rate (bpm)	91.9±24.5	84.2±13.1	0.31	
Sp0 ₂ (%)	93.4±6.7	96.4±1.9	0.10	
Respiratory rate (per min)	18.3±4.6	16.1±1.7	0.073	
Glasgow Coma Scale	15 (15-15)	15 (15-15)	0.35	
Temperature > 37°C n (%) N=76	30 (48)	7 (50)	0.50	
Increased C-reactive protein n (%)	65 (95.6)	8 (57.1)	0.001	
Abnormal leucocyte number n (%)	33 (48.5)	6 (42.9)	0.70	
Glomerular filtration rate (ml/min/m ²)	61.2 (32.6)	82.2 (25.3)	0.044	
Pneumonia n (%)	24 (35.2)	5 (35.7)	0.98	
SARS-CoV-2 infection	3 (4.4)	1 (7.1)	0.68	
Urinary tract infection n (%)	11 (16.2)	1 (7.1)	0.65	
Diabetes n (%)	16 (23.5)	3 (21.4)	0.87	
In-hospital death n (%)	12 (17.7)	0 (0)	0.19	

That's why evidence for PCT-guided antibiotic therapy is strongest for de-escalation of antibiotic therapy in patients with sepsis or high-risk infection with serial PCT measurement rather than a single measurement advisable in most situations [8]. Because of quick rise in serum levels and quick fall after correct therapy, procalcitonin guidance significantly limits and targets the antibiotic exposure, without any obvious impact on the clinical outcomes [9] – following the PCT-guidance approach, the length of antibiotic therapy was reduced and there were survival benefits in terms of reduction in both in-hospital and 28-day mortality reflecting a direct impact on all baseline infections [10]. Recording PCT levels on hospital admission was found to substantially reduce the initiation of antibiotic treatment in low-risk situations (i.e., bronchitis, AECOPD). For more severe infections (i.e., pneumonia, sepsis), antibiotic stewardship by monitoring PCT kinetics resulted in shorter antibiotic treatment duration by early cessation of therapy [11].

According to literature, the biggest problem concerning procalcitonin is the lack of simple guidelines, that would help clinicians put it to practice. Doctors around the world are not sure when to measure PCT levels as well as which level of them is an indication to begin antibiotics treatment. Some people consider $0.1\mu g/L$ as the cut-off value between correct and elevated PCT and some people believe levels above 0.25µg/L are the ones we should be referring to. Considering the growing rate of multidrug-resistant infections worldwide, as well as the currently scarce antibiotic pipeline, all caused by the excessive use of unnecessary antibiotics, the application of stewardship strategies, including PCT, tailored to individual patient and hospital's needs to reduce antibiotic overuse, can help slow down this progressive antibiotic loss [12]. It especially would help in multifactorial departments such as emergency department, where an initial elevated PCT level could be used as a cue for the initiation of antibiotics, whereas the absence of PCT elevation could prompt clinicians to withhold antibiotics in patients in whom an infection was initially suspected and pursue further diagnostic investigations [13].

CONCLUSIONS

- 1. PCT level was increased in the majority of patients in whom this parameter was assessed by emergency physicians.
- Abnormal leucocyte number and the presence of temperature above 37°C had no prediction value of presence of increased PCT.
- 3. Increased PCT level may indicate the increased risk of the in hospital death.
- 4. Simple guidelines for PCT usage need to be created and implemented in everyday clinical practice.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest.

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RESULTS OF THE IMPACT OF ANTIPROTEINASE HEMOSORBENT ON THE DYNAMICS OF THE MAIN MARKERS OF INFLAMMATION IN CHILDREN WITH SEVERE FORMS OF PERITONITIS

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Aim: To study the effect of the antiproteinasehemosorbent "Hemo-proteasesorb" on the dynamics of the main markers of inflammation in the complex intensive care of children with generalized peritonitis.

Abstract

Material and methods: A prospective randomized study of 60 children with generalized peritonitis was conducted. Group I included 30 patients who underwent hemoperfusion through the sorbent "Hemo-proteazsorb". Group II included 30 patients who underwent traditional treatment. The examined groups were comparable in the nature of pathology and severity of the condition.

Results: After hemoperfusion, a significant decrease in the main markers of inflammation was found: C-reactive protein decreased from 83.7 (72.2; 131.3) to 12.9 (10.0;22.0) (p=0,0003) mg/l, procalcitonin level normalized from 4.65 (2.1;7.4) to 0.21 (0.07;0.4) (p=0,00002) ng/ml, presepsin level decreased from 5.7 (2.5; 8.8) to 0.4 (0.3; 0.8) (p=0,25) ng/ml, the level of IL-6 decreased from 25.3 (6.0; 68.8) to 4.6 (0.9; 8.3) (p=0.000001) pg/ml. When compared in the second group, the studied indicators changed much more slowly.

Conclusions: The data obtained as a result of the study indicate a decrease in the severity of the inflammatory process, a decrease in the risk of sepsis in the group of patients who underwent hemoperfusion, and thereby prove the effectiveness of this method.

Key words

children, peritonitis, markers of inflammation, cytokines, hemoperfusion

INTRODUCTION

Generalized peritonitis refers to a severe form of abdominal infection, as a result of which, during the generalization of inflammation, bacteria are translocated from the intestine into the bloodstream, followed by the development of a severe septic condition. On the surface of pathogenic bacteria are found specific components known as pathogen associated molecular patterns (PAMP), such as endotoxin of gram-negative bacteria, peptidoglycans of grampositive microorganisms, lipoteichoic acid, lipopeptides, flagellin, mannan, etc. During infection, PAMP is identified by pattern recognition receptors (PRR) expressed on the surface of immune cells [1]. The signal from these receptors activates leukocytes and induces the synthesis of both pro and anti-inflammatory cytokines, including tumor necrosis factor-alpha (TNF- α), interleukin (IL) -1, IL-6, IL-8 and IL-10. The massive release of cytokines into the blood is described in the world literature as a "cytokine storm",

as a result of which multiple organ failure develops, which is accompanied by high mortality [2, 3]. However, it has not been established whether the release of cytokines during sepsis is the result of their increased production or a decrease in their natural elimination [4].

The leading role in the body's immune response to microbial agents and their toxins, of course, belongs to the innate (nonspecific) immunity system aimed at recognizing highly conserved antigenic structures. The response of the innate immune system is necessary not only to destroy the pathogen, but also to trigger a specific adaptive immune response with the participation of T and B lymphocytes [5].Pattern recognition receptors for lipopolysaccharide belong to class I transmembrane proteins and are known as Toll-like receptors. Full activation of TLR4 occurs after endotoxin is combined with lipopolysaccharidebinding protein and the complex interacts with the CD14 receptor and additional protein MD2 (myeloid

differentiation factor 2). After that, the nuclear factor kappa-light-chain-enhancer of activated B cells (NF-kB) transcription factor is activated through the system of proteins MyD88, TIRAP, and IRAC, which form a signaling complex with mitogen-activating protein kinase, and the transcription of early pro-inflammatory genes encoding IL and TNF-α synthesis is triggered. There are other adapter proteins involved in transduction of an intracellular signal upon activation of other Toll-like receptors - Tram, Trif [6-8]. The transcription factor NF- κ B, binding to DNA regions, activates target genes, which leads to the production of early (primary) pro-inflammatory cytokines - TNF- α and IL-1 β [9], as well as antiinflammatory cytokines - IL-4, IL-10, transforming growth factor.Excessive production of TNF-α and IL- 1β stimulates the release by mononuclear phagocytes and immunocompetent cells of secondary pro-inflammatory cytokines - IL-6, IL-8, platelet activation factors, thromboxanes, prostaglandins, components of the complement system and nitric oxide, which is the main mediator of vasodilation.When released into the bloodstream, pro-inflammatory mediators bind through their receptors to immunocompetent cells, activating and enhancing a nonspecific immune response. Anti-inflammatory cytokines act here as pro-inflammatory cytokine antagonists. The result is an imbalance between the inflammatory and antiinflammatory response that clinically coincides with sepsis and septic shock.Further, the regulation of the body's response to severe infection is lost and there is a massive, excessive release of pro-inflammatory cytokines by cells, such as TNF- α and IL-1 β , thus making the course of the disease worse. TNF-aacts synergistically with IL-1 β , with their joint influence, the development of hypotension or shock takes place. Excessive production of these cytokines is very dangerous due to the initiation of such pathological processes as diffuse capillary injury, activation of coagulation processes and a decrease in fibrinolysis, leading to the development of disseminated intravascular coagulation syndrome, tissue hypoxia with subsequent organ dysfunction [4]. Understanding this complex mechanism has led to the development of a treatment strategy aimed at restoring a balanced immune response by removing these inflammatory mediators.At present, various methods of anticytokine adsorption are being actively and successfully developed and introduced into practice. Of course, not all methods of extracorporeal hemocorrection have been fully studied in relation to a particular critical situation, however, it is clear that carrying out extracorporeal hemocorrection in sepsis from the point of view of evidence-based medicine is not a waste of time, but an effective direction in the treatment of septic patients [8, 9].

THE AIM

The aim of the study was to study the effect of the antiproteinasehemosorbent "Hemo-proteasesorb" on the dynamics of the main markers of inflammation in the complex intensive care of children with generalized peritonitis.

MATERIAL AND METHODS

A prospective randomized controlled study was carried out in 60 pediatric patients admitted to the anesthesiology and intensive care unit of the Grodno Regional Children's Clinical Hospital after surgery for appendicular peritonitis. With the help of a program-generator of random numbers, 2 groups are formed. The comparison group (II) consisted of 30 patients who underwent complex conservative treatment in the postoperative period in accordance with the clinical protocol for the diagnosis and treatment of children with a general surgical profile. The main (I) group consisted of 30 children who, as part of a complex conservative therapy, underwent a selective hemoperfusion operation using the Hemo-proteasesorb. The study was conducted in accordance with bioethical standards, approved by the institution's ethics committee and in accordance with the principles of the Declaration of Helsinki. Each legal representative of the child obtained an informed consent for hemoperfusion and blood sampling with the subsequent use of the obtained medical data.

The quantitative determination of C-reactive protein (CRP) in blood serum was carried out by the immunoturbidimitry method on analyzers BS - 200 (Mindray, China), AU-480 (Beckman coulter, USA). Determination of the quantitative concentration of procalcitonin (PCT) in serum and plasma was carried out using an automatic enzyme-linked immunosorbent system miniVIDAS (VIDAS B.R.A.H.M.S PCT, "bioMerieux S.A.", France) based on an enzymelinked immunosorbent assay. The fibrinogen level was studied using an ACL 10000 coagulometric analyzer (Instrumentation Laboratory, USA). The content of human sCD14 ("Elabscience Biotechnology Co., Ltd", USA), presepsin (human sCD14st, "Wuhan Fine Biotch Co., Ltd", China) of proinflammatory cytokines (TNF-α, IL-1 beta, IL-6, "Vector-Best", Russia), anti-inflammatory cytokines (IL-4, IL-10, "Vector-Best", Russia) in plasma was measured using an enzyme immunoassay analyzer Sunrise ("Tecan Austria GmbH", Austria).

The study in the first and second groups was carried out in three stages: stage I - after surgery within 12 hours (initial data), stage II - after 24 hours, stage III - after 48 hours. The selective hemoperfusion procedure was carried out on average 12 (8.0; 24.0) hours after surgery. Statistical processing of data was carried out using the program for statistical processing of the material STATISTICA 10.0.To test the hypothesis that the distribution is normal, quantitative tests were used: Kolmogorova-Smirnova, Lillifors, Shapiro-Wilk. Methods of nonparametric statistics were used in connection with the abnormal distribution of features. The statistical significance of differences for independent samples was determined using the Mann-Whitney Utest, and for the dependent groups, the Wilcoxon test was used.Differences were considered significant at p <0.05. The Holm – Bonferroni correction was used for pairwise comparisons [10]. Quantitative variables are expressed as median, lower and upper quartiles: Me (L; U); Me (25%;75%). Calculations were made of relative risk (RR), relative risk reduction (RRR), absolute risk reduction (ARR), the number of patients who need to be treated to prevent 1 adverse outcome (NNT), the odds ratio for a particular outcome (OR) was calculated. The confidence interval was calculated for 95% probability.

RESULTS

All patients were admitted to the hospital with an acute appendicitis clinic, with a disease duration of 48.0 (24.0; 72.0) hours. The mean duration of the disease (p = 0.438) and the time from the moment of admission to the hospital to surgery (p = 0.26) did not differ significantly in both groups. Surgical treatment consisted in the removal of the destructively altered appendix, sanitation and drainage of the abdominal cavity. By gender, children were distributed as follows: boys 35 (58.0% CI 45.5-70.5), girls 25 (42.0% CI 29.5-54.5). The average age was 7.5 (4; 12) years. There were no significant differences in age (p =(0.539), weight (p = 0.662), gender (p = 0.27) in the groups. The indicator of the average length of stay in the intensive care unit for group I was 4.0 (3.0; (5.0) days versus (4.5) (3.0); (6.0) days in the second, and the indicator of the average total length of staywas 14.0 (11.0; 18.0) days versus 15.0 (12.0; 20.0) days. The examined groups were comparable in terms of the nature of the pathology and the severity of the condition.

STUDY OF C-REACTIVE PROTEIN, PROCALCITONIN, FIBRINOGEN

One of the simple and widely available methods of endotoxemia control is the determination of C-reactive

protein in blood serum. The progressive increase in CRP is associated with the activity of the inflammatory process and the degree of tissue damage. Its increase over 40 mg/l indicates the presence of a severe bacterial infection. The concentration of CRP reflects well the dynamics of the inflammatory process. The PCT level >2 ng/ml indicates the development of a severe inflammatory response and a high risk of developing sepsis against the background of a bacterial infection. In addition, it has been proven that its level correlates with the severity and severity of microbial invasion [11, 12]. The dynamics of CRP, PCT, fibrinogen in the studied groups is presented in Table 1.

When analyzing the initial data, the CRP level in the first group was 83.7 (72.2; 131.3) mg/l versus 117.5 (52.6; 150) mg/l in the second group, but the PCT value was significant (p = 0,012) was higher in the first group 4.65 (2.1; 7.4) ng/ml than in the second - 1.8 (0.3; 6.6) ng/ml. The data obtained indicate the absence of a direct correlation between these indicators.

When studying the CRP indicator in dynamics, it was found that in the first group, already 3 hours after the use of HP, a significant (p = 0,004) decrease by 12% to 69.4 (62.5; 88.1) mg/l was noted, after 24 hours, this indicator decreased from the initial by 18% (p = 0,039) and amounted to 61.2 (28.7; 78.1) mg/l, after 48 hours it decreased by another 6.5 times (p = 0,0003) to 12.9 (10.0; 22.0) mg/l. In the group without HP, this indicator remained at high numbers and only after 48 hours its slight decrease (p = 0,77) to 99.8 (51.0; 139.6) mg/l was noted.

After HP, a positive trend was established in relation to the PCT indicator: after 3 hours, its level decreased 2 times from the initial one and amounted to 2.4 (1.2; 4.8) ng/ml, and after 48 hours, this indicator normalized - 0,21 (0.07; 0.4) ng/ml. The decrease in PCT after hemoperfusion was statistically significant (p = 0,00002). In the second group, there was a minimal decrease in the PCT level from 1.8 (0.3; 6.6) ng/ml to 1.5 (0.4; 4.0) ng/ml within 48 hours, which indicates a weak positive response to ongoing therapy.

The fibrinogen concentration in two groups was slightly higher than the norm: in the first - 5.8 (4.9; 6.7) g/l, in the second - 5.4 (4.4; 6.7) g/l, And upon further examination after 24 (I group - 6.0 (5.0; 7.0) g/l, II group - 6.1 (4.8; 6.6) g/l) and 48 hours (I group - 5.8 (4.6; 7.2) g/l, II group - 6.6 (5.6; 7.1) g/l.) Significant differences (p>0.05) between groups is not received.

Table 1. Dynamics of CR	P, PCT, fibrinogen in the stud	lied groups.	
Indicators	CRP (mg/l)	PCT(ng/ml)	Fibrinogen(g/l)
1 group with HP, n=30			
initial data	83,7 (72,2; 131,3)	4,65(2,1;7,4)	5,8 (4,9; 6,7)
after the HP	69,4(62,5;88,1)	2,4(1,25;5,1)	5,5 (5,1;7,0)
р	0,004	0,0003	0,59
after 24 hours	61,2(28,7;78,1)	2,4(1,2;4,8)	6,0 (5,0; 7,0)
р1	0,039	0,0008	0,21
after 48 hours	12,9(10,0;22,0)	0,21(0,07;0,4)	5,8 (4,6; 7,2)
p2	0,0003	0,00002	0,25
group 2 without HP, n=30			
initial data	117,5(52,6;150)	1,8(0,3;6,6)	5,4 (4,4; 6,7)
after 24 hours	111,0(54,0;137,0)	1,5(0,5;3,7)	6,1 (4,8; 6,6)
р1	1,0	0,69	0,79
after 48 hours	99,8(51,0;139,6)	1,5(0,4;4,0)	6,6 (5,6; 7,1)
p2	1,0	0,01	0,48
р3	0,77	0,012	1,0
р4	0,26	0,48	0,37
р5	0,02	0,39	0,79
рб	<0,0001	0,003	0,16

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*p – reliability of differences in comparison before and after HP; p1 – reliability of differences in comparison with the initial data and after 24h.; p2 – reliability of differences in comparison with the initial data and after 48h.; p3 – reliability of differences in the initial data between groups; p4 – reliability of differences in comparison of group 1 after HP with the initial data of group 2; p5 – reliability of differences in comparison between groups after 24h; p6 – reliability of differences in comparison between groups after 24h; p6 – reliability of differences in comparison between groups after 24h; p6 – reliability of differences in comparison between groups after 48h.

STUDY SCD14, CD14ST

CD14 is a glycosyl-phosphatidylinositol-linked protein expressed on the surface of myeloid cells, especially macrophages, a component of the CD14-TLR4-MD2 complex that recognizes lipopolysaccharide. After binding with endotoxins, nonspecific immunity and pro-inflammatory response are activated. Then mCD14 is cleaved from macrophages and in a soluble form (sCD14) enters the circulation. When phagocytosis is activated, lysosomal proteinases cleave sCD14 to form the sCD14-ST fragment, which is called presepsin. This biomarker is associated only with bacterial infection, which makes it possible to use it as the most important criterion for assessing the severity of the condition and monitoring the therapy [13, 14].

The median concentration of the sCD14-ST biomarker before hemoperfusion in the main group was 5.7 (2.5; 8.8) ng/ml, with a norm of 0 - 0.2 ng/ml and was 4 times higher than in the second group - 1.5 (0.4; 3.7) ng/ml. The baseline level of presepsin in the blood directly correlates with the severity of the patient's condition in the two groups. According to the pSOFA scale, the severity of the condition of patients in the main group was significantly (p = 0.003) higher than in the second group (Igr. - 4.5 (3.0; 6.0)

and amounted to 3.7 (1.9; 5.0) ng/ml, and after 48 hours its further statistically significant (p = 0.009) decrease was noted. up to 0.4 (0.3; 0.8) ng/ml. There was also a significant decrease in the total points on the pSOFA scale, from 4.5 (3.0; 6.0) to 0.5 (0; 2.0), p <0.001 within 48 hours, which indicates a decrease in multiple organ dysfunction and improving the condition. In the group without hemoperfusion, at all stages of the study, there was no statistically significant decrease in the level of presepsin (stage I - 1.5 (0.4; 3.7) ng/ml, stage II - 1.0 (0.5; 2.1) ng/ml, stage III - 1.0 (0.4; 1.9) ng/ml, the severity of the condition on the pSOFA scale practically did not change and amounted to 3.0 (1.0; 3.0) points [15]. The concentration of SCD14 in two groups was within the normal range: in the first - 26.8 (25.3;

points, versus in IIgr. - 3.0 (3, 0; 4.0) points). As a

result of hemoperfusion in the main group, the lev-

el of presepsin decreased 1.5 times from the initial

within the normal range: in the first - 26.8 (25.3; 28.5) ng/ml, in the second - 29.6 (26.3; 31.7) ng/ml, and with further study after 24 (I group - 27.5 (25.6; 28.7) ng/ml, II group - 30.9 (29.8; 32.8) ng / ml) and 48 hours (I group - 27.4 (26.3; 28.9) ng/ml, II group - 30.7 (29.4; 32.6) ng/ml) this indicator remained practically unchanged, significant differences (p>0.05) between groups was not obtained.

RESEARCH ON PRO-INFLAMMATORY AND ANTI-INFLAMMATORY CYTOKINES

Cytokines are a system of low molecular weight proteins in the body, under normal conditions their production is insignificant, they regulate the interaction of cells with each other and perform an immunomodulatory function. The damaging effect of pro-inflammatory interleukins is largely neutralized by anti-inflammatory ones, and balance is maintained in their production. With the generalization of inflammation, their excessive release from the cell into the bloodstream occurs with a violation of the regulatory function of the immune system, which leads to an imbalance between pro-inflammatory and anti-inflammatory cytokines in favor of pro-inflammatory ones. In this regard, inflammatory mediators from factors that protect the body become damaging.

Table 2 shows the results of measuring the concentration of cytokines in the blood serum in patients of two groups. In the study of indicators of the cy-

In diamana	Pro-inflammatory cytokines		Anti-inflamma	atory cytokines	
Indicators	TNF-alpha(pg/ml)	lL-1β(pg/ml)	IL-6(pg/ml)	IL-4(pg/ml)	IL-10(pg/ml)
Average value, conditionally healthy	<0,5 pg/ml	<1, pg/ml	2,0 -pg/ml	<0,2 pg/ml	<5,0 pg/ml
1 group with HP, n=30					
initial data	1,9(1,0;16,0)	3,3(1,3;4,7)	25,3(6,0;68,8)	0,8(0,1;2,0)	15,1(6,9;30,4)
after 24 hours	3,7(1,4;15,3)	3,7(1,3;5,2)	8,8(2,0;37,3)	0,5(0,1;2,2)	11,5(5,8;28,0)
p1	0,85	0,78	0,0005	0,26	0,06
after 48 hours	3,1(0,9;17,4)	3,6(1,3;4,7)	4,6(0,9;8,3)	0,8(0,1;2,2)	6,7(4,5;9,5)
p2	0,85	1,0	<0,001	0,13	<0,001
group 2 without HP, n=3	0				
initial data	1,5(1,9;10,1)	3,3(1,3;4,7)	38,0(13,9;73,9)	0,8(0,1;2,1)	15,0(9,4;25,5)
after 24 hours	1,7(0,9;12,4)	3,7(1,2;5,2)	19,2(3,0;39,5)	0,3(0,1;1,5)	9,4(4,9;14,4)
p1	0,55	0,85	<0,001	0,004	0,002
after 48 hours	1,9(0,9;12,4)	3,6(1,2;4,7)	5,5(1,8;9,2)	0,2(0,1;1,4)	6,1(3,2;8,7)
p2	0,85	1,0	<0,001	0,009	<0,001
р3	0,76	0,99	0,46	0,95	0,84
p4	0,41	0,98	0,39	0,39	0,22
p5	0,57	0,95	0,51	0,44	0,24

*p1 – reliability of differences in comparison with the initial data and after 24h; p2 – reliability of differences in comparison with the initial data and after 48h; p3 – reliability of differences in the initial data between groups; p4 – reliability of differences in comparison between groups after 24h; p5 – reliability of differences in comparison between groups after 48h.

Table 3. Evaluation data for the effectiveness of the use of hemoperfusion on the "Hemo-proteazsorb" sorbent after 48 hours.

Clinical efficacy	y Observation time after 48 hours					
criteria	pSofa scale	WBC	CRP	РСТ	presepsin	IL-6
Risk of event in the control group	90%	76,7 %	81,5%	50%	64,7%	50%
Risk of an event in the intervention group	43,3%	16,6%	30,7%	35,2%	7%	36,7%
Relative risk	0,48	0,21	0,37	0,7	0,11	0,73
Reducing absolute risk	46,7% Cl 28,8 – 64,5	60% CI 47,6 – 72,4	50,7 % CI 37,2– 64,2	14,7% Cl 1,8 – 27,6	57,0% Cl 39,3 — 74,7	13,3% Cl 4,7 – 22,0
Reducing relative risk	51,9%	78,2%	62,2%	29,4%	88%	26,7%
Number of patients to be treated	2 (2,14) Cl1,5 — 3,5	2(1,67) Cl 1,4 – 2,1	2 (1,97) Cl1,6 — 2,7	7 (6,8) Cl 3,6– 55,2	2 (1,8) Cl1,3– 2,5	8 (7,5) Cl 4,5 – 21,2
Odds ratio for a particular outcome	11,8	16,4	9,9	1,8	22	1,7

Table

tokine status on the first day after surgery, all children showed the same increase in the level of proinflammatory cytokines: IL-1 β (in group I - 3.3 (1.3; 4.7) pg/ ml, in group II - 3.3(1.3; 4.7) pg/ml), the level of IL-6 (in group I - 25.3 (6.0; 68.8)pg/ml, in group II - 38.0 (13.9; 73.9) pg/ml), and the level of TNF-alpha (in group I - 1.9 (1.0; 16.0) pg/ml, in group II - 1, 5 (1.9; 10.1) pg/ml). The overproduction of these cytokines, without appropriate therapy, results in an inability to control the infection. At the same time, the level of anti-inflammatory cytokines increased slightly: the level of IL-10 in group I. was 15.1 (6.9; 30.4) pg/ml, in group II. - 15.0 (9.4; 25.5) pg/ml). Also, a minimal increase in the level of IL-4 was noted both in the first group - 0.8 (0.1; 2.0) pg/ml, and in the second group - 0.8 (0.1; 2.1) pg/ml.

Analyzing the dynamics of the cytokine status at the second and third stages of the study in group I after the use of HS, there was a significant decrease in such indicators as IL-6 to 8.8 (2.0; 37.3) pg/ml, (p = 0.0005) with a subsequent decrease on the second day to 4.6 (0.9; 8.3) (p = 0.000001) pg/ml. IL-6 plays a key role in the development of cytokine release syndrome due to its pleiotropic properties. In addition to a strong proinflammatory effect, it induces the production of various acute phase proteins, such as C-reactive protein, antitrypsin, fibrinogen, and complement components that trigger inflammatory reactions and activate the coagulation system with the start of DIC, therefore, its normalization is very important. Further, it was found that after the HP, the level of IL-1 β did not change (the second stage - 3.7(1.3; 5.2) pg/ml, the third stage - 3.6(1.3; 4.7)), and the level of TNF-alpha, on the contrary, increased to (the second stage - 3.7 (1.4; 15.3)) pg/ml and at the third stage it was at the same level - 3.1 (0.9; 17.4) pg/ml). These indicators did not have a significant decrease in comparison with the initial stage, which indicated the lack of proper elimination of these metabolites using hemoperfusion. At the same time, the level of IL-10 decreased to 11.5 (5.8; 28.0) pg/ml, (p = 0.06) and after 48 hours was 6.7 (4.5; 9.5) pg/ ml, p = 0.001. As for the level of IL-4, after HP this indicator decreased to 0.5 (0.1; 2.2) pg/ml, and after 48 hours it returned to the initial values 0.8 (0.1; 2.2)pg/ml. Continuing the analysis of the data obtained in group II, during the traditional treatment of peritonitis, we can state only a slow decrease in such cytokines as IL-4, IL-6, IL-10 only 48 hours after the start of treatment, and the level of TNF-alpha and IL-1ß after 48 hours, on the contrary, it increased in comparison with the first stage, the data are presented in table 2.

Taking into account that the statistical reliability is not synonymous with the clinical significance of the study results, the analysis of the effect of HP on the main clinical and laboratory parameters characterizing the severity of the patient's condition was carried out. The following indicators were used as criteria for the effectiveness of treatment: pSOFA scale, leukocytes, CRP, PCT, presepsin, interleukin-6. Table 3 presents data on the clinical effectiveness of the use of hemoperfusion on the "Hemo-proteazsorb" sorbent in the treatment of severe forms of peritonitis.

The data presented in Table 3 show that the use of the HP procedure in the complex treatment of severe forms of peritonitis has a significant positive effect on the course of the inflammatory process. So, 48 hours after the HP, the value of the relative risk of developing negative changes from all selected indicators was less than 1.0. The data obtained indicate a favorable outcome from the intervention. Considering the decrease in the percentage value of the absolute and relative risk by an average of 60% on the part of the pSOFA scale, leukocytes, CRP and presepsin indicate that when using hemoperfusion in two patients, it is possible to avoid negative consequences in one child. If we take into account only PCT and IL-6, then in this case the number of patients who need to be treated will increase to an average of seven. With therapy with standard methods, negative dynamics will be observed 15 times more often than with the use of HP.

DISCUSSION

In 2000, Claudio Ronco pointed out the importance and expediency of using hemosorbents in sepsis [16]. The following selective hemosorbents are currently used in world clinical practice: a cartridge with immobilized polymyxin B (Toraymyxin, Japan), an LPS Adsorber cartridge (Alteco Medical AB, Sweden), a MATISSE-Fresenius system (Fresenius SE, Germany), and a CytoSorbhemoperfusion cartridge (CytoSorbents, Monmouth Junction, USA) [17].

In the literature, most studies evaluating the clinical and laboratory efficacy of hemoperfusion in severe forms of peritonitis refer mainly to adult patients. The available studies in children are described in the form of isolated clinical cases, which makes it difficult to compare them with our results. Positive data on the use of polymyxinhemoperfusion in combination with prolonged veno-venous hemodiafiltration are described in the study by Markova K. et al. in children with refractory septic shock and multiple organ dysfunction syndrome caused by N. Meningitidis. Thanks to the study, it was found that in the group of patients with the use of extracorporeal methods of therapy, it was possible to ensure the stabilization of central hemody-

namics, reduce the concentration of cytokines (IL-6, IL-10, TNF), procalcitonin, lactate, as well as reduce the doses of vasopressor drugs and respiratory support parameters and thereby increasing survival by 82.6%, while in the comparison group all children died (p <0.001) [18]. Yarustovsky M. with a team of authors used Toraymyxin-PMX-05R cartridges in the intensive care of sepsis in children after cardiac surgery. As a result of the treatment, an improvement in hemodynamic parameters, oxygenating lung function, a decrease in the intensity of the infectious process was noted, which was characterized by a decrease in body temperature, a decrease in the level of endotoxin activity, values of procalcitonin, presepsin and C-reactive protein. 28-day survival after extracorporeal therapy was 80% [19].

Numerous randomized clinical trials in adults (EUPHAS, EUPHRATES, ABDO-MIX) comparing polymyxin B adsorption with standard treatment have yielded inconsistent results, suggesting that the beneficial effect of PMX-F may only be in certain subgroups of patients where endotoxin activity levels are initially higher [20, 21, 22, 23]. Experimental and clinical work on the study of the effectiveness of Alteco[®] LPS Adsorber in sepsis showed a significant decrease in the concentration of lipopolysaccharide in the blood, inflammatory mediators and an improvement in hemodynamic parameters and, above all, cardiac output [24, 25, 26]. However, the ASSET (abdominal septic shock - endotoxin adsorption treatment) multicenter randomized clinical trial evaluating the use of theAlteco® adsorber was terminated at an early stage due to patient recruitment problems [27]. CytoSorb technology (CytoSorbents, Monmouth Junction, USA), recognized in Europe, is able to remove not only broad-spectrum cytokines, but also myoglobin, bilirubin, bile acids, pathogen-associated molecular structures (PAMPs) and damageassociated molecular fragment (DAMP) [28]. However, clinical studies remain scarce at this stage and are often limited to case series reporting encouraging results in terms of hemodynamic parameters and blood lactate levels [29, 30]. In a recent randomized controlled trial, Schadler D. et al compared standard treatment for septic shock with CytoSorbhemoperfusion (applied 6 hours a day for 7 days) and found no

decrease in plasma IL-6 levels over time despite to its significant removal during sessions [31].

The analysis of the use of various hemosorbents in the world in sepsis prompted us to use the hemosorbent of domestic production "Hemo-proteazsorb" in children with severe forms of peritonitis. The accumulated experience in the use of hemosorbents in adults allows the use of hemoperfusion in pediatric practice. The data obtained as a result of the study prove the high efficiency of the use of the hemosorbent "Hemo-proteazsorb" along with world-famous hemosorbents.

CONCLUSIONS

- 1. The decisive importance in the intensive care of severe abdominal infection is the timeliness and validity of the initiation of extracorporeal procedures. The maximum effect can be achieved if extracorporeal hemocorrection is performed in the early stages of the onset of clinical and laboratory manifestations of the cytokine release syndrome.
- 2. The early use of hemoperfusion in the complex treatment of widespread peritonitis in children makes it possible to level the imbalance between pro-inflammatory and anti-inflammatory cytokines, which contributes to a favorable resolution of the process and provides a real opportunity to improve the results of treatment of this category of patients.
- 3. Hemoperfusion has a significant positive effect on the course of the inflammatory process, which is confirmed by a significant decrease in the level of markers (CRP and PCT).
- 4. A high postoperative level of presepsin indicates the manifestation of sepsis and is one of the markers for establishing indications for starting hemoperfusion. As a result of the study, a statistically significant decrease in the level of presepsin was found in the group of patients who underwent hemoperfusion, which indicates a decrease in the severity of the inflammatory process and a decrease in the risk of sepsis.
- 5. No reliable data have been obtained on the effect of hemoperfusion on the SCD14 and fibrinogen content in the examined patients.

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CONFLICT OF INTEREST

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WHY DO NOT POMERANIAN VOIVODSHIP (POLAND) CITIZENS WANT TO USE AED DEVICES?

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Abstract	Key words	
Aim: To analyze the level of knowledge and awareness among the inhabitants of the Pomeranian Voivodeship about the AED apparatus and its use in a life and health threatening situation. Material and methods: The survey was conducted on a group of 20,971 inhabit-ants of the Pomeranian Voivodeship (northern Poland).	emergency medicine, automated external defibrillators, first aid	
Results: The responses of people with primary education indicated that they did not know what AED was used for.		
People from cities with district status with incomplete or higher education most often answered that they knew what		
AED was for. The analysis showed a relationship between the level of education and the willingness to start training.		
People with primary and vocational education usually did not want to undertake such activities. Women with lower		
than incomplete higher and higher education would not provide the greatest aid with the use of AED.		
Conclusions: There is a need to install more devices, as well as educational and preventive measures in the areas		
defined as ruralurban and rural communes. Educational activities targeted at the youngest should be implemented.		
The implementation of educational activities with the youngest recipients will result in positive results in the future.		

INTRODUCTION

The automatic external defibrillator (AED) and rapid application of defibrillation [1] are a tool that is widely popularized all over the world and contributes to the improvement of survival rates due to sudden cardiac arrest. Helping the injured person with the use of the apparatus discussed above minimizes the potential consequences of hypoxia, which in turn increases the overall chances of survival. It is estimated that the risk of death in this case drops by about 40% [2]. However, the opportunities offered by the AED are not used satisfactorily [3]. Many components contribute to this. First of all, it is the necessity to apply the discussed device to the injured person as soon as possible after the incident [4]. It is associated with a decrease in the effectiveness of defibrillation by nearly 10% with the passage of each subsequent minute [5]. Taking this fact into account, there is a need to build the largest possible AED network in public space [6].

The issues that equally affect the effectiveness of a rescue operation are: public awareness of the AED, its use and positive consequences resulting from its use, learning to provide first aid and knowledge about the location of devices in the immediate vicinity or their appropriate marking [7]. In view of the above, it becomes obvious that just investing in the largest AED networks will not contribute to increasing survival [8]. The abovementioned side aspects of activities aimed at supporting rescue operations in public spaces are equally important.

AED devices are more and more often found in public spaces. This is due to the increase in the popularity of AED around the world, as well as the results of social programs, reports and orders carried out so far, which constitute socially and economically positive aspects of using AED assistance in case of cardiac arrest [9]. Despite this, the level of use of the AED does not increase. What accounts for the negligible interest of people in this type of help? The study described below was aimed at checking what is behind the fact of not using an AED in the event of a threat to the life and health of people who have suffered from sudden cardiac arrest.

THE AIM

The essence of this work is to analyze the level of knowledge and awareness among the inhabitants of the Pomeranian Voivodeship about the AED apparatus and its use in life and health threatening situations, as well as to identify the basic problems behind the still low level of use of these devices in public space.

MATERIAL AND METHODS

CHARACTERISTICS OF THE GROUP

The questionnaire sheet, in addition to the questions directly related to the AED, took into account the need to provide basic record information: gender, year of birth, educa-tion level and place of residence (municipalities).

20,971 respondents participated in the study. 11,754 women and 9,217 men replied, which is 56% and 44% of the respondents, respectively. The average age of the re-spondents was 41 years. Apart from the sex, year of birth and place of residence, the record information also concerned the level of education. The respondent could choose between education: basic vocational, secondary, incomplete (bachelor's or engineering) and higher (master's). The analysis showed that the largest group of respondents were those who described their level of education as higher (N = 5,694; 27%). The respondents with higher education were immediately followed by people who completed primary education (N = 4,868; 23%).

The above results are different for gender. In the group of women, the most numerous respondents had higher education (N = 3,450; as much as 29%), but the largest group among men were those with primary education (N = 2,383; 35%).

The least numerous groups among both sexes were, respectively: the group with incomplete higher education (N = 1,197; 10%) and secondary education (N = 1,413; 15%).

The vast majority of respondents lived in rural (23%), urban-rural (21%) and urban (19%) areas, i.e. areas that are not large agglomerations. Respectively, 36% of the respondents declared that they live in one of the 4 largest cities of the Pomeranian Voivodeship (Gdańsk, Gdynia Sopot or Słupsk).

METHODS

For the purposes of the following study, a proprietary survey was created. His questions focused on the basic information about automatic external defibrillator. The questions are based on the publication: American Heart Association – AED Program, Q&A 2018 [10]. Any adult resident of the Pomeranian Voivodeship could participate in the study. The form was made available via the Internet using the Google platform – using the main assumptions of the CAWI (Computer Assisted Web Interview) method – and the direct method, i.e. interviews conducted in 123 communes and 4 cities with district rights in the Pomeranian Voivodeship (PAPI – Paper & Pen Personal Interview). The analysis included 20,971 responses (16,488 – PAPI, 4,483 – CAWI form).

The statistical analysis was performed with the use of MS Excel 2013 and the Statistica 13.3 (StatSoft) program (tests with the chi² distribution). 5% was assumed as the sta-tistical error rate. The relationships for which the analysis values are in the range x <0.05 were considered statistically significant.

RESULTS

SURVEY RESULTS

The analysis of the survey focused on possible correlations between the knowledge about the AED apparatus / willingness to use it and the metric data – primarily gender, education and the place of confusion. The following information presents the most important results of the analysis.

SURVEY QUESTIONS AND RESPONSE CHARACTERISTICS

The proprietary questionnaire, prepared for the purposes of the study below, was divided into two parts preceded by a question common to both segments. The first part was addressed to those who answered in the affirmative in the first question. The second part contained questions to the respondents who responded negatively.

First question: Do you know what an automatic external defibrillator AED is?

The affirmative answer was given by 9,011 people (43%). This means that the vast majority of respondents do not know what an AED is (11,960; 57%). In addition, the vast majority of people living in towns located in rural and urban-rural communes were in favor of a negative answer to having knowledge about AED. Despite this, a statistical analysis focused on correlations, only in the two largest cities of the Pomeranian Voivodeship - Gdańsk and Gdynia – revealed a relationship: there is a noticeable relationship between the knowledge of the concept of AED and gender and level of education Women and men, living in the above-mentioned cities and having higher education, showed actual knowledge about external defibrillator equipment. The analysis did not reveal any other statistically significant relationships.

Part I – For those who answered in the affirmative to the first question (part consisting of four questions)

9,011 respondents answered the four questions contained in the first part of the questionnaire.

Among them there were: 4,490 women and 4,521 men (ratio 49% to 51%). Nearly 70% of them lived in municipalities and district towns. This is reflected in the analysis of statistical dependence. The results characteristic for each of the questions are as follows:

The question that started this part of the survey was an introduction to how many people know what AED is. Almost 70% of people (including 67% of men) could not indicate what this apparatus is. Moreover, 92% of the respondents living in rural com-munes were in favor of the lack of knowledge on this subject. The results were also analyzed for correlation. The dependencies were shown confirming the above results:

- The answers of people with primary education most often indicate that they do not know what exactly AED is used for (p = 0.017).
- People from the largest cities, with incomplete or higher education, most often say that they know what AED is for (p = 0.048).

The second question was about the safety of AED use by emergency responders. Similarly to the answer to the first question, the groups that are not familiar with the ap-paratus and its operation were those living in rural areas (86% of this group replied that indicated the danger of using AED). Moreover, the vast majority of people with primary and vocational education stated that AED could contribute to harm to a person who suffered from SCA. Statistical significance analysis confirmed the above results and showed that people with primary and vocational education, living in rural communes, are much more likely to support the use of AED (p =0.009). The respondents, answering the above-mentioned question in the negative, could justify their choice. The most common arguments were:

- electric current and the possibility of electric shock,
- the possibility of electrocution of the injured person.

The third question concerned the willingness to use the AED device (for the first time or again) in the event of a threat to the life or health of the injured person. The city whose inhabitants – in the case of women (47%) and men (54%) – would provide the greatest assistance with the use of AED was Sopot. More than half of the respondents from that city (51%) were in favor of using AED. At the same time, this result was far ahead of other locations. The average level of interest among people living in other administrative units (except Sopot) was 34%. The vast majority of people in favor of using AED in the event of a threat to life and health were those who had incomplete or higher edu-cation (nearly 75% of this group). This was also confirmed in the statistical analysis. It showed that women with lower than incomplete higher education and higher education would not provide assistance with AED to the greatest extent (p = 0.033). Contrary to the previous results, the place of residence did not affect the level of dependence.

The fourth and last question related to the willingness to participate in the first aid + AED course (first / next time). The inhabitants of the largest cities (94%) showed the greatest willingness to participate in the first aid course. A similar level of interest in learning first aid (BLS) + AED was demonstrated by men living in urban-rural districts (96%). This result is extremely favorable in relation to the answer to the third question in this group of respondents. People who would not help the victim are almost 100% in favor of learning first aid. The analysis showed a relationship between the level of education and the willingness to start training. People with primary and vocational education most often do not show willingness to participate in this type of course (p = 0.011).

Part II – for people who answered the first question in the negative (part consisting of two questions)

11,960 respondents answered the two questions included in the second part of the questionnaire. Among them there were 4,450 women and 7,510 men (ratio 37% to 63%).

The first question was related to a course in first aid in the past. It is remarkable that the highest results obtained here reach the level of 20%. Women from the cities of Gdansk and Sopot (both 19%) and men from Gdynia (21%), and therefore of the greatest cities in the Pomeranian province, called for in the past the actual date of the qualified first aid course with elements of AED use. Individuals living in rural areas and ruralurban to very small proportion of the scheduled rate (about 4-7% of these groups). It is surprising, therefore, that in spite of holding such training, they further argued that they do not know what equipment is AED. Similarly to the questions of the first part of the survey, you will see that the level of education plays an important role. People with education more often opted for the holding of such a course (45% of this group). This state of affairs is probably associated with the necessity of holding the first aid courses during undergraduate and graduate engineering.

The situation is different for the second question (willingness to participate in the training). The willingness to take part in the BLS + AED course is high in each of the analyzed administrative units (rural, urbanrural, urban and the largest cities of the voivodeship with district rights). The group of men (97%) and women (98%) living in the largest cities showed the highest results. Other administrative units, such as rural communes, despite the lowest result, did not differ at all from people living in cities with district status. Nearly 82% of people declaring their residence there declared their willingness to join such a course. Statistical analysis showed that men would be much more likely to take part in first aid and AED training (p = 0.03).

DISCUSSION

The current legal situation in Poland does not show reasons that make it difficult to use AED if needed, and at the same time does not in any way block the possibility of increasing the importance of AED and its use by the society [9]. For this reason, the rare use of external defibrillator equipment in the Pomeranian Voivodeship is puzzling. By analyzing the information on AEDs and the degree of their use in the light of the global results and the results obtained thanks to this study, the situation of this region can be described as worrying. The constantly developing infrastructure, infrastructure preparation of the public zone, the coefficient of greater survival or the operation of the AED itself are imperceptible [11]. In this situation, the decisive factor is the lack of interest and awareness of the usefulness and benefits of using automatic external defibrillator equipment.

The most important reason for not using the potential of the AED in the Pomeranian Voivodeship is the fear of using the AED incorrectly, and as a result causing harm to the injured person. The study by Woolard and colleagues proves the existence of tangible benefits of training in the principles of first aid with the use of a defibrillator [11]. This study proves that completing even a short course on basic BLS issues contributes to the increase in the percentage of people who declared assistance with the use of AED in a situation where human life is at risk. Initially, only 44% of respondents were in favor of being ready to use the equipment in the event of sudden cardiac arrest (SCA). Surprising results were brought by the re-examination carried out shortly after the end of the training. At that time, the possibility of using the AED was declared by 100% of the course participants. Therefore, it can

be concluded that even the basic scope of preparation in the field of first aid results in great benefits in terms of saving human life, in a situation requiring immediate response.

Similar results were obtained in the study included in the above publication. The participants of the study, i.e. 9,011 people (people who answered the question about AED knowledge in the affirmative), in only 34% expressed the willingness to provide first aid with the use of AED in the event of a sudden cardiac arrest in outofhospital conditions. It is noteworthy that 89% of respondents were in favor of taking part again / for the first time in the first aid training with the use of a defibrillator.

It should be considered in which target group the promotional, preventive and educa-tional activities. Considering the nature of the event in which sudden cardiac arrest occurs (its suddenness, no previous symptoms, randomness of the place where bystanders are present), the addressees of the above activities should be everyone - adults, adolescents and seniors. Since the introduction of the Public Access to Defibrillation System in Poland (2000), numerous campaigns and educational campaigns on the use of AED have been created. They were aimed at various recipients - from drivers to medical staff. They were conducted in all age groups. First aid trainings were even carried out among preschoolers. Actions of this type make it possible to increase the efficiency indicators and profitability of the already existing AED locations in the public space [9].

The society's perception of the apparatus itself and its marking in public space is also puzzling. In the light of the research carried out by Rega and colleagues, it is advisable to use a standardized form of marking the locations where the defibrillator apparatus is located [12]. The group covered by the study consisted of people professionally connected with the place where the first aid training was conducted. They were asked to complete the questionnaire. The questionnaire concerned the knowledge of the course participants about the location of the nearest AED. Only 19.9% of the respondents could indicate the correct answer about the location of the defibrillator in the building where they spent the last few hours.

A national study deals with a very similar issue. The project, which was carried out by Pogorzelczyk and colleagues within the administrative borders of the Tri-City in 2017, consisted of an analysis of several hundred interviews conducted in direct conversation with people living in Gdańsk,

Gdynia and Sopot [8]. The greatest distance from the defibrillator from which questions were asked was 100 m. Despite such a short distance between the respondent and the AED, only 33% of respondents were able to provide the closest location of the device. The main reason was the residents' lack of interest in the subject. The reasons for the described situations are problems with the correct indication of the point for installing the defibrillator. Such a conclusion was reached in their research by the team working under the command of Huig [13]. He verified the legibility of AED information in several shopping centers. As shown by the results, only 40% of the employees of the sites covered by the analysis indicated that the markings located there were visible and legible to them. As many as 29% of the points covered by the study were characterized by the lack of any way of marking the location of the AED. The Bogle research group [14] reached similar conclusions. After completing the course in first aid, including the use of an AED, nearly 88%

of the study group, consisting of academics and students, were able to indicate the correct location where the AED was installed.

The presented results show that even temporarily limited informational and educational activities, promotion of defibrillation and actions raising awareness of the im-portance of providing aid, are extremely effective activities increasing the profitability and efficiency of investments focused on the Public Access Defibrillation Program group.

CONCLUSIONS

In the light of the results obtained, as well as those presented by the global community, a conclusion arises that it is necessary to impose a priority on the development of ed-ucational and preventive base. Such activities can contribute to the greatest extent to increasing the level of AED equipment operation in the event of a threat to the life and health of people who have suffered from sudden cardiac arrest, and thus to the survival rate.

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

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ORIGINAL ARTICLE

ENDOTHELIUM DYSFUNCTION IN PATIENTS WITH LIVER CIRRHOSIS

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Abstract	key words
Aim: To assess endothelial dysfunction in patients with liver cirrhosis. Material and methods: The study involved 95 patients with alcoholic liver cirrhosis. The data were subjected to analysis of variance involving the calculation of arithmetic mean value and variance (M±m), estimating the values validity according to Student's t-test and measuring Pearson correlation coefficient for binary variables. Results: The brachial artery diameter was 0.4 ± 0.02 mm narrower, with its blood velocity flow being 25.8 ± 3.4 cm/s slower in the mean, in the patients with liver cirrhosis with signs of hepatic encephalopathy as compared to the control group. The maximum EDV values were recorded in the patients in Group I (7.5 ± 1.9 %), while Group III patients displayed the lowest EDV value (5.6 ± 1.9 %). The LC patients were found to exhibit a significant increase in the concentration of ET-1 up to 1.14 ± 0.07 fmol/ml as opposed to 0.34 ± 0.05 fmol/ml in the control group ($p<0.01$), an increase in the level of VWF by 139.4 ± 24.8 % as compared to the control group ($p<0.01$) and D-dimer by a factor of 6.8. Conclusions: The patients with liver cirrhosis were found to have endothelial damage, namely the dysfunction of the vasoregulating activity of vascular wall against the background of portal hypertension. Changes in the vasoactive BAS values are indicative of the damage to the vascular endothelium in LC patients with signs of HE. A steady and gradual increase or decrease in the levels of ET-1, VWF, AT III, and D-dimer may suggest the progressive character of ED in the LC patients.	liver cirrhosis, endothelial dysfunction, portal hypertension

INTRODUCTION

At present, vascular endothelium (ETH) and its functional status are attracting increasing scholars' attention. According to the present-day knowledge, ETH is an active endocrine organ that is dispersed throughout all the tissues, is the largest human body's organ and is capable of the continuous production of biologically active substances (BAS) rather than a simple semi-permeable membrane that lines the inside of blood vessels [1-3, 24].

There is scarce research on the issue, although its importance is apparent. The study into the particular aspects of the participation of vasodilatory (VD), angioprotective and vasoconstrictive (VC) agents may enable the objective assessment of the role these substances play in the physiological control of many system processes and analysis of their pathogenic role in the development of portal hypertension (PH) and its complications in patients with liver cirrhosis (LC) [4, 5]. Internal hepatic hemodynamic disorders affect LC pathogenesis and its progression, which may be attributed to the injury of endothelial lining of sinusoidal capillaries and endothelium dysfunction (ED). ED is primarily understood as an imbalance in the production of vasodilatory angioprotective, prothrombotic and proliferative agents [3, 6, 21-26].

THE AIM

The research paper aims to assess the endothelium dysfunction in patients with liver cirrhosis.

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MATERIAL AND METHODS

The study involved 95 patients with LC who were admitted to the anesthesiology and intensive care unit, the surgery unit or the gastroenterological unit of A. Novak Transcarpathian Regional Clinical Hospital (Uzhhorod) during the period from 2018 to 2020. The study group comprised only the patients with alcoholrelated liver cirrhosis. The exclusion criteria for the study were virus-related LC, primary biliary cirrhosis, liver cancer and Budd-Chiari syndrome.

The participants' ages ranged from 28 to 65 years, the mean age being 42.1 ± 6.8 years. The control group included 15 apparently healthy individuals aged 26-59 years, the mean age being 42.2 ± 3.4 years. The group was composed of 9 males (60.0 %) and 6 females (40.0 %). The patients with LC were allocated to the respective severity class of the disease according to the Child-Pugh classification. Group I (class A by Child-Pugh – well-compensated disease) included 18 (18.95 %) patients, Group II (class B – moderate disease with significant compromise) included 25 (26.3 %) patients, and Group III (class C – decompensated disease) was composed of 52 (54.7 %) patients. The groups were homogenous with respect to the severity class of liver cirrhosis. The effects of gender and age on LC treatment outcomes were not taken into account. The presence of concurrent conditions and changes in other systems were assessed consistently in each group depending on the liver cirrhosis severity class.

In order to perform the clinical assessment of the endothelium function the standard technique developed by D. Celermajer was used. The endotheliumdependent vasodilation (EDV) of the brachial artery (BA) was studied using D. Celermajer method - the brachial artery was examined 3-10 cm above the crook of the arm. The examination was performed by scanning in the two-dimensional display mode while simultaneously recording an electrocardiogram (ECG); the arterial diameter was measured in the diastolic phase in the B-scan mode; the flow velocity changes were measured in the Doppler mode before and after the reactive hyperemia test. A 10% and over 10% increase in the BA diameter within 60-90 seconds in the presence of reactive hyperemia was considered to be a normal response. A lesser degree of the magnitude of dilation or vasoconstriction was evaluated as a pathological response. Ultrasound duplex scanning of the brachial artery was performed with an HDI-1500 device (USA) using a pulse-wave Doppler sensor 2.5 MHz and 5-10 MHz "Zonarae" (USA).

Within 15 minutes after the artery resumed its natural diameter the patient took 0,5 mg of nitroglycerin sublingually. In this procedure, nitroglycerin was used as an endothelium-independent (EIV) stimulus that causes the relaxation of peripheral vessels. The measurements were taken consecutively after 2 and 5 min following the nitroglycerin administration. It is generally accepted that the normal response of the brachial artery is its 10% and over 10% dilation in comparison with its original diameter in the presence of reactive hyperemia. A lesser degree of the magnitude of dilation or vasoconstriction was evaluated as a pathological response. Endothelium dysfunction was detected to be significantly less when the vessel dilated in response to reactive hyperemeia than when nitrates were administered.

The data collected at the patients' examination were analysed and processed using the software STATISTICA (StatSoft Inc, USA). The obtained results were subjected to the analysis of variance that involved calculating arithmetic mean value and variance (M±m), estimating the validity of values according to Student's t-test and measuring Pearson correlation coefficient for binary variables to find the relationships between the values obtained.

RESULTS

During the dopplerographic examination, the patients with LC with signs of hepatic encephalopathy (HE) exhibited a significant decrease in the BA diameter as compared to the control group. Hyperergic response to occlusion, i.e. the enlargement of the BA diameter, was also evaluated (Table 1).

The BA diameter was $0,4\pm0,02$ mm narrower in the patients with LC with HE signs as compared to the control group at the beginning of the study. The patients with LC also exhibited less pronounced enlargement of the BA diameter in the 30th and the 60th second of the examination as compared to the control group.

The patients with LC showed the following results in the increase in the BA diameter in the 30th second of the examination: BA increased in the mean only by 0.57 ± 0.02 mm as opposed to 0.98 ± 0.01 mm in the control group. The same results for this value were registered in the 60th second of the examination, namely: BA in the LC patients increased in the mean only by 0.13 ± 0.01 mm as opposed to 0.49 ± 0.03 mm in the control group. The blood velocity flow in the BA was also in the mean 25.8 ± 3.4 cm/s slower in the LC patients than in the control group. The groups of the patients with LC exhibited the same results when these values were measured (Table 2).

At the beginning of the study, among all the examined LC patients with HE, Group I patients exhibited the maximum BA diameter whose value was 4.11±0.12 mm as compared to 3.84±0.07 mm (the minimum value) displayed by Group II patients, p<0.05. Group I patients were also found to display the largest increase in the BA in the 30th second of the examination $(4.86\pm0.04 \text{ mm})$, while the minimum enlargement of the BA diameter was recorded in Group III patients (4.41±0.08 mm), p<0.05. The same tendency was displayed in the 60th second of the examination. In particular, the maximum value was recorded in Group I patients (4.52±0.06 mm), whereas the minimum value was shown by Group III patients $(3.99\pm0.17 \text{ mm})$, p<0.05. The blood flow velocity in the BA was also13.7±2.7 cm/s higher in Group I patients with LC than in Group III patients.

The changes experienced by the LC patients described above are indicative of the paradoxical vasoconstrictor response which is one of the manifestations of the endothelium dysfunction in this patient population.

The analysis of the results of the instrumental examination, namely the evaluation of endotheliumdependent vasodilation (EDV), is indicative of the presence of endothelium dysfunction in LC patients with HE signs, which was exhibited by the decrease in this value as compared to the same value in the control group (8.2 ± 0.2 % as opposed to 13.9 ± 1.1 % respectively).

Within 15 minutes after the artery resumed its natural diameter, the patients took 0,5 mg nitroglycerin sublingually, which acted as an endothelium-independent stimulus. The measurements were repeated 2 and 5 minutes after the patients taking nitroglycerin. When evaluating endothelium-independent vasodilation (EIV) in the LC patients, the respective value was found to decrease as compared to the control group (in the mean by $10.3\pm1.0\%$).

Hence, according to the results of the reactive hyperemia technique applied to evaluate EDV and EIV, the LC patients with HE signs exhibited pronounced signs of the endothelium dysfunction.

The further analysis of the findings showed that there was a dependence between the LC patients' functional classes by the Child-Pugh classification and EDV and EIV values (Table III).

The findings of the study indicate that there is a dependence between the ED values in the LC patients and the liver injury grade by Child-Pugh. The analysis of the ED value dynamics in the presence of the progression of hepatic impairment indicated the presence of stage-related changes, in particular, Class A patients with LC exhibited higher EDV and EIV values than LC patients belonging to Classes B and C.

The maximum EDV values were recorded in the LC patients in Group I ($7.5\pm1.9\%$), while the LC patients belonging to Group III displayed the lowest EDV value ($5.6\pm1.9\%$).

The analysis of EIV values yielded the same results as the EDV evaluation, in particular, the presence of the maximum values in Group I patients ($16.2\pm4.4\%$) and minimum values in Group III patients ($10.7\pm4.1\%$).

The performed examinations are indicative of the pronounced changes in ED in patients with LC at the subcompensation and decompensation stages. The specified regularity may be caused by the fact that the progression of liver damages affects the steady balance between the components of the vascular control. This fact is indicative of the involvement of the liver in the synthesis and deactivation of BAS with vasoactive properties. The ED pronouncement depends on the functional capacity of the liver. Conversely, ED promotes the faster progression of the complications in the presence of LC.

The further analysis of the data obtained in the study showed that there was a correlational dependence between EDV and EIV values and functioning hepatocyte mass according to the results of 13C methacetin breath test (13C-MBT). In all the cases, the comparison of functioning hepatocyte mass (FHM) with EDV and EIV values was indicative of the correlation. The correlation was found to be more pronounced between Class C patients with LC and the EDV values (r=0,79, p<0,01). According to the results of the analysis, the most pronounced correlation between FHM and EIV was recorded in Group II and Group III (r= 0.97; p<0.01 and r= 0.90; p<0.01 respectively).

All these changes are indicative of the lack of the functional capacity of the vessel wall in LC patients in the presence of the progression of the signs of portal hypertension. Hence, it has been proven that there are signs of the endothelium injury, in particular the impairment of the vasoregulating activity of the vessel wall in LC patients with portal hypertension.

The findings presented show that patients with LC at the subcompensation and decompensation stages of the disease (classes B and C by Child-Pugh) exhibit the most pronounced ED values. In addition, the findings suggest there is a dependence between functioning hepatocyte mass and the EDV and EIV values with the EDV and EIV values displaying the tendency to reduce when the number of hepatocytes decreases.

The endothelium has been found to regulate the vascular tone through the release of the vasoactive factors by means of which it modulates the contraction activity of smooth muscle cells.

The LC patients exhibited a significant increase in the concentration of ET-1 up to 1.14 ± 0.07 fmol/ ml as opposed to 0.34 ± 0.05 fmol/ml in the control group (p<0.01), an increase in the level of VWF by 139.4±24.8% as compared to the control group (p<0.01) and D-dimer by a factor of 6.8. Additionally, the LC patients displayed a significant decrease in AT III by 32.0±0.2% as compared to the values recorded in the control group p<0.05 (Tables 3).

Table 4 shows the ED laboratory markers recorded in the patients with LC by the groups.

The analysis of the ED laboratory values depending on the severity class of LC by Child-Pugh yielded the same results as the evaluation of EDV and EIV according to Celermajer method. Class A patients with LC (Group I) exhibited the least pronounced changes in the levels of Et-1, VWF, AT III and D-dimer, while the maximum deviations from the normal values were recorded at the subcompensation and decompensation stages of the liver cirrhosis (Group II and Group III).

The concentration of vasoactive BAS in the blood serum increases due to disorders of their deactivation in the cirrhotically altered liver. The more pronounced liver injury is, the higher the values for ET-1, VWF are, etc. The level of ET-1 and VWF strongly correlates with the severity of the liver injury depending on FHM in all the cases. When determining the correlations between AT III and the severity of cirrhosis in the examined patients, the dependence was found only in FHM class B (r = 0.43; p <0.05), and in the analysis of D-dimer - only between FHM in patients of classes B and C (r = 0.37; p <0.05 and r = 0.50; p <0.05, respectively).

DISCUSSION

According to Poredos et al, normal endothelial function is achieved by maintaining the balance between vasodilation and vasoconstriction [5].

One of the endothelial key functions is balanced secretion of regulating substances that ensure the integrated manner of the operation of the cardiovascular system. These substances play a pivotal role in a human body by regulating the vascular tone (the secretion of vasoactive mediators), maintaining the anatomic structure of blood vessels (the synthesis and inhibition of proliferation factors), maintaining normal haemostasis (the synthesis and inhibition of fibrinolytic factors and platelet aggregation) and contributing to local inflammatory processes (the production of proinflammatory and anti-inflammatory agents) [12-16].

The findings of the present study are in line with the results reported by Volosovets et al. researchers such as Deng et al., Pasarin at al., Davies et al., etc. More specifically, long-term exposure to harmful factors (hypoxia, intoxication, inflammation, hemodynamic abnormalities, etc.) results in the gradual exhaustion and distortion of the compensatory dilating mechanism of the endothelium [17]. When this occurs, vasoconstriction and dilation are the most prevailing types of response of endothelial cells to usual stimuli [18-23, 25, 27].

The nature of the relationships between the function of the endothelium and surrounding tissues remains poorly studied. Endothelial dysfunction is currently viewed as an imbalance between mediators that ensure the optimal performance of all endothelium-dependent processes under normal conditions [12, 14, 17-21].

Endothelial dysfunction has proven to have a pathogenetic effect in a range of the most common diseases and pathological conditions, however, its role in chronic liver diseases is understudied. According to Bulatov at al. [13], the treatment of liver cirrhosis must involve lowering target levels of the values of liver function performance as well as the recovery of the functions of the endothelium, which is also reflected in the present study.

CONCLUSIONS

- 1. Endothelial damage was found to be present in Group III LC patients, in particular, the patients were found to have disorder of the vasoregulating activity of the vascular wall against the background of portal hypertension, which is characterised by the correlation relationship between the reduction in FHM and EDV (r=0,79; p<0.01).
- 2. Changes in the values of the vasoactive BAS are indicative of the damage to the vascular endothelium in LC patients with signs of HE. A steady and gradual increase or decrease in the levels of ET-1, VWF, AT III, and D-dimer may suggest the progressive character of ED in the LC patients and can be used to predict the progression of the signs of hepatic encephalopathy.

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CONFLICT OF INTEREST

The Author declares no conflict of interest

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ASSESSMENT OF THE IMPACT OF ACCREDITATION STANDARDS ACCORDING TO THE ONE OF LODZ HOSPITAL MANAGEMENT STAFF

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Abstract

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Aim: To find out opinion of hospital management staff on impact of accreditation standards o entity.	on management of medical accreditation, healthcare quality,	
Material and methods: The study was conducted from March to April 2021 in one of hospital i (management, heads of hospital wards, heads of departments and ward nurses) were invited ir peted the questionnaire and submitted it for analysis. The study was conducted using the question of the study was conducted using the study was conducted u	in Lodz. A total of 22 people management n the study, 16 people com- ionnaire, which was built of	
19 quantitative and qualitative questions.	ant process are standards in	
area of Care Continuity, second in area of Patient Rights, and third in area of Patient Care. The n	majority of the respondents	
rated highly and very highly impact of the used standards on their management activities. Active	participation of the process	
implementation and maintenance of accreditation standards was committed by 12 respondents. In opini	ement tasks, while 5 people	
don't agree with this influence. In the same way the respondents assessed impact of the implement	entation of accreditation on	
the quality and safety of provided health services (11 people indicate correlation; 5 people have	a different opinion). Twelve	
Conclusion: In opinion of the respondents performing managerial functions, the process of m	naintaining and continuous	
improvement of individual accreditation standards is understood and desirable among the manac	gement staff of the hospital.	

INTRODUCTION

The concept of quality of health services has changed many times over years. Until recently healthcare quality had been synonymous with not making mistakes. With development of medicine and attempts to predict mistakes and studying their causes, quality has become the subject of overall management of the organization. Due to special care for the highest care standard as well as identification of risks and opportunities for the carried out processes, recently the quality has become an invaluable tool used in competition between individual medical institutions. This is also a hope for patients to be treated in friendly and, above all, safe care conditions [1].

In Poland, the interest in quality of healthcare appeared only in 1990s in context of transformation of the healthcare system. In 1996 process of restructuring of hospital care began and as a result there was change of form of hospital functioning from budgetary to independent units, and client/patient orientation became a new challenge. Medical entities were forced to act on the commercial market, which contributed to drawing their attention to quality of provided services and effectiveness and efficiency of taken actions.

In order to achieve high level of healthcare quality, we can use internal and external methods of providing it. Internal methods include, for example, proprietary quality providing and improvement programs, such as testing and assessing quality of medical or nursing care, monitoring and preventing occurrence of infections and adverse events. A very popular method is also testing the level of patient satisfaction [2-8]. External quality assessment systems include: a. Sectoral:

- Accreditation (hospital treatment/POZ)
- ISO (PN-EN 15224 quality management system EN ISO 9001 for the health sector, ISO 17025 for research and modeling laboratories),

b. Non-sectoral:

- ISO (ISO 9001 quality management, ISO 31000 risk management, ISO 14001 environmental management, ISO 45001 occupational health and safety management, ISO 22000 food safety),
- Excellence model EFQM (European Quality Award),

Others (Rzetelna Firma, Solidna Firma) [9].

Among mentioned above external quality assessment systems, the most popular are ISO systems and accreditation.

ISO is the International Standard Organization which develops different types of standards and specifications. ISO standards of the 9000 family are dedicated to quality management systems and they are used in more than one hundred countries. Quality Management System implemented on the basis of these standards is a proof of ordering and rationalization of pro-quality activities. It is required here to establish quality policy, quality objectives and their implementation in relation to identified processes in the organization. The most important internal benefits of implementing ISO include: organizing all activity areas and the unit management system, monitoring and managing processes in the organization, fast and effective identification and solving problems, increase of employee involvement and motivation in improving quality at all levels of the organization, increase of patients and contractors credibility and trust in the organization, minimizing losses in medical supplies and services, fulfillment of selection criterion and market assessment made by NFZ. On the other hand external benefits include: increase of competitiveness on health services market, greater trust and credibility of potential patients and contractors, easier access to international markets [9].

On the other hand, accreditation is considered as the most effective and best proven method of ensuring quality of services in healthcare sector all over the world. It seeks out and focuses on issues which have the greatest impact on quality and safety of healthcare, creating measurable criteria for assessing healthcare entities, known as accreditation standards [10]. Accreditation is therefore part of the process of external evaluation of healthcare organization, which is verifying the degree of compliance with individual standards by external inspectors with professional experience related to healthcare. A medical entity applying for accreditation is always assessed holistically, therefore it isn't possible to assess one or two selected departments of a given unit [11].

Accreditation for each medical entity applying for it means necessity to accept and implement new models of attitudes and behaviors, as well as patterns of conduct. This is practical tool in creating and circulating the new management culture as well as in taking responsibility for quality and safety of care [9].

The accreditation system of the Minister of Health in Poland is regulated by following legal acts:

- Order of the Minister of Health of 2 July 2010 on the Center for Quality Monitoring in Healthcare [12],
- The Act on Accreditation in Healthcare of 6 November 2008 [13],
- The Act of 24 April 2009, the regulations introducing the Act on Patient Rights and Patient's Rights Ombudsman, the Act on Accreditation in Healthcare and the Act on Healthcare Consultants [14],
- Regulation of the Minister of Health of 6 August 2009 on the Accreditation Council [15],
- Regulation of the Minister of Health of 27 September 2019 amending regulations on the Accreditation Council [16],
- Regulation of the Minister of Health of 31 August 2009 on procedure for assessing compliance of the entity providing health services with accreditation standards and amount of fees for its implementation [17],
- Regulation of the Minister of Health of 11 October 2019 amending regulations on procedure for assessing compliance of the entity providing health services with accreditation standards and amount of fees for its implementation [18].

Widespread and known accreditation standards in Poland have been developed for two areas of healthcare: for primary healthcare (POZ) and for hospitals, and in this area, according to the subject of this article, the authors focused their attention.

He first set of accreditation standards for hospitals in Poland appeared in 1998, triggering a wave of changes in organizational culture in hospitals. Next publication of standards still in force took place in 2009. "Set of Accreditation Standards" consists of 15 areas, giving a total of 221 standards [19]. Standards which are dynamic and subject to periodic modification, are of key importance for accreditation process. Thanks to that, assumption of accreditation consisting in constant stimulation to achieve optimum level defined by accreditation standards is met. Each time requirements of the standards must be as high as possible, and at the same time realistically achievable [20].

Accreditation confirms competence of a given entity to carry out activities in a specific scope. It can refer to certification body (products, services, people, systems), a laboratory or an inspection body [21]. According to the PN-EN ISO/IEC 17000:2020-12 standard Conformity assessment – Terminology and general principles, accreditation is attestation by a third party regarding the conformity assessment body, serving to formally demonstrate its competence to perform specific tasks in the field of conformity assessment [22].

Rational benefits of accreditation process:

- a. for accredited units:
- obtaining certificates recognized by interested institutions in countries which are signatories to multilateral agreements (MLA/MRA),
- accreditation is a proof of operating in accordance with best practice and important argument while choosing suppliers on domestic and international market,
- a significant aspect affecting competitiveness of entities;
- b. for consumers:
- accreditation increases credibility of the results of product certification,
- affects quality level of products and services as well as competence of the staff,
- accreditation enables reliable results of analyzes and tests in areas related to safety, health and environment (e.g. medical analyzes, mechanical tests, chemical tests),
- accredited entities provide reliable information on the basis of which decisions can be made, e.g. in the field of health protection,
- accreditation contributes to minimizing trade barriers through mutual recognition of conformity assessment procedures (free international trade stimulates economic growth);
- c. for state administration:
- accreditation is used to ensure public trust in relation to the credibility of the activities relevant to impact on health, safety and environment,
- provides technical assistance to state authorities in assessing the units to be notified;
- d. for industry and business:
- accreditation is a tool used in decision-making process and in business risk management, it allows you to save time and money by choosing an accredited and therefore competent provider of conformity assessment services,
- accreditation is means of access to export markets in Europe and in the world according to the principle "tested or certified once accepted everywhere",
- ensures precise measurements and tests carried out in accordance with best practice, limits the

number of defective products, lowers the costs of control and production, and also enables the implementation of innovative solutions [23].

THE AIM

The aim of the study presented in this article was to find out opinion of hospital management staff on impact of accreditation standards on management of medical entity.

MATERIAL AND METHODS

Study of the research carried out at the location in the Łódź Voivodship. Group of respondents were: management, heads of hospital wards, heads of departments and ward nurses – people who have direct impact on management processes in the surveyed entity. A total of 22 people were included in the study, and due to the fact that participation in the study was voluntary, 16 people competed the questionnaire and submitted it for analysis.

The study was conducted using the proprietary questionnaire, which was built of 19 quantitative and qualitative questions and a record.

A 5-point scale was used in the evaluation questions (1 - very low, 2 - low, 3 - medium, 4 - high, 5 - very high). In the questions about the facts, answers were "yes", "no", "I don't know". Some questions had descriptive form of answer. Respondents were also asked to indicate the rank of the reasons for implementing accreditation in the examined hospital. At the end of the survey, the respondents were able to share additional comments, observations and suggestions on the taken topic.

The study was conducted from March to April 2021 in one of medical entities, whose founding body is the City of Łódź.

RESULTS

The group of respondents was dominated by people with work experience between 11 and 25 years, of which between 6 and 25 years in the examined institution. In terms of gender, 11 women took part in the study, which is vast majority as well as 4 men, one questionnaire didn't contain information in this regard. With regard of place of employment, most of the questionnaires were completed in hospital wards – 7, then in administration – 4 questionnaires, laboratories and departments – 3 questionnaires and in management – 1 questionnaire. Active participation in accreditation visit was indicated by 14 respondents (almost all). There was no representative of the clinic among the study participants. Particularly noteworthy is the fact that only one representative of the management team decided to participate in the study.

The respondents were asked if they use the requirements of accreditation standards in their managerial work. The vast majority clearly indicated that the requirements of accreditation standards are used in everyday professional work.

With regard to the place of employment, a representative of the management, all administrative employees (4), six out of seven employees of departments as well as all representatives of workshops/pants (3) and one employee who didn't specify the place of employment, indicated use of accreditation standards in their managerial function.

Then participants were asked to indicate all accreditation areas used in implementation of managerial tasks. The results clearly indicated that each of the accreditation areas is used in managerial function by the respondents, and number of indications for each of them is presented in Table 1.

When divided by place of employment, the most frequently used by the management are standards in the area of General Management (ZO), which is naturally related to creation of the organization mission, organizational structure, assigning responsibilities and powers to individual organizational units and positions, as well as developing strategic plan or supporting activities aimed at improving quality of provided health services. For administrative staff, as for management, the key areas are General Management (ZO) and, additionally, Information Management (ZI). Dominant areas in wards are Care Continuity (CO), Patient Rights (PP), Patient Care (OP), Infection Control (KZ), Nutrition (OD) and Patient Condition Assessment (OS) - standards closely related to the process of providing health services. The results also showed that in the wards Quality Improvement and Patient Safety standards, which are used for direct monitoring correctness and effectiveness of undertaken medical activities, are also important. In the case of respondents employed in laboratory/plant, the most important area is Medical Imaging, which probably results from nature of the work of the survey participants. In the case of one person who didn't provide a place of employment, the indicated areas are General Man-

Table 1. Indications of accreditation areas used in the managerial function.

ACCREDITATION AREA	INDICATIONS OF THE RESPONDENTS
ZO (General Management)	9 indications including one indication of the hospital management, all administrative staff (4), departments – 3 indications and one indication without assigning the place of employment
ZI (Information Management)	9 indications including all administrative staff (4), 3 indications from ward workers, one laboratory/plant indication and one indication without assigning the place of employment
CO (Care Continuity)	8 indications including 5 wards indications, 2 indications administrative staff and one laboratory/plant respondent indication
PP (Patient Rights)	8 indications including 4 wards indications, 2 indications administrative staff and one laboratory/plant and one without assigning the place of employment
PJ (Quality Improvement and Patient Safety)	7 indications including respectively 4 for wards and 3 for administration
OP (Patient Care)	6 indications including respectively 4 for wards and 2 for administration
KZ (Infection Control)	6 indications including respectively 4 for wards and 2 for administration
FA (Pharmacology)	6 indications including 3 for wards, 2 for administration and one for laboratory/plant
DO (Medical Imaging)	6 indications including 2 for wards, 2 for administration and 2 for laboratory/plant
OD (Nutrition)	6 indications including 4 for wards and 2 for administration
ZZ (Human Resource Management)	6 indications including 3 for wards and 3 for administration
ŚO (Care Environment Management)	6 indications including 3 for wards, 2 for administration and one for laboratory/plant
OS (Patient Condition Assessment)	5 indications including 4 for wards and one for administration
ZA (Treatments and Anesthesia)	5 indications including 3 for wards and 2 for administration
LA (Laboratory)	5 indications including 3 for wards and 2 for administration

Source: own study

agement (ZO), Information Management (ZI) and Patient Rights (PP).

In opinion of the respondents, the most often used accreditation areas in management process are standards in area of Care Continuity (4 indications), second in area of Patient Rights (4 indications), and third in area of Patient Care (4 indications).

The majority of the respondents rated highly and very highly impact of the used standards on their management activities. The most often the impact was indicated as high (7 responses), 4 people considered the impact very high and none of them considered the impact very low. A graphic image of collected results is presented in figure 1.

The representative of the management assessed impact of the used standards on the management process carried out by him as very high. On wards in two cases the impact was defined as very high, in three ones as high and in one as medium.

The administration in one case assessed the impact as very high, in two cases as high and in one case as medium. Representatives of clinic and laboratory staff in one case assessed the impact as high and in two cases as low. The person who didn't specify the place of employment assessed the impact as high.

Next questions in the survey concerned indication if the implemented accreditation standards facilitate or hinder management processes – Table 2. 12 respondents indicated implementation of accreditation standards as a facilitation for management process, of which 9 people clearly indicated the improvement such elements as organization and control. On the contrary, 7 respondents indicated difficulties in management process, of which 5 people emphasized limitation of organizing and motivating.

More than half of the respondents (9) confirmed their commitment and activity in the process of implementing accreditation standards for the medical entity where they work, nevertheless 7 people were passive in this process. The most work in the accreditation process was required from the respondents to implement such standards as: CO 5, CO 6, OS 3, OS 5, OP 3, OP 5, DO 1, DO 2, DO 3, DO 4 and DO 5. Active participation of the process of continuous improvement of accreditation standards was confirmed by 12 respondents, while 3 denied the above (2 employees of the laboratory/plant and 1 from a ward).

The respondents indicated that examples of actual use of the requirements of accreditation standards in everyday process of implementing management tasks are:

- setting goals for the organization,
- developing quality improvement plans,
- planning and implementation of trainings,
- undertaking activities to increase patient safety, e.g. simulations, safe drug administration,
- active participation in activities of problem teams,
- use of the results of the conducted analyzes of clinical activity (reoperations, readmissions, extended stays, deaths and others),
- use the results of patient opinion surveys in process of improving the quality of provided health services,
- implementation of the professional adaptation process,
- drug management supervision,
- ensuring the completeness and reliability of medical records.

In opinion of 11 respondents, the implementation and maintenance of accreditation standards affects the effectiveness of management tasks, while 5 people don't agree with this influence. Among the respondents giving affirmative answer for this question were: a representative of the Management, 5 representatives of wards, 3 representatives of administration, 1 representative of laboratory/plant and one respondent who didn't indicate the place of employment. The opposite answer was given by: 2 employees of laboratory/plant, 2 administration employees and 1 ward employee.

In the same way the respondents assessed impact of the implementation of accreditation on the quality and safety of provided health services (11 people indicate correlation; 5 people have a different opinion). In justifying affirmative answers the respondents indicated:

Table 2. Facilitations and difficulties for management process resulting from implementation of accreditation standards.

FACILITATIONS	DIFFICULTIES
Work organization,	Overflow of documentation,
Ready forms and checklists facilitating verification and checking of	Continuous supervision and control,
performed activities,	Demotivation as a lack of recognition of hard work in the process of
Completeness of medical documentation,	implementing and maintaining standards, with simultaneous lack of
High level of patient service,	additional salary and recognition from the superiors
Improvement of external and internal communication,	
Optimization of management processes	

Source: own study



- real implementation of quality improvement programs,
- real improvement of the quality of patient care,
- increasing patient safety, e.g. by ordering additional blood tests (creatinine) before administering the contrast medium, minimizing errors and adverse events.

On the other hand, negative responses included too high requirements for the staff.

More than half of the respondents (9 people) confirmed their participation In training in the field of accreditation standards. The last training was carried out in 2020 (participants were: a representative of the Management, 4 ward employees, 3 administration employees and 1 employee of laboratory/plant).

With reference to the previous issue, 12 respondents stated that they were constantly improving their knowledge in this area, while 3 people deny the above, one person didn't answer. Negative answers to the above question are from representatives of ward, administration and laboratory/plant.

Twelve out of sixteen respondents confirmed and justified that accreditation is needed in hospital (Fig. 2). The affirmative answer was given by: a representative of the Management, 4 ward employees, 4 administration employees, 2 employees of laboratory/ plant and 1 employee who didn't specify the place of employment.

The most often indicated justifications for affirmative answers were:

- improving quality and safety of the provided services,
- increase in prestige of the hospital,
- increased knowledge about adverse events which can appear in the process of process health services,
- additional bonuses for the hospital in contracting by NFZ,
- organizing medical records and increasing knowledge about its proper keeping,
- the only objective proof of quality.

Regarding the negative justification, lack of impact on quality of provided services was indicated, and such an answer was indicated by 2 ward representatives, 1 administration representative and 1 representative of laboratory/plant.

The respondents agreed that accreditation is one of the strategic goals of the hospital. However, in opinion of the respondents, the hierarchy of importance of motives for implementing accreditation in the hospital is as follows (from the most important to the least important motive):

- Increase in quality of staff and patient safety services,
- Additional funds for the hospital from primary hospital system of providing healthcare services (PSZ) and increasing knowledge about adverse events and possibility of learning from mistakes,
- Additional points when contracting services by NFZ,
- Organizing medical documentation,
- Ensuring implementation of all patient rights,
- Hospital prestige,
- Increase in knowledge about the unit and its processes,
- Strengthening management of the medical entity processes.

DISCUSSION

The certification system, including accreditation, is becoming an integral part of functioning healthcare entities and the environment. It begins to be perceived and understood as a tool supporting development of both production companies and entities from the service sector. Obtaining accreditation in specific areas, including healthcare sector, allows for raising standards, increasing prestige and continuous improvement of implemented processes [24].

Accreditation brings measurable benefits to all interested parties, e.g. individual stakeholders. It is beneficial both for entities which try to implement individual standards of operation, adapting their existing methods of operation to specific proven requirements as well as for organizations which constantly maintain the given standards by continuous improvement of implemented processes. For contractors and clients, accreditation certificates are recognizable and legible certificate confirming the highest quality the offered goods or provided services. Accreditation is used to build and strengthen confidence in tests and inspections, certified products and services, qualifications of certified people and certified management systems.

Summing up the collected and analyzed data from the conducted survey, it should be noted that the majority of those eligible to participate in it honestly filled and returned the survey. The vast majority also recognized that they use the requirements of individual accreditation standards in their managerial function.

According to the answers provided by the respondents, taking into account their place of employment, the correctness of division of accreditation standards into those relating to medical activity and those relating to management and quality processes in healthcare is confirmed. The former are much more often used by wards and laboratory/plants, while the latter are used in administration.

With regard to the level of the discussed impact of accreditation standards on management process, nearly half of the respondents considered it high and no one assessed this impact as very low.

According to the vast majority of respondents (12 people), implementation of accreditation standards facilitates management processes, especially organization and control. More than half of the respondents indicated their active participation in the process of implementing accreditation standards in the hospital and almost all of them declared active participation in the process of continuous improvement of them. This allows us to assume that the management staff of the examined hospital remains heavily involved in tasks connected with accreditation issues and strives for further development of them.

Thanks to the implemented standards, the vast majority of respondents indicate greater effectiveness of their management tasks. Also, the majority of respondents recognize that the implemented accreditation has a positive effect on quality and safety of provided health services.

In terms of participation in thematic training, slightly more than a half of the respondents have completed this type of training and at the same time declare further improvement of knowledge about the requirements of accreditation standards. Due to the above and the fact of indicating the date of the last training in 2020, the collected information allows for a conclusion about the need to plan periodic training on behalf of the hospital to provide staff with continuous broadening of knowledge in this field and confidence in the usefulness and reliability of obtained information. Improvement of the management staff and individual organizational units of medical activity can take place in the scope of updating and acquiring new knowledge in the field of accreditation standards, can be carried out through: dedicated training, general training. Moreover, interested people can participate in series of webinars carried out by experts of the Quality Monitoring Center [25].

Particularly is the fact that almost all respondents confirm their active participation in the process of the accreditation visit itself, which suggests that the staff is motivated and deeply involved in it. As the most important motives for implementing accreditation in the hospital, the respondents indicated: an increase in quality of staff and patient safety services, additional funds for the hospital from the basic hospital system of providing healthcare services (PSZ) and an increase in knowledge about adverse events (possibility of learning from mistakes), additional points when contracting services by NFZ and organizing medical documentation. The declaration of 3/4 respondents and recognition of accreditation as needed in the hospital are also important. According to the authors of the study, such a position and approach of the management of the examined hospital is the main source of success and further development of the unit, where the accreditation system was positively recommended by the Accreditation Council for the third time (2020).

Apart from the above-mentioned benefits related to implementation and maintenance of accreditation system in the surveyed hospital, the respondents also indicated negatives, such as: (1) accreditation hinders management processes, (2) restriction of organizing and motivating, (3) overflow of documentation, (4) continuous supervision and control, (5) demotivation (lack of recognition of hard work in the process of implementing and maintaining standards, with simultaneous lack of additional salary and recognition from the superiors).

When analyzing available literature on accreditation in hospitals, there is evidence to support the notion that compliance with accreditation standards is beneficial for quality of provided services [26] and for improving efficiency and effectiveness of hospital operations [27-28]. Moreover, at the international level, is recommended to make efforts to encourage and continuously update accreditation standards with the aim of institutionalizing and increasing the quality of organizations that undertake implementation of accreditation standards [29-30].

CONCLUSIONS

1. The staff performing managerial functions in the examined medical entity believe that accreditation has a positive effect on management processes. Due to the very structure of accreditation model, it is possible to improve processes related to management and patient care. In addition, visits are activities carried out on a regular basis, which enables constant possibility of influencing not only quality of provided services, but also modifying and improving procedures – adapting them to the current conditions. Moreover, hospitals that participate in accreditation are better prepared for changes, due to continuous analysis, monitoring and improvement of processes as well as designing and implementing new ones, if necessary.

2. In opinion of the respondents performing managerial functions, the process of maintaining and continuous improvement of individual accreditation standards is understood and desirable among the management staff of the unit. One of the key stages of hospital accreditation is the decision to voluntarily start the process and understand the specificity of the model of functioning, which consist in repeating and constantly improving the behavioral models and attitudes of employed staff as well as the patterns of action. This means that the staff responsible for compliance with the standards has an obligation not only to know the requirements for individual standards, but also to make other hospital employees know them.

According to the respondents, among the ac-3. creditation areas that are necessary to improve processes and increase quality of the services, the key areas are: Care Continuity (4 indications), Patient Rights (4 indications) and Patient Care (4 indications). A hospital that is preparing to analyze specific areas, including care continuity, should first of all consider and analyze the procedures related to admission of patients in terms of quality and quantity. After determining the purpose of hospitalization, it is important to analyze if the documentation and procedures are consistent with each other and understandable for the staff. The above-mentioned areas mainly include procedures related to patient care, and therefore include those activities during which the quality of services is built. Most respondents appreciate impact of implemented standards on building quality of both services and other processes related to provision of services and management.

He majority of respondents highly and very 4. highly assessed the impact of used standards on their management activities. The most often indicated impact was high (7 respondents), 4 people considered the impact very high and none of the respondents considered the impact very low. Accreditation standards, especially in areas of: General management and human resources management, give an opportunity not only to verify if the hospital, as an organization, takes into account a coherent and current mission on the basis of which a strategy for its operation has been developed. In addition, if the organizational scheme correspond to the specificity of the unit and support and systematize management processes, including the decision-making and related to the proper flow of information. The standards focused on aspects related to management underline continuous monitoring of processes and, if necessary, improving the procedures. An important issue is also improvement of qualifications and acquiring new competences by (mainly) the management staff, which means that the accreditation process not only affects he quality of provided services, but also underlines ensuring the best working conditions.

Assessment of the impact of accreditation standards

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CONFLICT OF INTEREST

The Authors declare no conflict of interest.

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CAUSES FOR SEARCH AND RESCUE IN ROCK CLIMBING ACCIDENTS IN POLISH TATRA MOUNTAINS – A 5-YEAR SURVEY

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Abstract	Key words	
 Aim: To review Tatra MRT (Mountain Rescue Team) SAR (search and rescue) events reported by rescuers in the study period of 2015-2019 (5-year survey) in terms of the profile of the injured, types of injuries, causes identified by MRT rescuers in reference to the NACA ICAR (National Advisory Committee for Aeronautics – International Committee for Alpine Rescue) score. Material and methods: A study was conducted on Tatra MRT reports, regarding RC (rock climbing), from 2015 through 2019. Reports included information on the trauma, possible causes, accompanying weather conditions and actions that were taken. The study group consisted of 174 report with a median age of 32.5 years (IQ I-III – 27–41) comprising 137 men and 37 women. Results: Our study revealed that there was no relation between RC SAR reported by Tatra MRT rescuers and age or sex. Apart from one – the fall from heights, causes were also not related with age or sex. According to our study older people were more likely to sustain a trauma as a result of a fall from heights (34 vs 31, p=0.009). We found that 42% of the victims did not sustain any actual trauma (NACA ICAR=0). According to the rescuers these cases were significantly more likely to be associated with the lack of skills or inadequate equipment (p<0.001). Conclusions: RC incidents constitute a small percentage of SAR operations by Tatra MRT. Almost half of RC SAR incidents is not associated with an actual trauma. 	SAR, rock climbing, NACA-ICAR, injury	

INTRODUCTION

Mountain activities, including rock climbing (RC), are becoming more prevalent among people in Europe and other developed parts of the world [1]. The growing interest in rock climbing is followed by an increase in risk factors associated with trauma. It is estimated that the current amount of rock climbers in Poland might be between 60-70,000 people [2]. The Tatra Mountains (central-southern part of Poland – highest peak Rysy 2 499 m) are one of the most popular climbing sites for vastly experienced individuals in Poland. Moreover, rock climbing has a long-standing tradition in the Tatra Mountains, therefore it also attracts climbing enthusiasts with much less experience. Each year the Tatra mountain rescue team (Tatra MRT), a volunteer search and rescue (SAR), is providing help and guidance to the tourists in distress [3]. The specificity of the mountain rescue operations (rough terrain, weather conditions, severity of the trauma) requires specially adjusted training for rescuers especially if RC incidents are involved. Despite the fact that all rescuers undergo continuous strenuous training in a variety of scenarios (ie use of helicopter, diving, fall from height) to improve their

skills and knowledge – some specialize in one particular field of expertise.

Rock climbers are often found to be as challenging as patients. A great deal of rock climbers ignore minor injuries believing them to be irrelevant in terms of their general health. Thus, they are more likely to avoid a consultation with a medical specialist (general practitioner, physiotherapist) or inform a nearby MRT about an injury sustained during the climbing process. According to studies, this may greatly affect the ratio of chronic and overuse injuries often reported in this group [4].

Due to the nature of the sport, there is a plethora of possible causes which may lead to an occurrence of an injury. The data provided often shows the importance of age, sex, weather conditions, technical skills of climbers, and faulty equipment [3, 5-7].

The primary aim of the study was to review Tatra MRT SAR events reported by rescuers in the study period of 2015-2019 (5-year survey) in terms of the profile of the injured, types of injuries, causes identified by MRT rescuers. The secondary aim included an analysis of the modes of transportation that were required in regards to weather conditions.

Jarosław Amarowicz

MATERIAL AND METHODS

The data for SAR reports 2015-2019 were collected from an electronic database operated by Tatra MRT. All reports were filed by the operation supervisors and checked by an archivist (for possible mistakes). Each report contains personal information of the victim following circumstances accompanying the SAR event such as weather conditions, detailed information about the injury (type, location) including its severity (NACA ICAR score) – in a fixed report form.

From 2015 to 2019 Tatra MRT had intervened 4218 times – with an average of 844 per year (44% increase in 5 years). Rock climbing incidents accounted for 120 SAR operations, carried out by Tatra MRT in that period, involving 174 people (4.1% of all SAR). The median age in the study group was 32.5 years (IQ I-III – 27–41) comprising 137 men and 37 women. To carry out the analysis, every person in the group of 174 rock climbers was treated as a separate record.

Reports contained information about the scale of the mission – the number of rescuers involved and its schedule. All operations were divided into 4 groups: expedition, action, intervention, and telephone intervention. An expedition is defined as a search and rescue operation that involves at least 3 rescuers, lasts for more than 3 hours, and requires transportation. An action is a mission that involves at least 2 rescuers, lasts for less than 2 hours, and requires transportation. An intervention is a situation requiring the help (usually basic first aid) of one rescuer with no need for transportation. A telephone intervention does not require the onsite help of a rescuer, advice is provided via a telephone connection. Due to the problem with the reception in a mountainous area, this option may be limited depending on the terrain.

Rescuers were obliged to provide a list of causes that necessitated a SAR operation. They were allowed to provide more than 1 possible cause. List of possible causes included: falls (from ground level or height), lack of abilities (skills required for safe rock climbing as assessed by rescuers), falling rock/ice, lack of appropriate equipment (ie helmet, climbing shoes, ropes), sudden illness (unexpected deterioration of health ie a myocardial infarction), temperature (high or low), avalanche, lightning strike, getting lost (losing orientation) and others (not predefined).

NACA ICAR (National Advisory Committee for Aeronautics – International Committee for Alpine Rescue) score used by Tatra MRT is an adapted 8-degree NACA scale designed to assess the severity of the trauma. Injuries classified as NACA 1 are considered as those with mild trauma without the need for immediate medical care whereas the number 8 is death in the ICU after the patient is already handled to EMT. Additional NACA O may be enclosed when there is no injury/disease present, for example in situations that require the evacuation of the climbers. A detailed description of the study group divided into NACA ICAR subgroups is enclosed in table 1.

An analysis was completed with the use of Microsoft Excel 365 (Microsoft Corporation, Redmond, WA) and Statistica 13.3 (TIBCO Software, StatSoft, Palo Alto, CA). Frequencies were defined with numbers or percentages. Tests used in the analysis included Shapiro Wilk test, Mann-Whitney U test, chi2, and Fisher exact test. The results were considered statistically significant with p<0.05. Additionally, the study was approved by the Jagiellonian University Ethics Committee (ap. nr. 1072.6120.259.2018) and funded by a scientific grant from the Jagiellonian University Medical College (project nr: N43/DBS/000061).

Table. 1. Detailed description of NACA ICAR* score in rock climbing related SAR operations conducted by Tatra MRT between 2015-2019.

NACA ICAR score	Description	N
0	No trauma, disease	74
1	Minor disturbance, mild disease, abrasions, bruises	10
2	Extensive superficial injuries, bruises, fractured fingers. Recommended outpatient treatment.	14
3	Open wounds with a vascular or nerve injury, fractures (hands, lower legs), sprains, dislocations, first and second degree hypothermia, high fever, appendicitis. Hospital treat- ment indicated.	62
4	Head injury with loss of consciousness >15 min, thigh fracture, limb amputation. Potential life threat.	6
5	Spine injury with neurological symptoms, multiple ribs frac- tures with respiratory failure, open chest wounds, numerous bone fractures, heavy shock, arrhythmia, heart pulmonary edema, third and fourth-degree hypothermia, life-threaten- ing status (death without immediate medical help).	4
6	Condition after successful resuscitation.	1
7	Death on-site or after unsuccessful resuscitation	2
8	Death after the patient was already handed to EMT	1
	Total	174

NACA – National Advisory Committee for Aeronautics ICAR – International Committee for Alpine Rescue

Causes for search and rescue in rock climbing accidents in Polish Tatra Mountains



RESULTS

According to the NACA ICAR scores enclosed in the reports a total of 74 climbers (42%) that contacted Tatra MRT between 2015 - 2019 did not sustain any actual trauma (NACA ICAR = 0). The second largest group that was identified by rescuers were people with a score of 3 in NACA ICAR as those who required hospital treatment (35.6%). Most of the SAR operations in the study period were identified as expeditions (137 climbers, 79%) or actions (33, 19%). Astonishingly, the intervention and telephone intervention were extremely rare (2 cases each, 1%).

CAUSES OF RC SARS

Accidents are often the result of an accumulation of possible unexpected factors. In every report archived by Tatra MRT, rescuers were obliged to identify possible causes for SAR. As to be expected fall from height was the most reported cause (65 reports, 37.5% of SARs) followed by the lack of abilities (47, 27%). Others included lack of appropriate equipment and not specified (20 each, 11.5% each), ground-level fall, and falling rock/ice (15, 8.6% each). Less common causes involved losing orientation (12 climbers), low temperature (8), avalanche (6), sudden illness (3). There were no reports pointing to a lightning strike or high temperature as possible causes. The analysis showed that among all predefined causes, only a fall from height was significantly associated with age (p=0.009, Fig. 1). Similar dependence has not been found in relation to age and

other causes. A follow-up analysis regarding sex and SAR causes did not show any significant differences between men and women.

CONDITIONS ACCOMPANYING SAR

The majority of the SAR operations took place over the height of 1500 m (94% of cases) and during the summer months, such as July – September (51.2%) (Fig. 1). The analysis showed that the NACA ICAR score did not correlate with the accompanying weather conditions. Despite being reported in 81/174 SAR cases – negative weather conditions (such as strong wind – 49, rain – 29, fog – 19) did not affect the severity of the trauma (as assessed in NACA ICAR). Women were more likely to be rescued when negative weather conditions were reported, however, the difference was not statistically significant. Moreover, one's age did not relate in any matter with the reported weather conditions.

SAR TIMING

According to the reports of Tatra MRT most RC accidents occur during the summer when the amount of tourists in Tatra National Park is at its highest (7.2 % increase from 3.7 million in 2015 to more than 3.9 million tourists in 2019). During the 5 year observation, the period between July to September covered more than half of all RC SAR incidents (with a peak in August – 43 SARs, 25% of all cases reported) (Fig. 2). The majority of RC SARs were carried by Tatra MRT during the weekend (Saturday-Sunday





accounted for 108/174 cases), usually in the afternoon (115 cases after 12.00 pm).

SAR AND RESOURCES INVOLVED

During 120 SAR operations, regarding RC incidents, there was a total of 713 rescuers involved (average of 6 per SAR). The most robust operation involved 37 rescuers, when all of the victims were adversely injured by an avalanche and ended with 1 person dead after unsuccessful resuscitation (NACA 7) and 1 rescued after successful resuscitation (NACA 6). The smallest SAR recorded involved 1 rescuer (2 cases) of which one was a telephone intervention due to a lack of appropriate skills.

Different modes of transportation were used depending on the weather, terrain, and severity of the trauma. In general, 160 climbers required transport (in some cases more than one type). A helicopter was the most common way to evacuate the climber as it was used in 103 people (59.2% of the analyzed group) followed by a car (57 cases, 32.8%), akia/ stretchers (25, 14.4%), snowmobile/quad (11, 6.3%), other (ie by foot with a rescuer, 10, 5.8%) and cable car (2 cases). A helicopter was more likely to be used in the case of an expedition rather than action (70.1% *vs* 18%, p=0.046).

RC AND THE LOCATION OF THE TRAUMA

Since the majority of the RC did not sustain any actual trauma, the most common answer in the reports was – not applicable (74 reports). Reported locations involved lower limb (observed in 64 cases, 36.8%), upper limb (33, 19%), head (20, 11.5%),

pelvis (6, 3.5%), abdomen (4, 2.3%). Analysis in relation to the sex of the RC and locations did not reveal any significant differences. Apart from reporting right lower limb more frequently (Me 38.5 vs 31.5 years, p=0.018) there were no significant differences for the trauma location in relation to age.

RC AND THE TYPE OF INJURY

In a group of 100 climbers who had a reported injury, the majority suffered either from a joint injury (54, 31% of the study group), bruise injury (51, 29.3%), or fracture (28, 16%). Less frequently observed involved hypothermia (7, 4%), other – not specified (4, 2.3%) suffocation, and frostbite (1 each). None of the above-mentioned trauma mechanisms correlated with the sex or age of the climbers.

RC SARS WITHOUT A TRAUMA

Since 42% of SAR cases were identified as NACA-ICAR = 0 (no trauma) authors placed special interest in those operations. Analysis showed that this group of climbers was likely to be younger (median age 31 years vs 34, p=0.081) and man (45% in a group of men vs 32% in a women group, p=0.161). Incidents with NACA 0 climbers were associated with higher elevation > 1500 m (p=0.008) and were usually specified as expeditions (p=0.046). SAR involving NACA 0 cases lasted significantly longer than operations for those within NACA range of 1 to 8 (median 2.75h vs 2, p=0.012) (Fig. 3). It should be however emphasized that it had not required modes of transport more often than climbers from NACA 1-8 group. In fact, transportation was required in 98% of NACA



1-8 and 84% of NACA 0 (p=0.007). Significant differences were found in regard to using akia/stretchers and vehicles as a form of transportation.

Analysis that considered causes of SAR showed that climbers with an identified trauma (NACA 1-8) were more likely to have their accident associated with random factors such as a fall from height, ground-level fall, rock/icefall. At the same time, according to the assessment of Tatra MRT rescuers, climbers from NACA 0 group were significantly more likely to require a SAR operation due to the lack of abilities, inadequate equipment, other (not specified) or losing orientation. A detailed description of SAR causes reported by Tatra MRT is presented in table 2.

DISCUSSION

Rock climbing has become extremely popular in the last 3 decades which is most likely due to the growing number of climbing gyms and artificial walls (which leads to the increase in outdoor climbing) [8]. As proof of the growing popularity, RC has been recognized as an Olympic discipline for Tokyo Olympics 2020. Despite the increased risk associated with RC when compared to other mountain-related activities – it covers a small percentage of SAR operations carried out by Tatra MRT (4.1%) in the observed study period. The percentage was similar to the one reported by Rugg et al (3% during a 13 year observation period) and Heggie et al (5%, 15year observation) [9]. Lack et al and Curran-Sills et

Table. 2. Causes of RC SAR identified by Tatra MRT within the period of 2015-2019. Causes such as hyperthermia and lightning strike were not reported in this study group.

Ali	NACA O		NAC	A 1-8	p-value
N*	Ν	%	Ν	%	
15	1	7	14	93	0.003
65	4	6	61	94	<0.001
12	10	83	2	17	0.003
15	2	13	13	87	0.016
6	1	17	5	83	0.192
8	4	50	4	50	0.661
3	0	0	3	100	0.133
47	41	87	6	13	<0.001
20	19	95	1	5	<0.001
20	19	95	1	5	<0.001
	AII N* 15 65 12 15 6 8 3 3 47 20	All Nat N* N 15 1 65 4 12 10 15 2 6 1 65 4 12 10 15 2 6 1 15 2 6 1 8 4 3 0 47 41 20 19	AIINACA N^* N 90 15 1 7 65 4 6 12 10 83 15 2 13 6 1 17 8 4 50 3 0 0 4 87 4 87 12 19 95	AII NACA NACA N^* N N N $1S$ 1 7 14 $1S$ 1 7 14 $6S$ 4 6 61 12 10 83 2 15 2 13 13 66 1 17 5 6 1 17 5 6 1 17 5 13 0 0 3 41 87 6 20 19 95 1	AIINACA \cdot NACA \cdot N*N $\%$ $\%$ 151714 93 151714 93 1654661 94 1210 83 2 17 1521313 87 61 17 5 83 84504 50 13003 100 14876132019951 5

*N-number of valid records

al reported significantly higher epidemiology of RC operations (19.5% and 18% accordingly) [10, 11].

What came to us as a surprise was the great amount of uninjured RC SAR cases (42% of NACA 0 in the reports). When possible reasons for SAR were taken into consideration in reference to age and sex, only fall from heights (most reported) was found to be a significant cause concerning age. Older subjects were more likely to fall from heights. Possible reasons for this may include observations made by Lutter et al that older climbers are more susceptible to overuse injuries (leading to a compromised endurance) [12].

Our analysis has shown however that causes for SAR significantly depend on the NACA ICAR score. Uninjured cases correlated with reasons identified by Tatra MRT rescuers as the lack of abilities, inadequate equipment, and other not specified causes. Hawley et al pointed out that despite their confidence, experience, and climbing, frequency rock climbers generally lacked knowledge on self-rescue skills [13]. Thus, in many cases may prevent unnecessary SAR operations.

Due to the nature of the SAR, incidents without trauma lasted longer. As to be expected – since in most cases, there was no threat to life, time was not of the essence for the rescuers. Although, NACA 0 SAR operations do not require comparable resources, it does require considerable time and human resources. Therefore, there is a risk that at some point another sudden expedition might miss qualified rescuers involved elsewhere in non-life-threatening operations. It is our belief that it is crucial to limit the number of SAR incidents without an injury. Achieving this goal would allow to lessen the burden on Tatra MRT and improve the safety of rock climbers and others involved in various types of tourism such as hiking.

A high percentage of overuse injuries along with a great deal of acute trauma, noticed by most at the very beginning of their climbing adventure, followed by specific negligence presented by the RC community and massive interest in this activity in the general population – all of that shows us how important it is to train smartly and diligently, and with proper guidance [4, 7, 13]. Individual predispositions are also vital [14].

Despite a high frequency of trauma observed in RC, authors generally agree that it is an activity that has a significantly positive impact on the physical fitness of the climbers [15].

People who start RC indoors often believe that it will prepare them for climbing outdoor activities whereas according to most trained RCs and authors the difference between those two activities is substantial [16, 17]. This may be another possible cause for such a high number of non-trauma RC SARs in the Tatra mountains – explaining the lack of preparation from climbers.

During the analyzed 5 year period there were 3 fatalities, associated with rock climbing, reported by Tatra MRT (1.7% of all cases). The number is smaller than those observed by other authors like Rugg et al. (4.7%) or Lack et al. (5.7%) [9, 11]. It is very likely that the specificity of SAR and its outcome strongly depends on the terrain and type of activity where it takes place [18].

LIMITATION OF THE STUDY

Despite our best efforts, the following study had some limitations that should be emphasized. First of all, the collected data, despite being gathered by trained rescuers (all of Tatra MRT undergo training on filling the report cards) are subjective, and therefore are at risk of interoperator variability and confirmation bias (trained rescuers are more likely to assume that a climber may be unexperienced if found in a non-trauma situation). Due to the retrospective character of the study and GDPR (General Data Protection Regulation) authors did not have a chance to speak with any of the victims personally. Despite the long study period (5 years) the amount of search and rescue cases regarding rock climbing incidents was relatively small, especially when compared to an overall number of SAR at the time (174/4218). Therefore, we believe that the results should be compared to a larger sample. Although the statistics on tourists visiting Tatra National Park are being published annually, the exact number of rock climbers in the area remains unknown.

CONCLUSIONS

We analyzed a total of 174 rock climbing victims all of whom required a SAR intervention by Tatra MRT during the period of 2015-2019. The study revealed that a vast number of climbers did not sustain any kind of injury. Despite that, resources were spent in order to help those climbers in distress (ie by evacuation). Causes for SAR identified by MRT rescuers relate to the NACA ICAR score in the report cards.

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REVIEW ARTICLE

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THE SURGICAL PHYSICIAN ASSISTANT – THE MISSING LINK IN THE POLISH HEALTH CARE SYSTEM

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Abstract	Key words	
The shortages of medical staff, especially medical ones, are increasingly contributing to the failure of Polish health care. The available data and forecasts are pessimistic, therefore it seems appropriate to create a new medical profession that will be able to fill the gap that has arisen among medical personnel (especially in terms of surgical specialties and closely related anasthesiology and intensive therapy). The Physican Assistant is a common and respected profession in the health care system of many developed and developing countries. Currently, 18 countries around the world have a fully developed PA training system in which, after training, Physician Assistants fully perform their specific duties. In many countries, the PA program is a pilot program. These countries include, among others, Poland, where the duties of PA have so far been performed in the pilot program by paramedics after undergraduate studies. The PA pilot program was very performed in the pilot program by paramedics after undergraduate studies.	paramedic, anasthesiology, surgery	

INTRODUCTION

The shortages of medical staff, especially medical ones, are increasingly contributing to the failure of Polish health care. Currently in Poland there are 2.3 doctors per 1,000 inhabitants, which is one of the lowest rates in Europe [1]. In addition, the current average age of doctors is 53 years. The available data and forecasts are pessimistic, therefore it seems appropriate to create a new medical profession that will be able to fill the gap that has arisen among medical personnel (especially in terms of surgical specialties and closely related anasthesiology and intensive therapy). The Physican Assistant is a common and respected profession in the health care system of many developed and developing countries. U.S. News & World Report placed the profession of the Assistant Physician in the 3rd place of the best profession in the world in 2020.

THE AIM

The aim of the study was to describe a new specialization intended for paramedics – the Surgical Physician Assistant.

MATERIAL AND METHODS

The study was conducted out by describing the course of a pilot program for paramedics at Silesian Center for Heart Diseases and analyzing the available literature on the functioning of Surgical Physician Assistant in the world.

REVIEW AND DISCUSSION

The Physician Assistant (PA) is an independent employee in the health care system, authorized to provide specific health and treatment services under the supervision of a physician. The detailed scope of responsibilities or the PA training process may vary depending on the national health organization. However, on a global scale, the basic assumptions about the functions and tasks of PA are very similar. The main competences of PA include: subject and subjective examination of the patient; analysis and diagnostics of test results; preparation of the operating field; or assisting in surgical procedures in the form of second or first assistance. PA practice may also include the scope of educational, research, or administrative duties. A 2017 meta-analysis of data was carried out, which included 10,369 children admitted to the emergency department up to the age of 6 years. The comparisons of the effectiveness of diagnostics were analyzed:

- PA
- emergency medicine doctor
- PA after consultation with an emergency medicine physician.

The patient's return to the emergency department within 72 hours was comparable in each group. This proves the effectiveness and clinical experience of well-trained PAs, which in turn increases the availability of patients to medical services while maintaining the appropriate quality. The effectiveness and efficiency of the work of the PA in the American pilot model influenced the development of this profession in other countries, which saw in the PA an opportunity to improve and develop their own health care systems.

THE EVOLUTION OF THE PA PROFESSION IN SELECTED COUNTRIES The USA

The pilot PA program was established in 1965 in the United States. It was a response to the growing deficit of primary care physicians. The group of students consisted mainly of paramedics serving on the front lines during World War II or the Vietnam War [2]. By 2010, there were 154 training programs in each state. The duration of the course is 24-36 months [3]. After completing the training, the graduates take the state examination (the Physician Assistant National Certifying Examination). Currently, over 120,000 PAs are working in the USA.

Canada

In 1980, Canada began training Physician Assistants. Recruits were trained at the Canadian Forces Health Services Training Center in Ontario [4]. In 2004, it is considered the official beginning of the Physician Assistant profession when the Canadian Physician Association accredited the Physician Assistant training program. The curriculum lasts 24 months [5]. Graduates are required to pass the Physician Assistant Certification Examination to become the Canadian Certified Physician Assistant [6].

Great Britian

Before launching the Physician Assistant training program, Great Britain checked the skills of US graduates. In 2004, 10 US PAs were employed in healthcare. It was a research program aimed at determining the usefulness of PAs in health care, their skills, and functioning. The positive evaluation of this study initiated the development of this medical specialty[7-8]. The first training program began at the University of Wolverhampton [9]. The 2006 National Health Service Department of Health report, "The Competence and Curriculum Framework for the Physician Assistant," defines the scope of teaching Physician Assistants [10].

The Netherlands

In the Netherlands, the Physician Assistant training program started at the Medical University of Leiden. Four students were enrolled in the program. Two years later, the Universities of Nijmegen and Utrecht joined the PA training program [11-12]. All training programs last 30 months.

THE PA IN THE WORLD

Currently, 18 countries around the world have a fully developed PA training system in which, after training, Physician Assistants fully perform their specific duties [13]. It is worth noting the presence of PA not only in developed countries but also in developing countries, such as India or Ghana. PAs can play a very important role in increasing access to medical services for patients in areas with poorly developed infrastructure, where they are often the only providers of health services in such areas. In many countries, the PA program is a pilot program. These countries include, among others, Poland, where the duties of PA have so far been performed in the pilot program by paramedics after undergraduate studies (Table 1).

Table 1. The list of countries with a fully developed PA training and employment system.

1.	USA	10.	Ghana
2.	Canada	11.	Saudi Arabia
3.	Great Britain	12.	New Zealand
4.	Germany	13.	Afghanistan
5.	The Netherlands	14.	Ireland
6.	Israel	15.	Kenya
7.	Australia	16.	Liberia
8.	Switzerland	17.	South Africa
9.	India	18.	Bulgaria

THE BEGINNINGS OF PA IN POLAND

On May 27, 2008, the Ministry of Health hosted a meeting at the initiative of Professor Michał Zembala from the Silesian Center for Heart Diseases in Zabrze and the Club of Polish Heart Doctors. The subject of the meeting was to discuss the emergence of the Physician Assistant profession. As a consequence, in 2011, a three-year pilot program was launched at the Silesian Center for Heart Diseases. Graduates of the medical emergency department were qualified for it [14]. The PA pilot program was very positively assessed by the entire hospital community, both medical staff and management.

THE LATEST INFORMATION:

THE SURGICAL PHYSICIAN ASSISTANT

IS THE POLISH EQUIVALENT OF THE WORLD'S PAS

After many years of consultations with the medical community, the Ministry of Health approved the Surgical Physician Assistant specialization program for people with a master's or master's degree in engineering or an equivalent degree in nursing, physiotherapy, medical rescue, or dietetics, food technology, human nutrition, management, and public health, on the condition of completing first-cycle studies and obtaining a bachelor's degree in emergency medical or nursing studies.

The specialization training program was developed by a team of experts:

- Professor, habilitated doctor Grzegorz Wallner National Consultant in the field of general surgery, Team Chairman.
- 2. Professor, habilitated doctor Michał Zembala representative of the national consultant.
- 3. Professor, habilitated doctor Krzysztof Zieniewicz representative of the national consultant.
- 4. Professor, habilitated doctor Tomasz Banasiewicz representative of the Society of Polish Surgeons.
- Professor Wiesław Tarnowski, habilitated doctor representative of the Medical Center of Postgraduate Education.

Preparatory work on the development of the specialization training program was carried out with the participation of:

- 1. Professor Marian Zembala, habilitated doctor.
- Professor Jerzy Robert Ładny habilitated doctor – national consultant in the field of emergency medicine.
- Habilitated doctor of medical sciences Łukasz Kaska.
- 4. Professor Piotr Knapik, habilitated doctor.
- 5. Ryszard Walas, doctor of medical sciences.
- 6. Klaudiusz Nadolny, habilitated doctor in health sciences.

The aim of the specialization training will be to educate an independent Surgical Physician Assistant with modern knowledge and practical skills, allowing for effective help and assistance to a specialist doctor in the field of general surgery and other surgical disciplines during surgical procedures and assistance in the treatment of patients staying in hospital wards. Surgical procedures include preparing the patient for surgery, performing basic diagnostic procedures as part of urgent indications for surgical treatment and outpatient treatment as part of so-called minor surgery, as well as basic management of patients after surgery. The specialization training will last 2 years and will be conducted by the Medical and Postgraduate Education Center. Training participants will be obliged to undergo numerous courses and internships in the fields of, among others, general surgery, cardiosurgery, thoracic surgery, orthopedics, anesthesiology, and intensive care. After passing the state examination, the graduate will be awarded the title of "The Specialist in Surgical Physician Assistant", which will be the equivalent of the PA profession.

CONCLUSIONS

The benefits of creating the PA specialization are multifaceted and have a positive impact on the functioning of health protection in each country. This has been proved by the rich experiences of the USA, Canada and many European countries. The presence of PA in the health care system increases the availability of patients to primary health care and improves the quality of medical services. PAs can relieve working specialist doctors by taking over the duties and activities of specialist doctors related to documentation, diagnostics, treatment assistance, or by performing less advanced services and medical activities. Thanks to this help, a specialist doctor will have more time, be more accessible to patients, and be able to concentrate better on more advanced medical activities and more thorough treatment.

Positive world, European and Polish experiences (SCCS Pilot Program) clearly show that the PA function is needed in every health care system. It should be emphasized that PAs are not meant to replace physicians. The function and purpose of PA is to complement the work of a physician to increase the universality of medical services and improve their quality.

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PROPOFOL AND PRIAPISM. HOW MUCH RISK IS THERE - CURRENT LITERATURE REVIEW

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Abstract	Key words	
Priapism is one of the most common conditions requiring urgent medical intervention. There are several types of pria-	priapism,	
pism, including pharmacologically induced priapism. The authors focused on reviewing articles related to propofol-	propofol,	
induced priapism and presented all cases described so far. Propofol is a fast-acting, short-acting drug used by physi-	medics	
cians in many specialties for both children and adults. The mechanism of action is poorly understood. Recognizing the		
type of priapism will allow medics to determine the cause and implement appropriate treatment as soon as possible.		
It includes several regimens, depending on the type of priapism. Prolonged complication can cause very serious and		
sometimes irreversible consequences, such as penile shortening. Although priapism is not recognized as one of the		
side effects of propofol, this review is relevant to the entire medical community, including emergency physicians and		
those working in hospital emergency departments and emergency rooms because of the high frequency of propofol		
use for most medical procedures.		

INTRODUCTION

WHAT IS PRIAPISM

Of all the emergencies requiring urologic intervention, priapism is one of the most common conditions that certainly cannot be underestimated [1]. Priapism is defined as a pathologic, usually painful, independent and unrelated to sexual stimulation or desire penile erection lasting 4 hours or more [2, 3]. The forms of priapism include ischemic priapism – with low flow, which accounts for about 95% of cases, non-ischemic priapism - with high flow, and stuttering or recurrent priapism [2, 4, 5]. This condition can occur in all men regardless of age, including neonates [1]. Priapism is thought to be quite rare, ranging from 0.5 to 0.9 per 100,000 person-years in the general population. It should be noted, however, that many people affected by priapism do not seek medical attention and thus are not included in the statistics. The reason for this behavior is often embarrassment, but also spontaneous cessation of symptoms [2, 6]. Importantly, the incidence of priapism is characterized by bimodality, with most cases reported in two ranges – in children between 5 and 10 years of age and in men aged 20-50 years [7].

THE AIM

In this review, the authors focused on discussing propofol-induced priapism and presenting current reports.

REVIEW AND DISCUSSION

PROPOFOL

Propofol is a short-acting, intravenous drug commonly used during general anesthesia in children and adults. It is also used in situations where sedation, maintaining awareness, is required in patients undergoing diagnostic and therapeutic measures, either alone or in combination with other drugs [8]. The advantage of propofol is its immediate onset of action (after about 30 seconds) and possibility to awaken the patient quickly after completion of pharmacotherapy, which makes it one of the most commonly used anaesthetics [9]. The mechanism of action is poorly understood. At present, it is believed that propofol affects the positive inhibitory modulation of the neurotransmitter gamma-aminobutyric acid (GABA), prolongs its binding with the receptor, which in turn prolongs chloride conduction and enhances its action.

Consequently, the time during which neurons remain in a hyperpolarized and inactive state is prolonged. [10]. The most common adverse effects include bradycardia, hypotension, apnea during induction of anesthesia, nausea, and headache during awakening [8].

TYPES OF PRIAPISM

Recognizing the cause of priapism can help physicians identify risk factors and prevent future episodes and potential permanent penile damage from more effective interventions. There are several types of priapism discussed below [6, 11].

ISCHEMIC PRIAPISM

Low-flow priapism also called ischemic priapism, is the most common type of prolonged erection. It is caused by, among other things, impaired venous patency, which leads to blood stasis and reduced arterial supply. Prolonged erection may result in hypoxia and even irreversible tissue damage [12]. This condition requires immediate intervention, as delaying action for as little as 48-72 hours increases the risk of impotence. The cause of such priapism is often idiopathic, whereas factors that may influence the occurrence of the episode can be identified, such as hypercoagulable states, haematological disorders, spinal cord injuries and the consumption of certain drugs [11, 13, 14].

NON-ISCHEMIC PRIAPISM

High-flow priapism is caused by excessive arterial inflow, usually due to penile trauma. This condition does not require urgent intervention because the corpora cavernosa are sufficiently perfused, which can be observed in blood gasometry [15]. Perineal compression is useful to diagnose this type of priapism in boys, which may affect the temporary cessation of erection [11].

STUTTERING PRIAPISM

Recurrent priapism is a condition with recurrent episodes of prolonged erection over a lifetime. In boys, it may co-occur with sickle cell anemia [11, 16]. Recurrent episodes may involve not only those with high flow, but also those with low flow, or be complications after the onset of ischemic priapism [5, 11].

PHARMACOLOGICALLY INDUCED PRIAPISM

Pharmacologic priapism can be induced by commonly used drugs. Although some of them have a similar mechanism of causing long-lasting erection, it is believed that each in an individual way induces priapism. A large proportion of cases are associated with ischemic priapism, so it is important for physicians and patients to be aware of the risks before using medications [12].

MECHANISM OF PROPOFOL-ASSOCIATED PRIAPISM

The mechanism of propofol-associated priapism is incompletely clear and understood. There are many theories regarding its formation. Some authors report parasympathetic vasodilatory effects, sympathetic vasoconstrictive effects, and nitric oxide-mediated smooth muscle relaxation [9, 17-20]. On the other hand, Scherzer et al. on the basis of analyzed cases presented a hypothesis about the possibility of 3 potential mechanisms: dose-dependent vasodilatation, fat embolism, and blockade of sympathetic spinal cord contraction [6]. The first theory citing dosedependent vasodilatation is unlikely because none of the patients showed signs of systemic hypotension [21, 22]. When analyzing another mechanism, it is worth referring to 1987, in which priapism was described after intravenous administration of a 20% concentration of fat emulsions in total parenteral nutrition [23]. On this basis, the authors reported one of the mechanisms; however, in the case of propofol, the concentration of lipids is much lower, which makes it unlikely that this mechanism applies to the drug in question [21]. Propofol, by blocking sympathetic activity, can induce priapism through uncontrollable vasodilation driven by the parasympathetic nervous system [24]. However, high-flow priapism is more commonly associated with a non-ischemic etiology, and most drug-induced priapisms are ischemic.

TREATMENT

Prolonged priapism is associated with many serious consequences, such as future erectile dysfunction and fibrosis of the corpora cavernosa [4, 19]. Therefore, it is clearly an emergency condition requiring urgent medical intervention. The initial physical examination of the patient should focus on pain assessment, stiffness, and trauma examination [15]. In addition, the American Urological Association Guidelines recommend, urine drug testing, complete blood count, peripheral blood gasometry, and sickle cell electrophoresis in African Americans. To differentiate ischemic from non-ischemic priapism, color Doppler ultrasonography is also worthwhile [15].

Initial treatment of both low- and high-flow priapism may include watchful waiting and the use of ice packs, urination, hydration, cold bathing or exercise, and possible urologic consultation [25, 26]. However, according to the American Urological Association Guidelines, cavernous aspiration is necessary in most cases, followed by administration of

Table 1. The details of cases.						
Age	Procedure	Propofol dose	Other anesthetic /analgesics used	Other conditions	Other medications	
58	Laparoscopic right hemicolec-tomy for colonic carcinoma	1,662 mg total amount administered using pump	All medications were administered via the epidural space Remifentanil (2,765 mg) Sufentanil (15 µg) Ropivacaine (60 mg)	Colon cancer	Non reported	
25	Right shoulder reduction	100 mg	None	None reported	None reported	
25 – same patient as above	Right shoulder reduction — patient reinjured shoulder)	50 mg	Fentanyl 100 µg	None reported	None reported	
17	Ablation	Infusion rate: 2.8 mg/min (total dose 550 mg)	Midazolam (4 mg) Sevoflurane inhalation Nitrous oxide inhalation Cisatracurium (rate of 90 μg/min)	Supraventricular tachycardia Crohn's disease	Atenolol (100 mg/d) Polyethylene glycol (17 g/per night Mesalamine (1 g/d) Mercaptopurine (30 mg/d) Tramadol (50-100 mg every 6 h, as needed) Gabapentin (300 mg/4 times daily)	
17 – same patient as above	Transeso-phageal echocardio-gram	Infusion rate: 40 mg over 20 min	Fentanyl (75 µg) Midazolam (3 mg)	As above	As above	

phenylephrine (a relatively selective α -1 adrenergic receptor agonist) at a dose of 200 µg by intravenous injection of 0.5-1 mL in the acute period [4, 15]. This procedure can be repeated every 5-10 minutes until the maximum dose of 1 g is reached. Phenylephrine stimulates sympathetic control of erectile resolution and edema. Pharmacological treatment may also include vasoconstricting agents such as terbutaline (a b2-receptor agonist) given orally or a local injection of epinephrine [4]. If such management fails or provokes significant cardiovascular side effects, penile prosthesis implantation or surgical shunt may be necessary [27-29]. However, it is not clear at exactly what time point of persistent priapism, prosthesis implantation will be appropriate. Zacharakis et al. demonstrated that the later the procedure is performed (after 5 months), the lower the satisfaction and the greater the degree of difficulty of the operation compared to early access within 7 days [30]. It is also important to note the advantages of early prosthesis implantation, such as preservation of penile length and lack of fixation of solid fibrosis, which makes the operation easier [27, 28].

Before any procedure, even a short one such as a shoulder positioning, with propofol, it is worth informing the patient about the possibility of priapism. It is important that patients do not ignore this side effect and report to the hospital emergency department or emergency room as soon as possible. This will allow timely implementation of appropriate management and prevent long-term, sometimes irreversible consequences such as penile shortening.

REPORTS

Although it is rare and priapism is not recognized as a potential adverse effect of propofol, there are 3 such reports in the literature [21, 22, 31] and 2 confirmed by retesting in the same young men aged 17 and 25 years [6, 22]. The third case also involved a male patient aged 58 years who received epidural anesthesia in combination with propofol for laparoscopic hemilectomy [19]. None of these cases stated what type of priapism was suspected in their patients. The scientific community believes that most druginduced priapisms (except cocaine) are ischemic or venoocclusive [12]. The details of each case are presented in Table 1.

CONCLUSIONS

Although priapism is not considered one of the adverse effects of propofol infusion, there are case reports in the scientific literature that contradict this statement. The occurrence of a temporal coincidence between the symptoms of priapism and the administration of propofol should be reported to the appropriate agencies as defined by the country, such as the Office for Registration of Medicinal Products, Medical Devices and Biocidal Products in the case of Poland. It is also worth noting that a patient receiving propofol who develops the most severe complications as a result of a sequence of adverse events may seek an explanation that will trigger further legal action. Therefore, it is important to inform the patient of the manufacturer's information and current medical knowledge about side effects. With an understanding of the pathophysiology, prevalence, and strategies for prompt and appropriate management, clinicians will be better equipped to minimize future morbidity. Understanding the compilation of this phenomenon will help them prevent it by avoiding medications that have been linked to priapism. However, it is also worth remembering that propofol is very commonly used in hospital emergency departments and emergency rooms. Therefore, this review is relevant to the medical community as a whole, not just to physicians who practice sexual medicine.

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A PATIENT WITH CHEST PAIN AND ST-SEGMENT ELEVATION ON A RESTING ECG – A CASE STUDY

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Abstract

The study aimed to discuss selected causes of chest pain in patients with ischemic changes on the resting ECG. The Emergency Medical Service (EMS) team was dispatched to a 49-year-old patient reporting crushing, retrosternal chest pain radiating to the left upper limb. The research material was obtained from the analysis of the patient's medical records during his stay in the Emergency Department (ED), the Interventional Cardiology Department, as well as from the medical emergency card and the dispatch order of the EMS team. The study used an individual case study method. An urgent qualification for coronary angiography and percutaneous coronary intervention is the priority in providing healthcare service to a patient with the suspected acute coronary syndrome with ST-segment elevation. The ED staff followed the guidelines on management of acute coronary syndrome with ST-segment elevation.

Key words

acute coronary syndrome, myocarditis, pulmonary embolism

INTRODUCTION

Chest pain is one of the most common complaints that makes patients present to Emergency Departments (ED). The basis of diagnostics is a detailed medical history and a thorough physical examination. Often there is a need for additional laboratory and imaging tests. Chest pain may indicate a severe illness that requires urgent treatment. There may be many causes of chest pain, but three will be discussed for the purpose of this paper, i.e., acute coronary syndrome, pulmonary embolism, and myocarditis.

Chest pain is a nonspecific symptom. According to the literature data, acute coronary syndrome (ACS) is responsible only for 10-30% of chest pain cases [1, 2]. In European countries, the incidence of ST-segment elevation acute coronary syndrome (STE-ACS) is decreasing, and the incidence of non-ST-segment elevation acute coronary syndrome (NSTE-ACS) is increasing [3-10].

The acute coronary syndrome includes three acute manifestations of coronary artery disease: ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTE-MI), and unstable angina (UA). NSTEMI and UA are known as NSTE-ACS. The direct ACS cause is an imbalance between the myocardial oxygen demand and its supply. Most often, it occurs due to sudden occlusion of the coronary artery by a thrombus formed on the ruptured atherosclerotic plaque. Due to the eccentric plaque damage in UA, the thrombus only limits the coronary flow but does not entirely block it. STEMI is caused by a blood clot that suddenly and completely closes the lumen of a coronary artery, and NSTEMI is often a consequence of UA. In such a case, the infarcted area has mostly a well-developed collateral circulation [11].

As mentioned before, the basis of diagnostics is a thorough and detailed medical history taking and physical examination.

NSTE-ACS patients present with chest pain, most often retrosternal, which may radiate to the neck, mandible, left upper limb, epigastric region, or, rarely, to the interscapular area. This pain is often caused by exercise or emotional stress. The intensity of pain is more frequent in the morning and can be exacerbated by cold air and a heavy meal. This pain does not change with the body's position or the respiratory cycle phase. In addition to typical angina pain, there are also so-called equivalents or "masks" of angina. These include exertional dyspnea (more common in the elderly and patients with diabetes), fatigue, abdominal pain, and nausea. The physical examination usually shows no abnormalities [11].

The most common complaints reported by STE-MI patients include chest pain, usually severe, burning, crushing, or squeezing, lasting more than 20 minutes. Pain can also be localized to the middle epigastric or upper right abdominal quadrant, with nausea and vomiting. In addition, there may be shortness of breath, weakness, dizziness, presyncope, fainting, palpitations, anxiety, or fear of impending death. The most common symptoms found in the physical examination are pale skin, hyperhidrosis, cardiac arrhythmias (tachycardia, arrhythmia, bradycardia), lowgrade fever, auscultatory abnormalities in the heart, rales over the lung fields in the case of left ventricular failure, or symptoms of right ventricular failure, i.e., hypotension and dilated jugular veins [12].

A resting ECG is the basic additional diagnostic test. To suspect myocardial ischemia, the abnormalities must be present in at least two adjacent leads, i.e., V1-V6 – from the anterior wall; II, III, aVF – from the inferior wall; I, aVL – from the lateral wall and apex, and VR3 and VR4 – from the free wall of the right ventricle [12-13].

In STEMI patients, we can see a typical evolution of changes, a left bundle branch block (LBBB; a recent infarction is suspected if we find a QS complex in V1-V4 and Q waves in V5 and V6 or regression of R waves in precordial leads) or right bundle branch block (RBBB; a recent infarction is suspected if we find new ST-segment depression or elevation $\geq 1 \text{ mm}$ in leads other than V1). A typical evolution of changes in STEMI is understood as changes in the resting ECG recording lasting from several hours to several days, including the appearance of high, pointed T waves, then convex or horizontal elevations of the ST-segment (Pardee sign), the formation of pathological Q waves with a decrease in R-wave voltage, the return of the ST-segments to the isoelectric line, and a further reduction in the amplitude of the R-waves, deepening of the Q-waves and the formation of negative T waves [12-13].

In patients with suspected ACS-NSTEMI, we can expect ST-segment depression (a diagnostic value in the case of horizontal or oblique ST-segment depression ≥ 0.05 mV) or negative T waves (depth > 0.1mV) or changes in T waves from negative to positive. However, about 30-50% of patients do not show any changes in the resting ECG, suggesting myocardial ischemia [12-14].

In the absence of changes in the resting ECG indicating myocardial ischemia, blood sampling is necessary to determine the value of cardiac biomarkers (troponin, CK-MB). If the values of the markers exceed the cut-off point for ACS, we diagnose NSTE-MI. In the absence of a significant increase, we can diagnose UA (12-14). Apart from the resting ECG, additional exams may include chest X-ray and resting echocardiography [12-14].

Myocarditis is the disease entity whose clinical picture may resemble ACS. It is a disease that, due to its clinical course, diagnostic difficulties, and the lack of specific, targeted therapy, is still a challenge for cardiologists. Myocarditis involves cardiomyocytes, interstitial tissue, vessels, and sometimes even the pericardium [15-16].

Infectious agents are the most common cause of myocarditis. There are mainly cardiotropic viruses, including Coxsackie viruses, cytomegalovirus, human immunodeficiency virus, influenza viruses, hepatitis, herpes zoster, varicella, mumps, and rubella viruses. In European countries, the most common etiological factors are adenoviruses and enteroviruses, and the more frequent causes, especially in children, are parvovirus B19 and the herpes virus type 6 [17-20]. Other infectious agents that can cause myocarditis are bacteria (beta-hemolytic streptococci, Corynebacterium diphteriae, Neisseria meningitidis, Borrelia burgdorferi), fungi (Candida, Aspergillus), protozoa, and parasites (Mycoplasma pneumoniae, Chlamydia pneumoniae, and rickettsiae) [15-16].

Non-infectious factors causing myocarditis are immune and autoimmune factors, hormonal disorders, microangiopathic lesions, drugs, physical and chemical factors, toxic agents, and drugs [21-25].

The symptoms of myocarditis are nonspecific. The basis for suspicion is a carefully collected medical history focusing on recent infections. Myocarditis's clinical symptoms may include dyspnea associated with heart failure, chest pain associated with coronary artery spasm, myocardial ischemia or concomitant pericarditis, and palpitations [15].

Due to clinical symptoms, myocarditis can be divided into:

- Acute myocarditis most often preceded by a viral infection, may take place under the mask of an acute coronary syndrome with a positive troponin result and a normal image of the vessels in coronary angiography
- Eosinophilic myocarditis may manifest as rapidly progressive (fulminant) heart failure, accompanied by rash and sometimes peripheral blood eosinophilia
- Giant cell myocarditis apart from symptoms of heart failure, conduction blocks, and ventricular tachycardia may also occur [15].

When dividing according to the course, we distinguish myocarditis:

- Fulminant sudden onset, rapid increase in symptoms of heart failure, including cardiogenic shock
- 2. Acute less distinct onset
- 3. Subacute or chronic progressive heart failure [15]. Additional auxiliary tests are ECG, echocardiog-

raphy, chest X-ray, and laboratory tests.

An electrocardiographic recoding may show various abnormalities. The most common are changes in the ST segment and the T wave in multiple leads, ventricular and supraventricular arrhythmias, disturbances in intraventricular and atrioventricular conduction. Sinus tachycardia is by far the most common abnormality [26].

Also, echocardiography does not show any features typical of myocarditis. The most common abnormalities are left ventricular systolic dysfunction with generalized wall hypokinesia, left ventricular diastolic dysfunction, relaxation disorders, and, in some cases, restriction features. In addition, some patients have pericardial fluid [27-28].

Laboratory tests reveal accelerated ESR, leukocytosis with a predominance of neutrophils, eosinophilia in the case of eosinophilic myocarditis, and increased CK-MB and troponin levels [15].

Another life-threatening cause of chest pain is pulmonary embolism (PE). It is the most serious and, at the same time, the most dangerous clinical manifestation of venous thromboembolism (VTE). Unfortunately, the incidence of PE is difficult to determine because some cases may be asymptomatic and the diagnosis is made by chance [29-30], and some cases are found during an autopsy [31-32].

Predisposing factors for acute PE according to the ESC 2014 guidelines are lower limb fracture, hospitalization for heart failure or atrial fibrillation within the last three months, replacement of the hip or knee joint, extensive trauma, myocardial infarction in the previous three months, history of venous thromboembolism and myocardial damage [33-34].

The clinical symptoms of PE, according to the frequency of occurrence, are sudden dyspnea (approx. 50% of patients), chest pain, most often caused by pleural irritation due to peripheral embolism leading to a pulmonary infarction (approx. 50% of patients) or due to ischemia of the right ventricle caused by the central pulmonary embolism (typical stenocardial pain), the cough usually dry (about 20% of patients), fainting or presyncope (about 6% of patients) or hemoptysis (about 7% of patients) [35].

More than half of the patients have tachypnea and tachycardia on physical examination. There may also be jugular venous dilatation, increased volume of the pulmonary component of the second tone, hypotension, or symptoms of shock in the case of right ventricular failure [36].

When PE is suspected, we can scales assessing the probability (Wells scale or Geneva scale). It considers predisposing factors (previous deep vein thrombosis – DVT or PE, surgery or immobilization within

the last two weeks, malignant neoplasm), symptoms (hemoptysis), signs (heart rate ≥ 100 bpm, signs of venous thromboembolism disease), and clinical evaluation (other diagnoses less likely than PE). The clinical probability can be low, medium, and high. Depending on this, the patient management and diagnostics are adjusted [33].

In the case of a low or intermediate PE risk, we measure the concentration of D-dimer. The negative predictive value of D-dimer is high, and its normal level indicates a low probability of PE or DVT. On the other hand, elevated D-dimer values have a low predictive value and do not help confirm PE [37-41].

When high-risk PE (concomitant shock or hypotension) is suspected, angio-CT of pulmonary vessels is the urgent procedure of choice. When this examination cannot be performed, bedside echocardiography is recommended. If, in the performed exam, we find symptoms of right ventricular overload, and we are not able to perform a CT scan, and the patient is not hemodynamically stable, then we can initiate specific treatment for high-risk PE [36, 40-41].

In treating pulmonary embolism, we use fibrinolytic and/or anticoagulant therapy. The decision to adopt a given strategy is based on analyzing risk factors and the patient's general condition [36].

THE AIM

The study aimed to recall the appropriate management in a patient suspected of STE-ACS.

MATERIAL AND METHODS

The Emergency Medical Service (EMS) team was dispatched to a 49-year-old patient reporting crushing, retrosternal chest pain radiating to the left upper limb. The research material was obtained from the analysis of the patient's medical records during his stay in the Emergency Department, the Interventional Cardiology Department, as well as from the medical emergency card and the dispatch order of the EMS team. The study used an individual case study method.

CASE REPORT

The basic type EMS team was dispatched to a patient who developed a crushing pain in the chest with a retrosternal location, radiating to the left upper limb, and dyspnea after a bit of effort. Although the patient denied the occurrence of such ailments in the past, he also denied the occurrence of decreased exercise tolerance, dyspnea, presyncope, or syncope. Earlier, the patient was not treated due to chronic diseases and was not taking medications permanently. In the physical examination, the patient was in average general condition, conscious, in full verballogical contact, autopsychic and allopsychic oriented. He was cardiovascularly and respiratorily stable with blood pressure (BP) of 159/98 mmHg, regular heart rate (HR) of 80 bpm, number of breaths (RR) of 16/ min, saturation without oxygen therapy 91%, marked respiratory effort, blood glucose measured by a glucose meter of 128 mg%. A resting ECG performed by an EMS team revealed a regular sinus rhythm of 80 bpm and ST-segment elevation by 0.5 mm in leads III and aVF. In the physical examination, there were no significant abnormalities.

After being brought to the ED, the patient was in a stable state, conscious, in full verbal and logical contact. Auscultation over the pulmonary fields revealed exaggerated vesicular breath sounds on both sides and single crackles at the base of lungs also on both sides. The number of breaths was $16-18/\min$, SaO2 - 97%with passive oxygen therapy 12 L/min (mask with a reservoir). Also, there was a regular heart rate of 98 bpm. The abdomen was soft, painless by palpation, with no peritoneal symptoms. Also, peristalsis was present. In a neurological examination, no significant deviations were revealed. A resting ECG performed in the ED revealed a regular sinus rhythm of 80 bpm and ST-segment elevation by 1.5 mm in leads III and aVF. The additional tests were as follows: WBC $9.30*10^{3}$ / µL, PLT 231*10^3/µL, HGB 15.7 g/dL, glucose 7.1 mmol/L, creatinine 104.1 µmol/L, CRP 0.7 mg/L, eGFR 74.7 mL/min/1.73m2, high-sensitive troponin T 16 ng/L, potassium 3.86 mmol/L, chloride 103.3 mmol/L, sodium 139.1 mmol/L, ALT 21 U/L, dimer-D 0.89 mg/L FEU. The antigen test for SARS-CoV-2 infection was negative.

Bedside echocardiography revealed segmental contractility abnormalities in the inferior and inferolateral walls with an ejection fraction of about 45%, no signs of right ventricular overload, no fluid in the pericardium, and no hemodynamically significant valve disease.

The early-hospital procedure aimed to diagnose and establish further treatment promptly.

This procedure included:

- 1. Recording of a resting ECG during the ED stay.
- 2. The patient was closely monitored, blood pressure, pulse rate, number of breaths, a level of consciousness.
- 3. Passive oxygen therapy was started due to increasing dyspnea.
- 4. A total of 300 mg of ASA, 180 mg of ticagrelor, and 5,000 IU of unfractionated heparin, sublingual nitroglycerin 3 x 0.4 mg/dose, and 8 mg of morphine were administered in total.

5. The patient was transferred to the cath lab for coronary angiography and potential PCI.

After initial diagnostics at the ED, the patient was admitted to the Interventional Cardiology Department for further treatment. The patient underwent coronary angiography, which did not reveal any significant lesions in coronary arteries. In the control laboratory tests, high-sensitive troponin T with an increasing tendency (after 1h - 266 ng/L, after another 3 hours - 1243 ng/L). Due to the persistent chest pain, dyspnea, and cooling of the left upper limb, angio-CT of the thoracic aorta and pulmonary vessels was performed. In angio-CT of the thoracic aorta, no signs of aortic dissection were found in the ascending part, arch, and thoracic segment. Moreover, the left subclavian and axillary arteries were patent, without any stenoses. In the performed angio-CT of the pulmonary arteries, no contrast intraluminal filling defects were observed in the pulmonary trunk, pulmonary arteries, and their lobar branches. However, such defects occurred at the level of some segmental arteries of the upper and lower lobe of the right lung and the lower lobe of the left lung. The presence of such defects suggests embolic material in the given area. The PCR smear for SARS-CoV-2 virus infection was performed, and this time the result was positive. Therefore, the patient was diagnosed with acute PE and suspected myocarditis. He was transferred to the Department of Cardiology of the hospital dedicated to patients infected with the SARS-CoV-2 virus.

DISCUSSION

A quick and correct diagnosis of STE-ACS is the main task for the ED staff.

- 1. Patients with ACS most often present with chest pain with typical radiation, decreased exercise tolerance, and dyspnea [42-44].
- 2. A carefully taken medical history is the basis for suspecting ACS [42-44].
- 3. The 12-lead resting ECG is the basic additional test in the event of ACS suspicion [42-44].
- 4. Trained EMS staff can recognize STEMI [42-44].
- In the absence of ST-segment elevation on the resting ECG, with a positive medical history and increased cardiac biomarkers levels (troponin and CK-MB), we can distinguish NSTEMI from STEMI and UA (no increase in cardiac markers) [42-44].
- 6. The determination of cardiac biomarkers should be the standard of care in chest pain patients presenting to the ED [42-44].
- Acute coronary syndromes are the most common cause of malignant arrhythmias leading to sudden cardiac death [42-44].

- 8. The best way to improve survival in patients with myocardial ischemia is to shorten the time between the onset of symptoms and the first contact with a healthcare professional [42-44].
- 9. Nitroglycerin is an effective drug used to relieve pain in the case of pain resulting from myocardial ischemia. It has a favorable hemodynamic action profile consisting of dilatation of venous capacity vessels, coronary arteries, and to a lesser extent, peripheral arteries [42-44].
- Morphine is the analgesic drug of choice in patients with suspected ACS. It has a sedative effect and dilates venous capacity vessels (especially beneficial in patients with pulmonary edema) [42-44].
- 11. Patients with chest pain and suspected ACS do not require oxygen therapy unless there are symptoms of hypoxia, dyspnea, and heart failure [42-44].
- 12. Antiplatelet therapy is the mainstay of treating ACS, with and without ST-segment elevation [42-44].
- 13. The diagnosis of acute myocarditis is based on history and clinical picture. It should be suspected if there are sudden symptoms of heart

failure, persistent arrhythmias, or arrhythmias and conduction disturbances. The features of myocardial infarction may also appear with normal coronary angiography, especially in young people, without comorbidities and with a negative history of coronary artery disease. In most patients, symptoms of heart failure are preceded by a viral infection [15].

- 14. Symptoms of PE are nonspecific and may suggest other cardiovascular and respiratory pathologies [33-34].
- 15. Because there are no pathognomonic symptoms for PE, in the differential diagnosis, we must consider the presence of risk factors and the clinical probability of PE in a particular patient [33-34].
- 16. In patients with low and intermediate PE probability, we determine D-dimer, and in high-risk PE, angio-CT is the diagnostic modality of choice [33-34].

CONCLUSIONS

The ED staff followed the applicable guidelines on the management of suspected STE-ACS. The appropriate diagnosis and implementation of proper treatment improve the patient's prognosis.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest.

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