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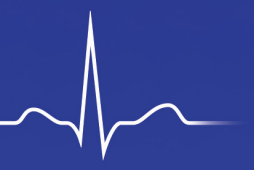

AGGRESSIVE BEHAVIOR TOWARDS HEALTH CARE WORKERS

PREDICTION OF LONG TERM OUTCOME IN MYOCARDIAL INFARCTION

PHYSICAL THERAPY IN THE INTENSIVE CARE UNIT

PNEUMONIA – EMERGENCY ROOM PHYSICIAN'S PERSPECTIVE

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CONTENTS

Emerg Med Serv, 2021; VIII, 3: 121-125

DOI: 10.36740/EmeMS202103111 **ORIGINAL ARTICLE**

THE ROLE OF THE LABORATORY SERVICE IN THE TIMELY ASSESSMENT OF RISK FACTORS IN PATIENTS WITH THYROID NODULES AS A TOOL TO PREVENT POSTOPERATIVE COMPLICATIONS

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Abstract

Aim: To study of thyroid hormones with one-time determination of risk factors in the laboratory.

Material and methods: The examination included the following researches: questionnaire, ultrasound examination with fine-needle aspiration (FNA), cytological examination, determination of the concentration of thyroid hormones and determining the body mass index.

Results and conclusions: the size and area of the tumor according to ultrasound ($H = 2.30$, $p > 0.05$ and $H = 1.92$, $p > 0.05$, respectively). At the same time, patients of the 1st group were younger in age than (when) compared with patients of other groups. For benign thyroid tumors (group I) are characterized by the following data: the level of free thyroxine (FT4) in the serum of 66.7% of patients did not exceed normal and averaged 14.0 (8.0-16.29) pmol/l. Group with suspected tumor malignancy include: very low concentration of FT4 in serum (1.94 (1.44-7.00) pmol/l); high level of FT3 production in 40.0% of cases with a shift of the mean values to the upper limit of the reference interval. Thyroid status of patients with malignant thyroid tumors (group III) is characterized by elevated levels of TSH compared with benign tumors ($p < 0.05$) and suspected malignancy of the tumor ($p < 0.1$). A significant decrease in the production of FT4 in the serum (7.4 times compared with the benign course; $p < 0.001$) against the background of average regulatory levels of FT3.

Key words

thyroid cancer,
laboratory diagnostics,
body mass index,
risk factors,
fine-needle aspiration

INTRODUCTION

In the last few decades, the incidence of thyroid cancer has increased sharply, and now it is the most common cancer in women, especially young people [1-3]. However, the incidence of thyroid cancer is also increasing in men [4].

The relationship between patient factors and postoperative complications is complex and influenced by intrinsic disease factors, patient comorbidities, and operative management. Select studies have revealed an increased risk of complications in outpatient total thyroidectomy associated with male sex, thyrotoxicosis, presence of malignancy, extent of resection, and revision surgery [5].

Treatment of patients with thyroid tumors causes clinical problems and social stress [6]. In particular, for many years the main problem remains the search for a powerful tool that can distinguish between benign and malignant follicular lesions, and minimize the diagnostic search [7].

In general, studies to prevent postoperative complications of the thyroid gland are based on the experience of endocrine surgeons. However, an important component is to identify risk factors during a fine-needle aspiration biopsy visit. The diagnostic link remains limited. For many years, it consists only of cytological examination and quality control with the help of pathomorphological inference. The terms of the latter can have wide variations.

As the incidence of thyroid cancer increases and surgical resection is the mainstay of treatment for patients with thyroid cancer, the number of thyroid surgeries is also increasing [8, 9].

It is especially important to determine the body mass index at the preoperative stage, because it is associated with many pathological features of thyroid cancer, such as larger tumors, extrathyroid invasion, advanced stage of TNM, lymph node metastasis (LN) and tumor multiplicity [10, 11].

Despite the achievement of surgical methods aimed at minimizing adverse effects for patients, thyroid surgery still has risks [12, 13]. Postoperative complications are not uncommon, so it is important to initiate a combined diagnosis using analysis of risk factors and a basic study of thyroid hormones.

THE AIM

The aim of the research is to study of thyroid hormones with one-time determination of risk factors in the laboratory.

MATERIAL AND METHODS

All research was performed in accordance with relevant guidelines and regulations. The prospective study included 60 patients aged 21 to 83 years (mean age 54.6 ± 1.9 years), who according to ultrasound of the thyroid gland were classified as TR-4 category of nodular thyroid tumor on the TIRADS scale (4-6 points, suspected malignant thyroid changes). The research program, information for the patient and the form of informed consent to participate in the study were considered and approved at a meeting of the commission on ethics of the clinical department of Kharkiv National Medical University. The patient confirmed his voluntary decision to participate in the study with a signature in the form of informed consent. The examination included the following researches: questionnaire, ultrasound examination with fine-needle aspiration puncture biopsy (FNA), cytological examination, determination of the concentration of thyroid hormones and determining the body mass index. The research of thyroid status was accomplished on the levels of TSH, free thyroxine (FT4), triiodothyronine free (FT3) and antibodies to thyroperoxidase by immunochemical method with electrochemiluminescent detection on a Cobas e 411 automatic analyzer from Roche Diagnostics, Germany. Ultrasound of the thyroid gland was accomplished using a Toshiba SSA-580A using the TIRADS classification system. A 23G needle (0.6x25 mm) was used for FNA. The puncture material on the slide was air dried and fixed with methanol for 5 minutes, staining for 30 minutes by the method of Romanovsky. The results of the cytological examination were evaluated by the Bethesda System (BSRTC) using a standard cytological protocol. Weight was measured in light clothing and absence of shoes with an accuracy of 0.1 kg, and height was measured with an accuracy of 0.1 cm using a digital scale. Body mass index (BMI) was calculated by dividing body weight (in kilograms) by the square of height (in square meters), and the equivalent of excess weight was 25.0-29.9 kg/m^2 according to specific criteria of Ukraine.

Depending on the cytological conclusion, patients with thyroid pathology were divided into three groups: group I consisted of 18 patients with benign thyroid tumors (Benign); group II included 20 patients suspected thyroid cancer (Suspicious for Malignancy (SFM); group III was formed by 22 patients with malignant thyroid cancer (Malignant). Exclusion criteria: age less than 18 years; pregnant women; reluctance of the patient to participate in the study; refusal of the patient to re-take material and patients with a history of surgery (reoperation, final thyroidectomy) for recurrence of the disease or non-radical primary operations in non-specialized medical institutions, known cardiovascular disease and the use of any medication that alters body weight and composition (e.g., corticosteroids, insulin, sulfonylureas).

Statistical processing of the research results was performed using generally accepted in biomedical research methods of statistical analysis using software products MedCalc v.14.8.1. (MedCalc Software) and Microsoft Excel 2016 (Microsoft). Parametric or non-parametric methods of analysis were used taking into account the law of distribution of quantitative data (Shapiro-Wilk test). To describe and compare data sets with normal distribution, we used the arithmetic mean and its standard error (M ± m), one-way analysis of variance ANOVA (F) with a posteriori comparison of groups with each other according to the Tukey criterion (HSD); with abnormal data distribution – median (Me), interquartile range (25-75%), nonparametric analysis of Kruskal-Wallis ANOVA (H) followed by pairwise comparison of Multiple Comparisons (MS) groups. Comparison of nominal data was performed using the Pearson Chi-square test (χ^2). The relationship between the various factors was determined by analysis of variance and Spearman's rank correlation coefficients (r). The level of significance $p < 0.05$ was considered statistically significant for all statistical analysis procedures, the trend was determined at $p < 0.1$.

RESULTS

A comparative analysis of the studied indicators (Table 1) showed that the selected groups probably did not differ in the gender of patients ($\chi^2 = 2.21$, $p > 0.05$), body mass index ($F = 0.25$, $p > 0.05$). All subjects included in the study had a mean body mass index (BMI) of 28.0 ± 0.6 kg/m², of which more than half (60.0%) were overweight or grade I-II obesity. The size and area of the tumor according to ultrasound ($H = 2.30$, $p > 0.05$ and $H = 1.92$, $p > 0.05$, respectively). At the same time, patients of the 1st group were younger in age than (when) compared with patients of other groups ($p < 0.05$ according to the HSD criterion).

Assessment of thyroid status of patients with thyroid tumors showed a probable correlation between the degree of malignancy in the thyroid gland and TSH levels (according to the analysis of Kraskel-Wallis $H = 7.30$, $p < 0.05$), FT4 ($H = 17.64$, $p < 0.001$)

Table 1. General characteristics of patients and thyroid tumors.

Indicator	Research groups			General difference between the groups
	Group 1 (n=18)	Group 2 (n=20)	Group 3 (n=22)	
Gender, % - female/male	88,9/ 11,1	100/ 0	90,9/ 9,1	χ2=2,21, p=0,331
Age, years, M±m	46,6±3,7	58,7±3,1*	57,4±2,4*	F=4,51, p=0,015
BMI, kg/m^2, M±m	28,7±1,3	27,5±1,4	27,8±0,8	F=0,25, p=0,777
Maximum diameter of formation, mm, Me (25-75%)	15,0 (13,0-17,0)	11,0 (10,0-20,0)	12,0 (10,0-27,0)	H=2,30, p=0,316
Area of formation, mm^2, Me (25-75%)	135,0 (112,0-225,0)	106,0 (60,0-312,0)	120,0 (70,0-513,0)	H=1,92, p=0,383

Note: * – p <0.05 compared to group 1 (by HSD criterion)

Table 2. Thyroid hormone levels of patients of the research groups.

Indicator	Group	Min – max	Me (25-75%)	General difference between the groups	Deviation from the norm [%]	Reference values
Thyroid-stimulating Hormone, μmol / l	I	0,01 – 3,0	1,45 (0,95-1,97)	H=7,30, p=0,026	11,1	0,27- 4,2
	II	0,30 – 2,75	1,39 (1,13-2,27)		–	
	III	0,95 – 2,66	2,00 (1,76-2,30)*		–	
Free Thyroxine, FT4 pmol / l	I	2,10 – 18,63	14,00 (8,00-16,29)	H=17,64, p<0,001	33,3	12,0-22,0
	II	1,12 – 13,5	1,94 (1,44-7,00)**		90,0	
	III	1,07 – 22,1	1,90 (1,21-9,00)**		90,9	
Free Triiodthyronine, FT3 pmol / l	I	4,67 – 6,30	5,67 (5,10-6,20)	H=12,41, p=0,002	–	3,1-6,8
	II	3,9 – 8,3	6,30 (5,40-8,00)		40,0	
	III	3,87 – 7,5	4,90 (4,00-5,30)*#		18,2	
Anti -thyroid peroxidase autoantibodies, IU / ml	I	13,7 – 47,9	23,0 (18,1-24,0)	H=0,20, p=0,903	11,1	До 34
	II	14,9 – 60,9	19,0 (18,1-23,3)		10,0	
	III	11,0 – 75,2	21,9 (16,9-25,8)		9,1	

Notes: * – p <0, 05, ** – p <0,001 in comparison with group I;
– p <0.001 compared to group II (by MC criterion)

and FT3 (H = 12.41, p <0.01). So, despite the fact that the values of TSH in the serum of most patients (96.7%) did not exceed normal, the average in the presence of malignancy was higher than in the benign nature of the tumor and suspected malignancy of the tumor – 2.0 (1.76 -2.30) μIU / l *vs.* 1.45 (0.95-1.97) μIU / L (p <0.05) and 1.39 (1.13-2.27) μIU / L (p < 0.1), respectively (Table 2). From the described data it is clear that patients with the highest concentration of TSH and borderline results of cytological examination need more careful examination compared to patients in whom TSH levels are low. Thus, the increase in TSH even within the reference values correlates with an increased risk of malignancy of the node (r = 0.34, p <0.05) and this indicator can be regarded as an independent predictor for thyroid cancer.

The research of the level of free T4 (FT4) in the serum of thematic patients showed an inverse correlation between the indicators and the potential for malignancy of the tumor – r = -0.45; p <0.001. In benign thyroid disease (group I), the level of FT4 in only one third of patients (33.3%) was below normal, ranged from 2.10 to 18.63 pmol / l and averaged 14.0 (8.0-16, 29) pmol / l (Table 2). In contrast, the vast majority of patients in groups II and III (90%) had a very low concentration of this hormone in the serum – the median rate was 7.2-7.4 times lower than in group I (p <0.001). Therefore, low levels of FT4 may serve as a differential diagnostic criterion and indicate a potentially malignant origin of the tumor.

In contrast to the previous hormone, the concentration of free T3 (FT3) in the serum of most patients

with thyroid tumors (80.0%) did not exceed the reference range. At the same time, a probable shift of FT3 values depending on the degree of malignancy of the node was established. Thus, for benign tumors and suspected malignancy of the tumor, the hormone level mostly approached the upper limit of normal or exceeded it, while in metastatic thyroid disease it's value was within the reference range ($p < 0.05$ compared with previous groups) (Table 2).

Regarding the levels of AT-TPO, the study did not show significant differences between groups of patients ($H = 0.20$, p & gt; 0.05), no process of immunogenic destruction of the thyroid gland. Therefore, autoimmune status is not prognostic factor of malignancy.

DISCUSSION

Timely detection of risk factors at the preoperative stage plays an important role in the prevention of complications after surgery. With the help of laboratory monitoring, it is possible to improve the quality of medical care for patients diagnosed with thyroid cancer.

Some studies have found an increased risk of complications of outpatient total thyroidectomy associated with male gender, thyrotoxicosis, the presence of malignancies, the degree of resection and revision surgery [14, 15].

The study of thyroid hormones in peripheral blood is important, especially recent studies report a positive relationship between TSH and blood pressure [16].

Epidemiological studies report a positive association between obesity and thyroid cancer risk and body mass index [17-19].

This single-center study indicates that the determination of risk factors and body mass index at the same time as the study of thyroid hormones significantly helps in the prevention of complications in the postoperative period.

CONCLUSIONS

1. Analysis of risk factors is especially important in the study of thyroid hormones. To prevent complications after surgery, our studied indicators are considered in the dynamics, which is important in the individual attitude to the patient;
2. Body mass index is positively correlated with thyroid tumors and together with risk factors acts as a mediator;
3. For benign thyroid tumors (group I) are characterized by the following data: the level of free thyroxine (FT4) in the serum of 66.7% of patients did not exceed normal and averaged 14.0 (8.0-16.29) pmol / l; the concentration of FT3 in all cases corresponded to the reference values, but with a shift of the average levels to the upper limit of normal (5.67 (5.10-6.20) pmol / l). Benign thyroid disease (category II BSRTC) is likely to be associated with younger patients (46.6 ± 3.7 years);
4. Group with suspected tumor malignancy include: very low concentration of FT4 in serum (1.94 (1.44-7.00) pmol / l); high level of FT3 production in 40.0% of cases with a shift of the mean values to the upper limit of the reference interval (6.30 (5.40-8.00) pmol / l;
5. Thyroid status of patients with malignant thyroid tumors (group III) is characterized by elevated levels of TSH compared with benign tumors ($p < 0.05$) and suspected malignancy of the tumor ($p < 0.1$), but within the reference range; a significant decrease in the production of FT4 in the serum (7.4 times compared with the benign course; $p < 0.001$) against the background of average regulatory levels of FT3.

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

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COMMAND SUPPORT SYSTEM EMS (SWD PRM)

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Abstract

Poland is the only country in the world, which has a uniform nationwide command support system for medical rescue, integrated with the command support systems of the National Fire Service and the Police. SWD PRM is understood as an ICT system that enables receiving alarm notifications from emergency notification centers and notifications about incidents, dispatching of emergency medical services, recording medical incidents, presentation of geographical location of the incident site, positioning of emergency medical services and support of tasks execution by emergency medical services and provincial coordinator of medical rescue. The purpose of this paper is to present assumptions of the SWD PRM system and history of its implementation as well as available technical and system capabilities. Its greatest advantage is the fact that it is a uniform nationwide teleinformatic system collecting data about medical events. Its functioning in terms of information and data collection allows for improvement of planning and organization of the PRM system, which enables effective management of available forces and resources, which translates into shortening the waiting time for assistance for a person in a state of emergency by reducing the time of arrival of the Medical Rescue Unit at the scene of the event.

Key words

emergency medical services, support system, emergency notification

INTRODUCTION

Pursuant to the Act on the State Medical Rescue, the term SWD PRM is understood as an ICT system that allows for receiving emergency reports from emergency notification centers and notifications about events, managing EMS, recording medical events, presenting the geographical location of the event, positioning EMS and supporting the implementation of tasks by EMS and the provincial coordinator of emergency medical services.

The concept of PRM SWD together with organizational assumptions and legal regulations was introduced to the Act of September 8, 2006 on the State Medical Rescue on the basis of the Act of November 22, 2013 on the emergency notification system (Journal of Laws of 2013, item 1635) and entered into force on 1 January 2015 [1].

THE AIM

The aim of this work is to present the assumptions of the SWD PRM system and the history of its implementation, as well as the available technical and system capabilities.

MATERIAL AND METHODS

The study was conducted by analyzing the most recent available literature on the subject matter.

REVIEW

Pursuant to the provisions of the Act in question, all specific issues concerning, inter alia, Functional parameters of SWD PRM and the method of its maintenance, as well as the way of functioning of SWD PRM in emergency situations, taking into account the need to ensure the optimal level of cooperation between the ICT system of the emergency notification system and SWD PRM, are specified by the Minister of Administration and Digitization, after consulting the Minister of Health. The document in question is the regulation of the Minister of Administration and Digitization of 31 December 2014 on the Command Support System of the State Medical Rescue (Journal of Laws of 2014, item 1994) [2].

It is worth noting that SWD PRM in its original version was planned for a very wide teleinformation system with numerous functions at many levels of use, which will be integrated with other command support

systems of units cooperating with the PRM system and the emergency notification system. However, for financial reasons the implementation of such wide functionalities was finally divided into two stages [3].

In the first stage, SWD PRM version 1.0 was developed, including functionalities in the field of key and necessary business processes essential for medical rescue, such as the above-mentioned acceptance of emergency notifications from the emergency notification center, event handling, including recording of medical events, managing the Medical Rescue Service, presenting the place geographical alarm event and EMS positioning [4]. Work on the construction of the SWD PRM 1.0 version was carried out in the years 2014-2015 [5]. On the other hand, the process of its implementation began in 2016, when both preparation for launch and production launch were carried out. Preparations for the launch included, inter alia, tests in two medical dispatching rooms: in Gorzów Wielkopolski and in Słupsk.

A particularly important date is June 22, 2016, when the first production implementation of SWD PRM 1.0 in Gorzów Wielkopolski took place, in which the system was implemented in one medical control room and in six ZMR. Then, on June 23, 2016, a similar implementation was performed in Słupsk in one medical dispatching room and in eight EMS teams. Completion of the production implementation of SWD PRM 1.0 in all functioning medical dispatching rooms is scheduled for the end of 2017 [4].

Simultaneously with the implementation of SWD PRM 1.0, the concentration of medical dispatching rooms was carried out. This action was aimed at improving the quality of operation of the emergency notification system about medical events, and above all, its improvement and standardization throughout the country based on ICT tools. Ultimately, during the implementation of SWD PRM 1.0, 296 medical dispatching rooms throughout the country were shut down. The system in version 1.0 was introduced in 16 positions of voivodeship medical rescue coordinators, in 42 concentrated medical dispatching rooms with 226 dispatcher positions and in 1552 EMS [6]. The concentration process of medical dispatching rooms is to be completed in 2028 to a maximum of 18 medical dispatching rooms throughout the country operating within the structures of Voivodship Offices [5]. Then, one medical dispatching room is to operate in each voivodeship, except for the Mazowieckie and Śląskie voivodships, where, due to the number of inhabitants, two such units are allowed to operate.

Simultaneously with the completion of works and the implementation of SWD PRM 1.0, work on the SWD PRM 2.0 version was started. For this purpose, by order of the Minister of Health of November 10, 2015, the Team for the development of SWD PRM (Journal of Laws of Min. Zdr. 2015.77) [7] was established. Among the areas of his activities, it is worth mentioning, among others work on proposals and priorities for additional functionalities of SWD PRM, as well as the development of a list of functionalities to be implemented in SWD PRM and the expansion and modification of SWD PRM by supplementing the currently implemented functionalities with new solutions based on the knowledge, experience and user reports. The Team includes representatives of the Ministry of Health, as well as representatives of Voivodship Offices and ZMR administrators [3].

The next step in the development of works on the entire SWD PRM was the change of the ordinance of the Minister of Health discussed above. Order of the Minister of Health of December 15, 2018 amending the ordinance on the appointment of the Team for the development of SWD PRM, the tasks of the Team have been modified (Journal of Laws. Min. Zdr. 2018.120) [8]. The tasks of the Team were distinguished both in the area of SWD PRM version 1.0 and in the area of SWD PRM 2.0. It is worth noting that the discussed ordinance also clearly indicates the date of completion of SWD PRM 2.0 implementation, which is also the date of termination of the functioning of the said Team. This date was set no later than December 31, 2020.

In terms of technology, the most important functionalities of SWD PRM are the following areas:

a) event handling - this is the main business process of the system, which is divided into sub-processes such as: receipt of the notification, ordering the EMS, acceptance of the departure order by the EMS and departure of the EMS;
b) monitoring PRM forces and resources;
c) taking over the handling of reports / events by another medical dispatching room;
d) user work control;
e) management of PRM forces and resources;
f) reporting, including: creating a dispatcher's book in control rooms and generating predefined and free reports [9].

DISCUSSION

Among the more precisely defined solutions possible thanks to SWD PRM, there are such functionalities as: receiving emergency notifications from the emergency notification center and notifications about events directed to the 999 emergency number, record-

ing medical events, presentation of the geographical location of the event, EMS positioning, management of EMS teams, communication between medical dispatchers and members of EMS, management of reports and events, managing HEMS, as well as verifying system users by managing the password policy and verifying logins, creating travel order cards that allow identification of the number of the person reporting the event and other medical documentation (cards medical rescue operations, the book of the EMS administrator), enabling listening to the recorded conversation with the person informing about the event, making a printout of order cards in a form acceptable to the public payer, recording patients and history and departures, as well as activities carried out by EMS, creating a database of notifications, events, keeping a book of refusals, creating a division of the region and separating the functions of the receiving dispatcher and the EMS service provider, interaction with the technical infrastructure (telephone exchanges, call recorders, status terminals, the EMS notification system via pagers, DWA alarm displays, SMS notifications, rescue tablets), updating the map module and creating a graphic visualization of the event location, preparing and archiving analyzes and statistics [3, 5].

The implementation of the above-mentioned functionalities is possible thanks to the use of four modules in SWD PRM, such as: dispatcher module, stationary and mobile module for EMS: reporting the EMS readiness to take action, taking an event, handling an event, preparation and printing of medical rescue cards, administrator module and planner as well as the analytical and reporting module.

The entire functioning of SWD PRM in the presented formula is also possible thanks to the integration with other external systems enabling the highest quality service of emergency notifications. The above-mentioned systems include, first of all, the IT system of emergency notification centers, including indirect communication with the command support system of the Police and the State Fire Service, as well as a universal map module and a subsystem of integrated radio-telephone communication, a location and information platform with a central database and dedicated automap [3].

As indicated by the provisions of the regulations in question, the business administrator of the SWD PRM system is the Minister of Health. On the other hand, the technical administrator of the system responsible for its maintenance and technical service until December 31, 2018 was the Minister of Administration and Digitization. From January 1, 2019, the National Medical Rescue Monitoring Center (KCMRM) located within the structures of the LPR is responsible for the maintenance of the PRM SWD. Within KCMRM there is the SWD PRM Department, which includes the SWD PRM Technical Center and the SWD PRM Development Team. The basic tasks of the Department for SWD PRM in the field of day-to-day service of SWD PRM include, among others: monitoring and round-the-clock technical service, providing technical support to users, as well as supervision, detection and elimination of irregularities in the functioning of the system. On the other hand, the planning and development tasks of the SWD PRM Department include, inter alia, design, organization and implementation of ICT solutions, analysis of errors reported by end users regarding the functioning of SWD PRM and analysis of new proposals and changes to existing functionalities reported by users in SWD PRM.

Poland is the only country in the world where there is a uniform for the whole country, integrated with the command support systems of the State Fire Service and Police, command support system for medical rescue [9].

SWD PRM is sometimes referred to as a key element of the emergency notification system for emergency health conditions. Its greatest advantage is the fact that it is a nationwide teleinformation system that collects data on medical events. Its functioning in the field of information and data collection allows to improve the planning and organization of the PRM system, which allows for effective management of the available forces and resources, which translates into shortening the waiting time for help for a person in a state of emergency by reducing the time of EMS to the scene.

CONCLUSIONS

The functioning of SWD PRM is both challenges and effects of action, which include, on the one hand, ensuring the efficient transfer of data between rescue and public order services, and, on the other hand, the development of the PRM system based on modern ICT technologies.

The operation of SWD PRM is also important from the economic point of view - financing the entire PRM system and health services provided to people in a state of sudden health emergency, including services provided in the HED. For the first time since the establishment of the PRM system in its present shape, it is possible to provide real data on its functioning based on the same criteria throughout the country [6].

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CONFLICT OF INTEREST

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ANALYSIS OF AGGRESSIVE BEHAVIOR TOWARDS HEALTHCARE WORKERS BEFORE AND DURING THE SARS-COV-2 EPIDEMIC IN POLAND. PART 1

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Abstract

Aim: To analyze aggressive behavior towards healthcare workers before and during the SARS-CoV-2 epidemic in Poland and confront the obtained results with reports on this phenomenon from the scientific world.
Material and methods: The study included 999 respondents constituting healthcare workers from all over Poland. The proprietary questionnaire consisting of three parts was the research tool.
Results: 86% of healthcare personnel encountered violence in the workplace before announcing the epidemic state, and 81% – during the epidemic state. Respondents indicated that the frequency of this phenomenon increased significantly after that date. Patients were the most frequent offenders.
Conclusions: Aggression being a relatively constant and unchanging problem in healthcare, according to the authors, requires the development of new, more effective solutions to improve the situation of victims. Encouraging staff to report aggressive behaviors and actively supporting them in these actions could lead to more frequent legal consequences for aggressors, increasing the chance for more respectful treatment of medical staff and disrupting the false sense of impunity in perpetrators.

Key words

aggression, healthcare workers, epidemic, respondents, workplace

INTRODUCTION

To this day, scientists do not agree on what behavior the phenomenon called aggression consists of. Some indicate that these are behaviors that may lead to the loss of values and cause harm to another person. Others, in addition to the features mentioned above, note the importance of intentionality and understand aggressive events as those that, by definition, should cause pain, harm, or hurt the victim [1-6]. It is therefore difficult to define precisely what constitutes "violence" or "physical attack". Behavior with a weak and moderate intensity of aggression includes, for example, offensive words, threats, property damage. In contrast, those severely saturated with aggression are behaviors leading to trauma and bodily harm [7]. Each profession is to some extent exposed to aggressive behavior, not only from third parties – patients, clients, etc., but also from colleagues [8]. However, the scale of this phenomenon is not fully understood, and the boundaries between verbal and physical aggression become blurred with time. According to Neuman, there are three groups of aggression to which employees are exposed: obstructionism, i.e., deliberate obstruction of work, manifested hostility, and outright aggression [9].

There is still little data on aggression in the workplace in Poland. It seems that the profession of a healthcare worker, from doctors, through nurses, paramedics, to stretcher-bearers and electroradiologists, is highly respected by society. However, research shows otherwise. Over 350,000 – this is, according to James and Gilliland, the mean number of attacks in the US faced by, among others, medical and mental healthcare professions [10]. On the other hand, the International Labor Organization reports that healthcare staff ranks second in terms of exposure to aggression in the workplace. As in the case of aggression in general, it is difficult to give an exact

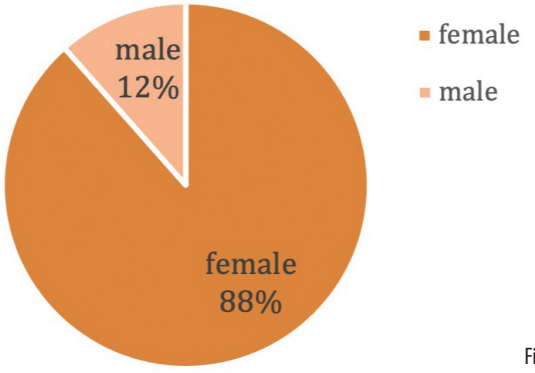

Fig. 1. Gender of the respondents in percentage terms.

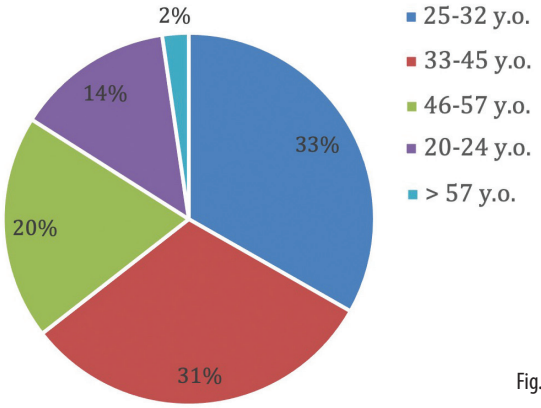

Fig. 2. The age range of the respondents in percentage terms.

definition of PVV (Patient and Visitor Violence), i.e., the phenomenon of aggression towards medical personnel [11]. The literature differentiates non-verbal, verbal, and mental behavior that has a negative impact on medical workers or destroys the property of a public (medical) institution [12]. Even in seemingly safe situations, such as discharging a patient or establishing medical records, one may encounter aggressive behaviors caused by the overlapping of many different factors [13].

Therefore, it must be clearly stated that aggression is a serious problem in the healthcare system. Medical personnel more and more often become a victim of verbal and physical violence. The aggressors are not only the patients mentioned above and colleagues but also the patients' families and friends.

THE AIM

Many articles deal with the problem of aggression towards healthcare professionals. Regarding this phenomenon, there are many positions and opinions that have been presented in the discussion section. The study aimed to analyze the aggressive behavior experienced by medical personnel, both before and during the epidemic. The authors wanted to obtain information on the scale and frequency of this problem and indicate the form of violence, the most common perpetrators, and the places where medical staff have to face aggression.

MATERIAL AND METHODS

Nine hundred ninety-nine healthcare workers from all over Poland of all ages participated in the study. The proprietary questionnaire prepared for the study was used in accordance with the methodology adopted in this type of research. The questionnaire consisted of three parts: the first – characterizing the research group, the second – containing questions about the form of aggression, its frequency, perpetrators, results of the proceedings initiated, etc. before announcing the epidemic state, and the third – the same questions as in the second part, but tackling the time after announcing the epidemic state.

The research was conducted in November 2020 in electronic form. Participation in the study was completely voluntary. The questionnaires completed independently by the respondents were anonymous.

Statistica 13.3 and Microsoft Office Excel 2010 software were used for statistical calculations. Chi-square test of independence, Q-Cochran test, and Wilcoxon test were used, and the significance level was $p < 0.05$. The percentages were rounded off. The qualitative and quantitative analysis of the obtained data was the basis for describing results and achieving the aim of the work.

RESULTS

The study group was characterized in terms of gender (Fig. 1), age (Fig. 2), and profession (Table 1).

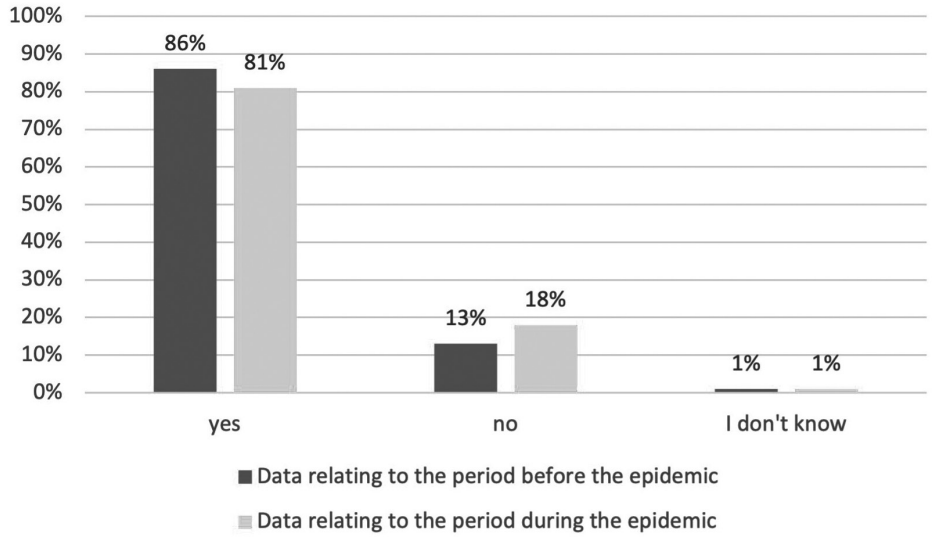

Fig. 3. The answers to questions "Before the epidemic state was announced (March 20, 2020), did you encounter aggressive behaviors in the workplace by patients/their relatives/ friends, etc.?" and "After the epidemic state was announced (March 20, 2020), did you encounter aggressive behavior in the workplace by patients/their relatives/ friends, etc.?" in percentage terms.

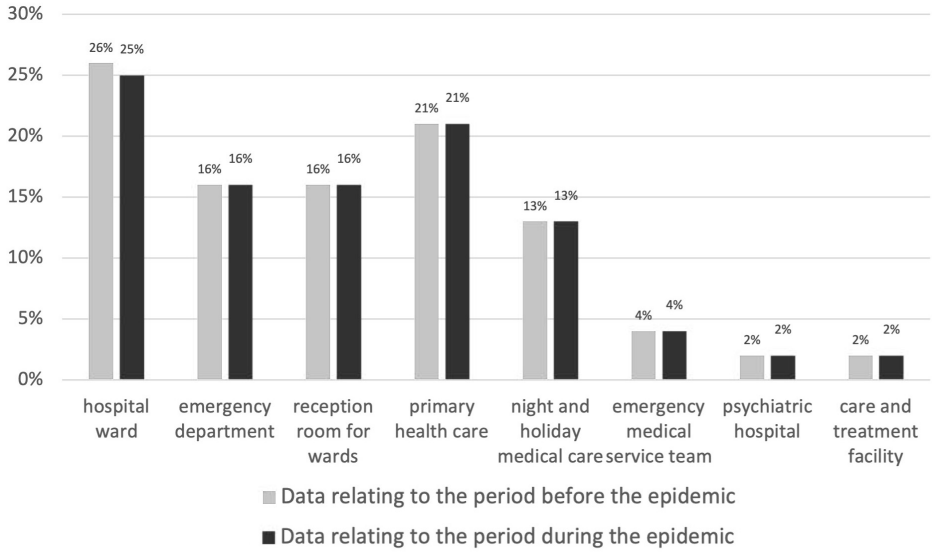

Fig. 4. The place where the respondents encountered aggression before and during the epidemic state, in percentage terms.

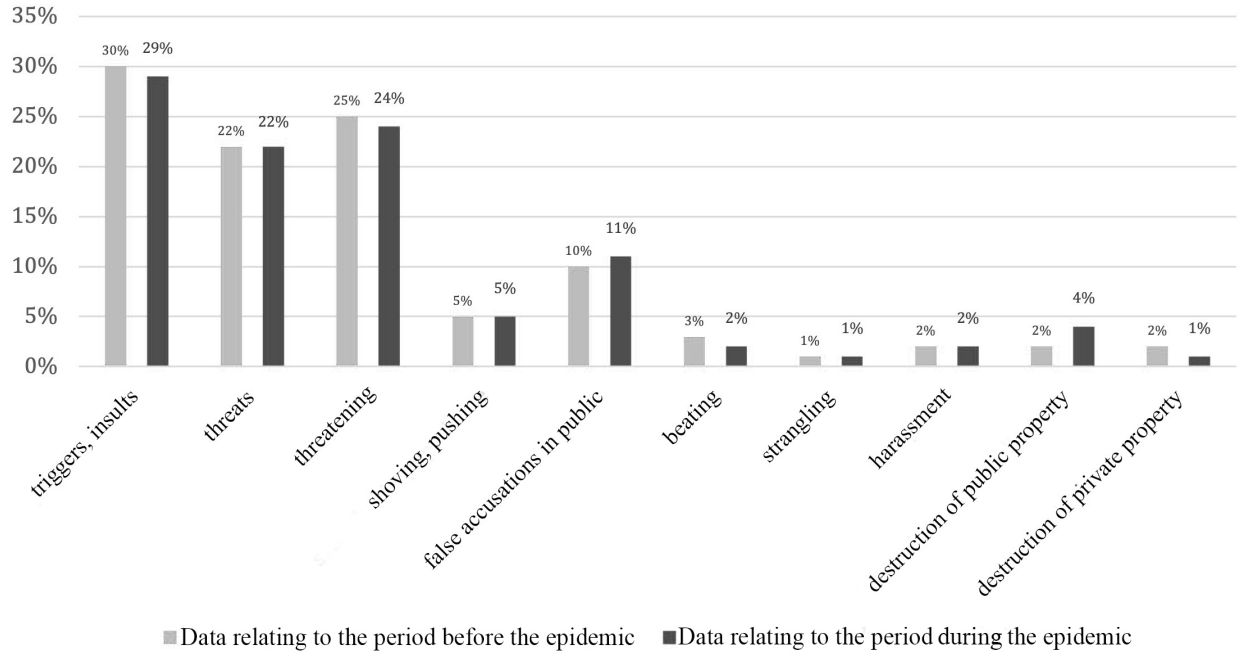

Fig. 5. Forms of aggression faced by health care workers before and during the epidemic state, in percentage terms.

Table 1. Occupation performed by the respondents in percentage terms.

Profession	Percentage
nurse	47.2%
physician	15.3%
midwife	12.6%
paramedic	6.8%
medical guardian	4.5%
medical clerk	4.6%
physiotherapist	4.7%
pharmacist	1.6%
stretcher-bearer	1.1%
electroradiologist	1.2%
laboratory diagnostician	0.4%

Table 2. Perpetrators of aggression in percentage and statistical terms.

Perpetrator of aggression	Percentage before announcing the epidemic state	Percentage during the epidemic state	P-value (test Q- Cochrana)
the patient	44% (SD=0.421)	44% (SD=0.4506)	0.0003
patient's relatives	35% (SD=0.4862)	34% (SD=0.4967)	0.0005
friends of the patient	16% (SD=0.3852)	12% (SD=0.4046)	0.0474
unknown people	3% (SD=0.2117)	6% (SD=0.3067)	0.0000
other medical personnel	2% (SD=0.2052)	4% (SD=0.2394)	0.0269

Table 3. The frequency of aggressive behavior in percentage and statistical terms.

Frequency	Percentage before announcing the epidemic state	Percentage during the epidemic state	P-value (test Wilcoxona)
several times a day	5% (SD=0.2007)	12.6% (SD=0.3028)	0.0000
a few times a week	13% (SD=0.3204)	30.5% (SD=0.432)	0.0000
several times a month	35% (SD=0.4622)	35.7% (SD=0.4539)	0.3457
several times a year	37% (SD=0.4696)	18.1% (SD=0.3543)	0.0000
once in a few years	10% (SD=0.2834)	3.1% (SD=0.1562)	0.0000

In the multiple-choice question about the workplace, the respondents answered as follows: Emergency Medical Services (EMS) – 4.6%, a communal hospital – 1.6%, a municipal/district hospital – 27.5%, a voivodeship hospital – 22.7%, a supra-voivodeship hospital – 10.1%, an outpatient clinic – 29.2%, a pharmacy – 1.4%, a clinical hospital – 1.4%, a nursing home – 1.1%, a ward's home – 0.3% and a laboratory – 0.1%.

Work experience in the range of 1-5 years was indicated by 34.1% of the respondents, 24.5% declared more than 20 years of work experience, and 18.7% – 6-11 years. 13.7% of the respondents declared 12-20 years of professional experience, and 9% worked for less than a year.

Two questions regarding encountered aggressive behavior in the workplace by patients/their relatives/friends in two study intervals were asked. The answers are presented in Figure 3.

The respondents were asked about where they encountered aggression both before and after the epidemic state was announced. Their answers are presented in Figure 4.

The percentage analysis of the form of aggression (a multiple-choice question) faced by medics was also performed. It is presented in Figure 5.

Table 2 characterizes the percentage of individual offenders in two analyzed periods. There was an increase in the answers: "unknown people" – by 3% and for other medical personnel – by 2%.

Table 3 presents the percentage and statistical analysis of the frequency of encountering violence declared by the respondents. In the responses after the epidemic state announcement, the percentage of people who experienced this form of behavior several times a day or several times a week increased significantly by 7.6% and 17.5%.

A statistical analysis of the respondents was performed, both before and after announcing the epidemic state, as well as regarding the following correlations:

- the gender and the form of aggressive behavior and its frequency,
- the type of profession and contact with aggressive behavior, its form, and frequency,
- a workplace and contact with aggression and its frequency,

Table 4. Statistically significant relationships and percentage values demonstrated for sex and various forms of aggression.

Time before announcing the epidemic state			
Variable 1	**Variable 2**	**P-value (test chi²)**	**Type of aggression in percentage, broken down by gender (women; men)**
gender	threats	0.0028	85.7% (SD=0.4509); 14.3% (SD=0.4707)
gender	cowing	0.0086	86.4% (SD=0.4293); 13.6% (SD=0.4832)
gender	buffeting	0.0000	73.6% (SD=0.4993); 26.4% (SD=0.3251)
gender	battery	0.0059	77.8% (SD=0.4976); 22.2% (SD=0.2849)
gender	suffocation	0.0001	58.9% (SD=0.4897); 41.1% (SD=0.2484)
gender	damage to public property	0.0397	78.6% (SD=0.4987); 21.4% (SD=0.2691)
gender	damage to private property	0.0002	70% (SD=0.4986); 30% (SD=0.2675)
Time after announcing the epidemic state			
Variable 1	**Variable 2**	**P-value (test chi²)**	**Type of aggression in percentage, broken down by gender (women; men)**
gender	buffeting	0.0000	73% (SD=0.4999); 27% (SD=0.3166)
gender	battery	0.0003	69.4% (SD=0.4984); 30.6% (SD=0.2643)
gender	suffocation	0.001	58.3% (SD=0.4973); 41.7% (SD=0.244)
gender	damage to public property	0.0215	81.1% (SD=0.4998); 18.9% (SD=0.3034)

Table 5. Statistically significant relationships and percentage values demonstrated between the medical profession and the forms of experienced aggression before and after announcing the epidemic state.

Time before announcing the epidemic state			
Variable 1- profession	**Variable 2 – the form of aggression**	**P-value (test chi²)**	**Percentage**
physician	threats	0.031	63% (SD=0.4771)
	cowing	0.0020	74% (SD=0.4878)
	false public accusations	0.0019	44% (SD=0.3979)
	harassment	0.0190	8% (SD=0.2974)
Time after announcing the epidemic state			
Variable 1- profession	**Variable 2 – the form of aggression**	**P-value (test chi²)**	**Percentage**
physician	threats	0.0263	62% (SD=0.4756)
	cowing	0.004	68% (SD=0.481)
	false public accusations	0.0325	33% (SD=0.4060)
	harassment	0.0464	8% (SD=0.3034)

Table 6. Statistically significant relationships and percentage values demonstrated between the paramedic profession and the forms of experienced aggression before and after announcing the epidemic state.

Time before announcing the epidemic state			
Variable 1- profession	**Variable 2 – the form of aggression**	**P-value (test chi²)**	**Percentage**
paramedic	insults	0.0018	90% (SD=0.4236)
	threats	0.0014	69% (SD=0.4616)
	cowing	0.031	75% (SD=0.4763)
	buffeting	0.0000	59% (SD=0.2954)
	battery	0.0052	16% (SD=0.2475)
	suffocation	0.0058	6% (SD=0.2018)
	damage to public property	0.0001	13% (SD=0,2281)
	damage to private property	0.0001	13% (SD=0.2261)
Time after announcing the epidemic state			
Variable 1- profession	**Variable 2 – the form of aggression**	**P-value (test chi²)**	**Percentage**
paramedic	buffeting	0.0000	28% (SD=0.2856)
	battery	0.0022	10% (SD=0.2221)

- work experience and the form of experienced behavior,
- a place of meeting aggressive behavior and the frequency,
- frequency before and after announcing the epidemic state,
- the perpetrator of aggression in two time periods.

Regarding the relationship between sex and the form of aggressive behavior before and after announcing the epidemic state, statistical significance was demonstrated for some forms of verbal and physical aggression (Table 4).

85% of the surveyed women and 92% of men had contact with various forms of aggression, and after March 20, 2020, the rates were 81% and 77%, respectively. In the percentage analysis, 90% of all aggressive behavior towards women was verbal (insults, threats, cowing, false public accusations, and harassment). In men, it was 79%, while physical aggression (buffeting, battery, suffocation, damage to public and private property) accounted for 21% – twice as much as in the opposite sex. The same results were developed during the epidemic state for both groups.

We observed no statistical significance between gender and the frequency of aggressive behavior.

A similar statistical analysis results from the relationship between the type of profession and exposure to such behavior, except for physiotherapists (p=0.0000). After the epidemic state was announced, a statistically significant correlation was found between the following professions: physiotherapist (p = 0.0007), medical clerk (p = 0.0306), and pharmacist (p = 0.0078).

Data on the percentage of a given healthcare professional who experienced violence are presented in Figure 6.

Statistical significance was obtained between some professions and some forms of aggressive behavior (Table 5-10). The tables also include the percentages.

73% of the surveyed doctors faced insults, 74% – cowing, and 63% – threats. The situation was similar after March 20, 2020 – 73% of doctors met with insults, 68% – cowing, and 62% – threats.

As many as 90% of the surveyed paramedics encountered insults, 85% – false public accusations, and 75% – cowing. In the second analyzed period – 78% had contact with insults, and 63% with threats and cowing.

In the case of the medical care profession and the form of aggressive behavior, a correlation was demonstrated only after the epidemic state was announced, i.e., threats (p = 0.0074), cowing (p = 0.0025), false public accusations (p = 0.0066).

Before the announcement of the epidemic state, statistical significance was demonstrated between the nursing profession and battery (p = 0.0076) and harassment (p = 0.0223). However, in the second

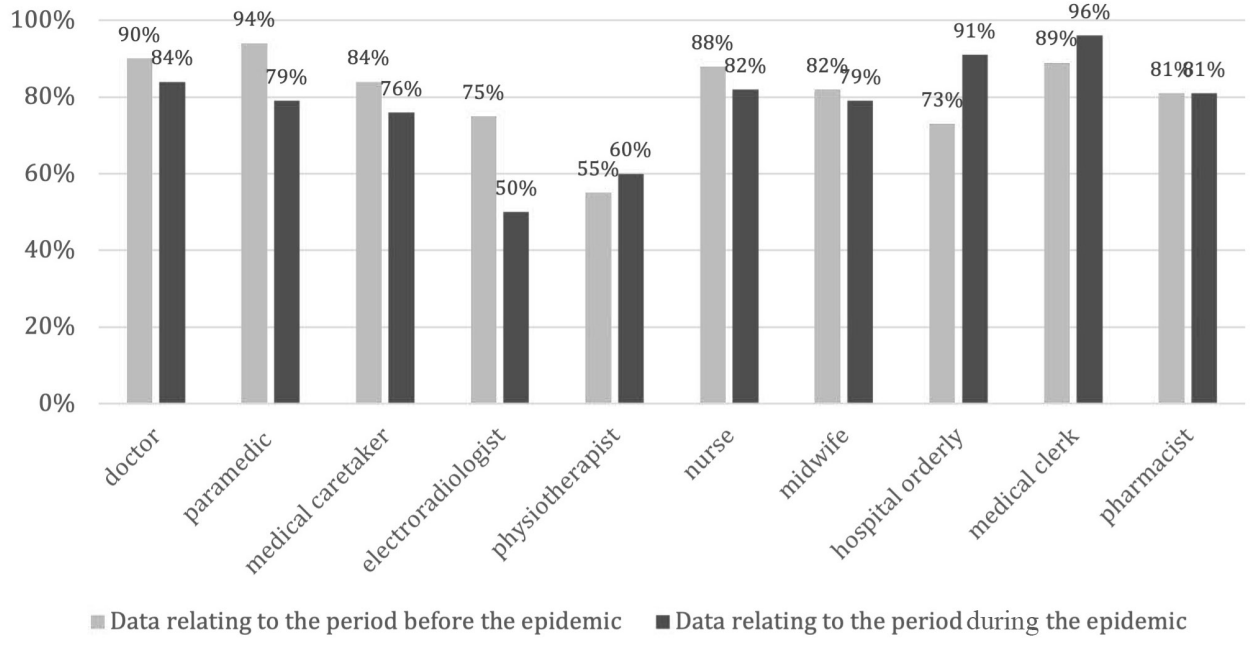

Fig. 6. Percentage of a given profession that encountered aggressive behavior before announcing and during the epidemic state.

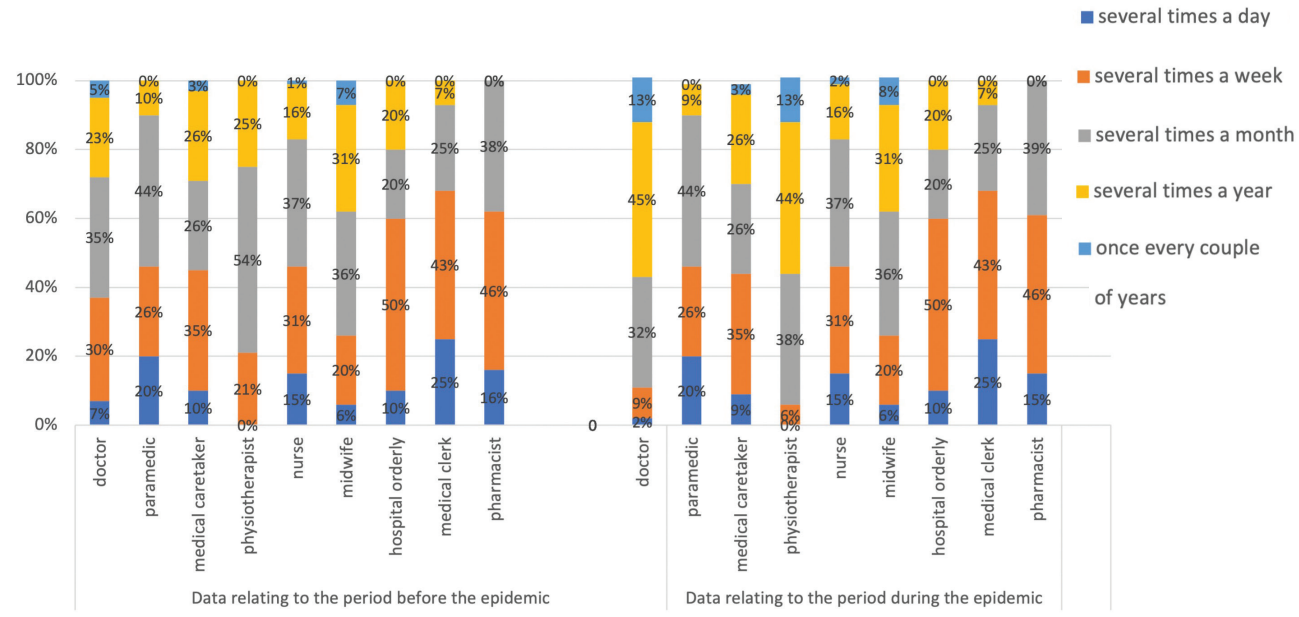

Fig. 7. The frequency with which the respondents encountered aggressive behavior before announcing and during the epidemic state, depending on the profession.

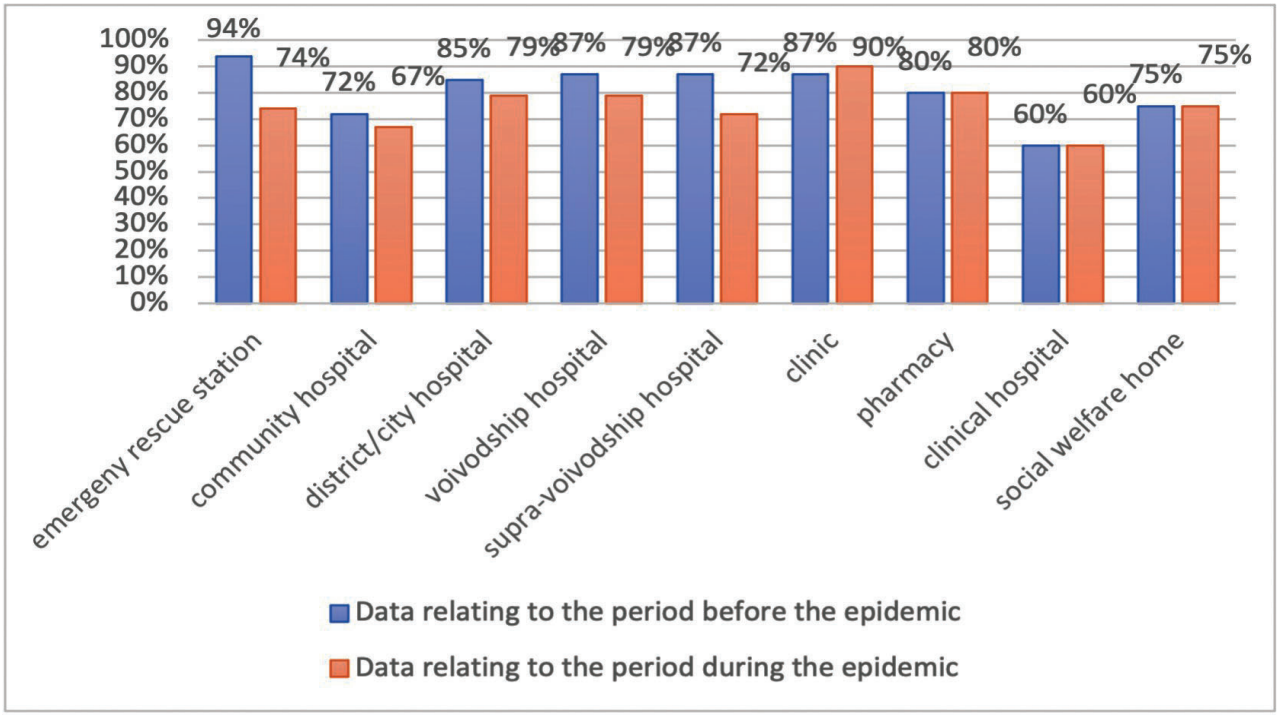

Fig. 8. The workplace of the respondents and encountering aggressive behavior before announcing and during the epidemic state, in percentage terms.

period, no correlation was proved. As many as 75% of nurses encountered insults, 64% – cowing, and 57% – threats. It was similar during the epidemic, 70%, 58%, 54%, respectively.

As with other medical professions, midwives were most often insulted, threatened, and met with cowing.

Statistical significance was observed between the profession of a paramedic and the damage to public property only after March 20, 2020 ($p = 0.0334$). The forms of aggression they faced most often were the same as with other healthcare professionals.

As many as 91% of the surveyed medical clerks encountered insults during the epidemic. No correla-

Table 7. Statistically significant relationships and percentages observed between the profession of a physiotherapist and the forms of experienced aggression before and after announcing the epidemic state.

Time before announcing the epidemic state			
Variable 1 – profession	**Variable 2 – the form of aggression**	**P-value (test chi²)**	**Percentage**
physiotherapist	insults	0.0012	53% (SD=0.4881))
	threats	0.0001	28% (SD=0.4571)
	cowing	0.0004	38% (SD=0.4728)
	false public accusations	0.0269	11% (SD=0.3512)
Time after announcing the epidemic state			
Variable 1 – profession	**Variable 2 – the form of aggression**	**P-value (test chi²)**	**Percentage**
physiotherapist	insults	0.0082	53% (SD=0,4842)
	threats	0.0053	34% (SD=0,4550)
	cowing	0.0009	34% (SD=0,4626)

Table 8. Statistically significant relationships and percentage values demonstrated between the profession of a midwife and the forms of experienced aggression before and after announcing the epidemic state.

Time before announcing the epidemic state			
Variable 1 – profession	**Variable 2 – the form of aggression**	**P-value (test chi²)**	**Percentage**
midwife	insults	0.0005	61% (SD=0.4951)
	threats	0.0448	46% (SD=0.4725)
	buffeting	0.0000	3% (SD=0.3309)
	battery	0.0068	1% (SD=0.292)
	damage to public property	0.0123	1% (SD=0.2768)
Time after announcing the epidemic state			
Variable 1 – profession	**Variable 2 – the form of aggression**	**P-value (test chi²)**	**Percentage**
midwife	insults	0.0369	62% (SD=0.4926)
	threats	0.0060	42% (SD=0.4709)
	buffeting	0.0009	2% (SD=0.3227)
	damage to public property	0.0058	2% (SD=0.3099)

Table 9. Statistically significant relationships and percentage values demonstrated between the profession of a midwife and the forms of experienced aggression before and after announcing the epidemic state.

Time before announcing the epidemic state			
Variable 1 – profession	**Variable 2 – the form of aggression**	**P-value (test chi²)**	**Percentage**
medical clerk	buffeting	0.0300	2% (SD=0.2798)
	harassment	0.0000	17% (SD=0.2063)
Time after announcing the epidemic state			
Variable 1 – profession	**Variable 2 – the form of aggression**	**P-value (test chi²)**	**Percentage**
medical clerk	insults	0.0015	91% (SD=0.4841)
	threats	0.002	76% (SD=0.4548)
	cowing	0.0085	76% (SD=0.4624)
	false public accusations	0.0182	41% (SD=0.3616)
	harassment	0.0001	17% (SD=0.216)
	damage to public property	0.0003	24% (SD=0.3714)

tion was observed between the profession of pharmacist and the forms of aggression. A statistical analysis of the relationship between the occupation and the frequency of committed acts of aggression was also performed (Table 10).

The frequency of violence depending on the profession performed was presented in the analyzed periods (Fig. 7).

Regarding the workplace and contact with aggressive behavior, the results were statistically

Table 10. Statistically significant relationships demonstrated between the occupation and the frequency of aggressive behavior before and after announcing the epidemic state.

Time before announcing the epidemic state		
Variable 1 – profession	**Variable 2**	**P-value (test chi²)**
physician	frequency	0.0304
paramedic		0.0036
physiotherapist		0.0004
midwife		0.0000
medical clerk		0.0000
Time after announcing the epidemic state		
Variable 1 – profession	**Variable 2**	**P-value (test chi²)**
physician	frequency	0.0447
physiotherapist		0.0027
midwife		0.0001
medical clerk		0.0003

significant: EMS – p = 0.0063 and a communal hospital – p = 0.0001; after March 20, 2020 – a supra-voivodeship hospital p = 0.0248, an outpatient clinic p=0.0000, and a pharmacy p = 0.0005.

Statistical significance was also noted in the case of the district hospital (p = 0.0365), an outpatient clinic (p = 0.0100), and a clinical hospital (p = 0.0002) and the frequency of such behavior. In the second examined period, it was proven in the field of EMS (p = 0.0096), a district hospital (p = 0.0003), a supra-voivodeship hospital (p = 0.0167), and an outpatient clinic (p = 0.0000).

The length of work experience with forms of aggressive behavior was also analyzed. In the case of verbal aggression before the epidemic state, statistical significance was proved ($p < 0.05$) and in the case of one form of physical aggression – buffeting (p = 0.0070). After March 20, 2020, a correlation was noted in terms of harassment (p = 0.0003) and damage to public property (p = 0.0054).

The survey results showed that verbal aggression was most often felt by healthcare workers who worked from 1 to 11 years in the profession. Physical aggression was associated with 11-20 years of work experience. During the epidemic, medics who worked from 1 to 5 years most often came into contact with the verbal form of violence. On the other hand, physical violence most often affected persons working in the profession from 1 to 11 years.

Statistical analysis was performed in terms of the place where one encountered aggression and its frequency. The collected data showed a significance level equal to p=0.0000 for Emergency Department (ED), emergency room, hospital ward, and primary healthcare. In the case of the EMS team, night and holiday medical healthcare, psychiatric hospital, care and treatment facility and pharmacy, the p-values were as follows: p = 0.0019, p = 0.0035, p = 0.0251, p = 0.1272, p = 0.7807. The last two analyzed factors were statistically insignificant, also after announcing the epidemic state. In the second period, the correlation was proved for the ED, the admission room, the hospital ward, the EMS team, primary healthcare, night and holiday medical healthcare, all at the level of p=0.0000, and for the psychiatric hospital p = 0.0220.

The percentage analysis was also performed for the variables: a place of meeting aggression and frequency. In the case of the ED before and during the epidemic, the most frequently selected answer was "several times a month", followed by 44% and 39%, respectively. The respondents who declared the emergency room as a place of meeting with aggressive behavior most often indicated the variant "several times a year" (36%), and after the state of the epidemic was announced – "several times a week" (39%). Employees of the hospital ward most often encountered aggression "several times a year" (39%), while after March 20, 2020, the responses changed to "several times a month" (40%). Almost half of the respondents working in the EMS teams indicated that they encountered violence several times a month before the epidemic (40%) and after its announcement (49%). In primary healthcare, the frequency "several times a month" was the most frequent and was at the level of 34%. The situation was different after March 20, 2020 – as much as 41% percent of respondents indicated the answer "several times a week". Similar results were shown in the night and holiday medical healthcare, where medical personnel most often en-

countered aggression several times a month (37%). In comparison, during an epidemic, the response "several times a week" reached 44%.

The percentage analysis between the respondents' workplace and the encounter with violence before and during the announcement of the epidemic was also performed (Fig. 8).

DISCUSSION

A broadly understood aggressive behavior is a global problem in the healthcare system [14, 15]. Many scientific publications discuss the aggression encountered in the workplace by healthcare workers. These reports were confronted with the results of our study. According to various sources (National Crime Victimisation Survey [NCVS], British Crime Survey, Bureau of Labor Statistics, International Labor Organization), medical professions are one of the occupational groups more exposed to aggression in the workplace than others [16-20]. These reports are confirmed by many scientists publishing articles on violence, pointing to nurses as the most exposed to the aggressive behavior of patients [21, 22].

Our survey confirms the observations mentioned above. In the proprietary survey, 90% of doctors, 94% of paramedics, 82% of midwives, and 82% of nurses encountered aggression before the epidemic. However, after its announcement (March 20, 2020), the percentage of people who had contact with such behavior, working as a doctor (84%), paramedic (79%), and midwife (79%), decreased. The percentage of nurses was stable (82%).

Other authors indicate that half of the surveyed nurses encountered aggression every time they were at work [23]. Others note that more than half (57%) of people in this profession experienced threats and verbal aggression (according to the estimates of the American Nurses Association from 2001). About 25% of nurses believe that aggression is a serious problem in the workplace [10]. Also, our study confirms this data and shows that as many as 75% of nurses faced insults, 64% – cowing, and 57% – threats. It was similar during the epidemic, 70%, 58%, 54%, respectively. According to the observations of other authors, in addition to nurses, paramedics also deal with patients using raised voices more often than, for example, midwives. However, nurses faced the threats significantly more often than the other studied professional groups [24]. In our study, paramedics were more likely to deal with verbal aggression than nurses and midwives. As many as 90% of the surveyed paramedics encountered insults, 85% – false public accusations, and 75% – cowing. In the second analyzed period, 78% had contact with insults, and 63% with threats and cowing. However, not only nurses or paramedics encounter aggressive behavior in their work. Schablon et al. conducted a study in 81 different medical facilities on 1984 employees, which showed that 94.1% of people experienced verbal violence within 12 months, and 69.8% – physical aggression. Aggressive events most often took place in hospitals and nursing homes for people with disabilities [25]. On the other hand, the authors of "Workplace violence towards healthcare workers: an observational study in the College of Physicians and Surgeons of Rome" indicate that out of 956 medical personnel, as many as 66.5% experienced at least one episode of aggression during their professional lives. Interestingly, men were less likely to be victims than women, especially of verbal aggression [26]. This is confirmed by our observations, which indicated that 90% of all aggressive behavior towards women was verbal, and in men, it was 79%. Also, physical aggression affects men twice as often as women. The same percentage was obtained after an epidemic was declared.

European studies indicate that verbal aggression is the most common form of aggression of patients towards healthcare workers. The frequency of exposure to this phenomenon ranges from over 60% to nearly 90% [27-31]. In 203 nurses and five male nurses who participated in the study by Lickiewicz et al., verbal aggression accounted for 70%, and physical – 36% [32]. Markiewicz presented similar observations – as many as 78% of psychiatric nurses were a victim of physical aggression, and 35% – verbal aggression [33]. Using a raised voice, which constitutes verbal aggression, was the most common phenomenon encountered by the surveyed employees in the next group [26]. In turn, the authors of the article "Nurses experiencing aggression at the workplace" formulated the following conclusions: nurses faced physical and verbal aggression, the former being less frequent. The authors of the publication do not agree on which way of showing aggression, whether verbal or physical, is the most common. According to Lickiewicz et al., the most common form of verbally aggressive behavior are insults, while physical blows are less frequent [32].

Berent et al. indicated other most common forms of aggression, such as threatening with making a complaint and dismissal, verbal clashes, but also mentions that there are also physical forms of aggression (throwing objects) [34]. Psychological violence is considered less obvious than physical violence. In this study, it is worth mentioning that the situation with aggressive behavior from colleagues

was similar, and they were also less noticeable. They are often underestimated and even perceived as something embarrassing, which leads to hiding them. In turn, violence by strangers is immediately noticed [35,36].

One should also pay attention to the location of aggressive events. There are many discrepancies in scientific research on this subject. In the case of the original study, the highest percentage was in the hospital ward (31%), followed by the clinic (19%), ED (17%), and the emergency room (15%). After the epidemic was announced, the respondents faced aggression in the facilities as mentioned above to a similar extent. A significant increase in the night and holiday medical healthcare aggressive behavior (from 7% to 13%) was observed.

In 2018, the Medical Ombudsman's Office published a report stating that doctors (107 reports) and nurses (21 reports) were the most common victims of patient violence. Aggressive events were reported in outpatient clinics (63 cases) and in hospitals (ward, ED, and emergency room (33 cases). Verbal aggression (111 reports), including insults (71), threats (59), slander (56), blackmail (24), other behavior (16), was the most common type of violence [37].

It is also worth mentioning the question of the survey prepared by the Supreme Council of Nurses and Midwives, published on the website in mid-December 2019 and still collecting data. Its results have so far indicated a disturbingly large scale of the phenomenon of aggression in healthcare. Eight hundred seventeen nurses and midwives completed the questionnaire, specifying 21 facilities where they met violence cases. The responses of medical staff showed that the most aggression was in hospital departments, ED and emergency room, and slightly less in psychiatric institutions. Nurses and midwives claimed that the risk of experiencing aggression was inherent in the workplace, hence the low reporting rate of such behavior [38]. In turn, Lickiewicz et al. compared aggressive events in the ED and the surgical department – 74% of them occurred in the first place, and the most common was verbal aggression [39]. Like other authors, Hahn et al. indicated an ED and a psychiatric hospital as high-risk places [12]. The authors made comparable observations of another study. It was proved that the risk index for personnel working in the obstetrics or pediatrics wards, outpatient clinics, and psychiatric wards was lower than in the emergency ward [40].

Nevertheless, many authors indicate a psychiatric hospital as the place with the highest risk of attack [10, 41, 42].

Berent et al. conducted a study in a psychiatric hospital where 27 out of 30 employees faced aggression from patients. Sixteen respondents indicated that they met her every day [23]. A similar scale of the phenomenon is noticed by Delaney, who indicated that as many as 88% of psychiatric nurses dealt with verbal and physical aggression on the part of patients [43]. In the case of the proprietary questionnaire, the psychiatric hospital was indicated by only 4% of respondents before the announcement of the epidemic and 2% after that date.

Research conducted in Italy also indicated that encountering aggression did not depend on the function of a healthcare worker. However, a lower risk of exposure was demonstrated for women and older workers [40].

Interestingly, a study on the time of day of aggression was presented. In a survey by Roberts et al. conducted in Australian hospitals, it was found that most of the aggressive behavior took place at night and in the afternoon due to the limited number of employees and people in medical facilities [44].

The discussion should also mention the perpetrators of aggressive behavior. It seems that the perpetrators of the misconduct are only patients or their families. Yes, this is the most common situation – the report provided indicates that the perpetrators were most often patients (71 reports) or their family (39 reports). It is also worth adding that in as many as 23 cases, the reported act of aggression was not the first such behavior performed by the perpetrator [37]. In the case of the proprietary questionnaire, patients constituted 44% of the aggressors, and the family – 35%. Other researchers present similar conclusions – the study by Kowalczuk et al. proved that 92% of the surveyed nurses, 86% of doctors, and 74% of midwives among the medics participating in the survey experienced aggression from patients [45].

However, in the study cited above, aggressive incidents involving colleagues were also noticed. Such acts of aggression were experienced by 55% of midwives, 54% of nurses, and 40% of doctors [45].

Lickiewicz and Piątek revealed similar observations. The authors indicated that this might indicate the need to react to negative emotions, and such behavior was a way of coping with stress in the workplace [32].

The authors point out that many studies on aggression in the workplace concern nurses, doctors, and paramedics. Future research should also include other medical personnel, such as paramedics, electroradiologists, or medical consultants, because it is worth noting that the phenomenon of aggression towards medical personnel is constant and does not change [32].

CONCLUSIONS

Most healthcare workers experienced aggressive behavior in the workplace before and after announcing the epidemic state, but the frequency of this phenomenon increased in all study groups during the epidemic. The perpetrators of the attacks were most often patients. What's important during the epidemic, the number of aggressive incidents involving colleagues increased. During the epidemic, medical personnel more often dealt with inappropriate behavior during night and holiday medical healthcare.

As a result of the stress related to the protracted pandemic, an increase in social anxiety and growing frustration of the society can be observed. This may lead to more frequent attacks on medical personnel. It must be undoubtedly stated that aggression is a constant and unchanging problem in healthcare and requires a deeper analysis.

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The survey was conducted based on a sociological sample. The information collected in it did not directly impact healthcare professionals; therefore, no application for consent to conduct the study was submitted to the Bioethics Committee.

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

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IMPLEMENTING THE REGULATION OF THE MINISTER OF HEALTH BY POLISH EMERGENCY DEPARTMENTS IN 2020

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Abstract

Aim: The inadequate system of triage in Emergency Departments leads to the situation in which the personnel is not always able to provide care on time. A regulation determining the conditions of performing triage in Emergency Departments (paragraph 1, section 2) was issued on 27 June 2019. In order to present the level of the fulfilment of rules from the regulation and to determine the level of organization in the Polish health care, the percentage of Emergency Departments which provided the required information on their websites, was examined.
Material and methods: The study was conducted in April 2020. 236 websites of hospitals with Emergency Departments were analyzed. The criteria of data retrieval were as follows: 1. The presence of the information concerning the rules of redirecting patients to Primary Health Care/After Hours Medical Centers. 2. The presence of information concerning the time an Emergency Department doctor has to inform the patient about the admission or about refusal to admit a patient. The collected data were statistically analyzed. Each Emergency Department was given the following statuses: "yes", "no", or "incomplete".
Results: Information concerning the 1st criterion were available in case of 59 hospitals (25%), while no such information was on the website in Opole and West Pomeranian Provinces. Information concerning the 2nd criterion was placed by 51 hospitals. In 28 cases the information was described as "complete" and in 23 as "incomplete".
Conclusions: The majority of hospitals failed to observe the obligation to provide the information included in the Regulation.

Key words

triage,
website,
healthcare,
law,
emergency room

INTRODUCTION

Emergency Departments (ED) are specialized wards established to save people's health and life in emergency situations. The situation of overfilled EDs, which in many cases is associated with the excessive number of patients whose life or health are not directly threatened, impedes saving lives and health of those who need it the most urgently and is linked to many hours of waiting for medical assistance.

In order to prevent the excessive inflow of patients and to provide good work coordination in EDs and the facilities of Primary Health Care (PHC) and After Hours Medical Centers (AHMC) the Minister of Health issued a new regulation in 2019 concerning Emergency Departments. The regulation introduced, for example, the necessity of determining the maximum time of waiting for the decision of being admitted to a hospital, and the rules concerning the redirection of patients with less urgent problems to PHC or AHMC facilities.

Regarding the patients' rights and patient-ED communication the regulation included the obligation of providing the above mentioned information on the websites of hospitals.

THE AIM

A new regulation determining such aspects as the detailed conditions of performing triage in hospital Emergency Departments (paragraph 1, section 2) was issued on 27 June 2019. The websites of all 236 EDs were verified in order to confirm the compliance with the rules specified in the regulation. More specifically, the hospitals were obliged to: place information concerning the possibility and rules of redirecting individuals marked as green or blue in the triage system to facilities providing primary health care (§6, sections 11 and 12)[2], specify the maximum time the doctor on duty may take to make a decision concerning the admission of a patient to the hospital in which the ED is located or to refuse to admit the patient, and time which a doctor of a specific department has to admit a patient (§13, sections 1 and 2)[2]. The study aimed to assess to what degree hospital management teams complied with the requirement of the publication of the above mentioned information, as of April 2020.

At the same time, the aim of the study was to reflect on the ways in which complying with legal norms may translate into the efficient organization of health care system.

MATERIAL AND METHODS

The study was conducted in April 2020 and covered all 236 Emergency Departments (EDs) in Poland which were included in provincial action plans of the system of the State Medical Rescue (as of April 2020). The websites of hospitals with EDs were verified in terms of the presence of the information included in the Regulation of the Minister of Health dated from 27 June 2019 [2] concerning Emergency Departments basing on Article 34 of the Act dated from 8 September 2006 concerning State Medical Rescue (Journal of Acts, 2019, item 993)[3]. The following requirements were specified as regards the content of hospital websites which should be complied with by hospital management:

- information concerning the possibility and rules of redirecting individuals marked as green or blue in the triage system to facilities providing primary health care (§6, sections 11 and 12),
- the maximum time the doctor on duty may take to make a decision concerning the admission of a patient to the hospital in which the ED is located or to refuse to admit the patient, and the time during which a doctor of a specific department has to decide whether to admit a patient (§13, sections 1 and 2).

According to the law applicable at the time when the present study was conducted, the above mentioned information should be included on the websites of hospitals until 30 September 2019 [2].

The data were collected and statistically analyzed with Microsoft Excel programme. Each ED was described with the following statuses: "yes", "no", or "incomplete" depending on the content of websites.

The category "yes" referred to situations in which:

- referring to §13, sections 1 and 2 – the website included information concerning the maximum time the ED doctor on duty may take to make a decision concerning the admission of a patient to the hospital in which the ED is located or to refuse to admit the patient, and the time during which a doctor of a specific department has to decide whether to admit a patient.

The category "incomplete" referred to the following cases:

- − referring to §13, sections 1 and 2 [2] – the website included information concerning the maximum time the ED doctor on duty may take to make a decision concerning the admission of a patient to the hospital in which the ED is located or to refuse to admit the patient, but the time during which a doctor of a specific department has to decide whether to admit a patient was not specified,
- referring to §13, sections 1 and 2 [2]– the website included information concerning the maximum time the ED doctor on duty may take to make a decision concerning the admission of a patient to the hospital in which the ED is located but no time was specified in which the doctor on duty may refuse to admit the patient, or the time during which a doctor of a specific department has to decide whether to admit a patient.

The category "no" referred to situations in which:

- referring to §13, sections 1 and 2 [2]– the website included no information concerning the maximum time the ED doctor on duty may take to make a decision concerning the admission of a patient to the hospital in which the ED is located or to refuse admitting the patient, or the time during which a doctor of a specific department has to decide whether to admit a patient.

The information concerning the redirection of patients from ED to primary health care facilities (§6, sections 11 and 12 [2]) was regarded as "yes" if:

- information concerning the possibility and rules of redirecting individuals marked as green or blue in the triage system to facilities providing primary health care was provided on the website,
- information concerning the possibility and rules of redirecting individuals marked as green or blue in the triage system to facilities providing primary health care was provided on the website,

and "no" if:

- information concerning the possibility and rules of redirecting individuals marked as green or blue in the triage system to facilities providing primary health care was unavailable on the website.

RESULTS

We analyzed the websites of all 236 hospitals in Poland which have an Emergency Department in their structure.

Information concerning the possibility and rules of redirecting individuals marked as green or blue in the triage system to facilities providing primary health care was provided by 59 hospitals (25%) (Fig. 1). When analyzing the division into provinces it needs to be noted that the most hospitals complied with the requirement in Świętokrzyskie Province with the result of 80%. The opposite situation was recorded in

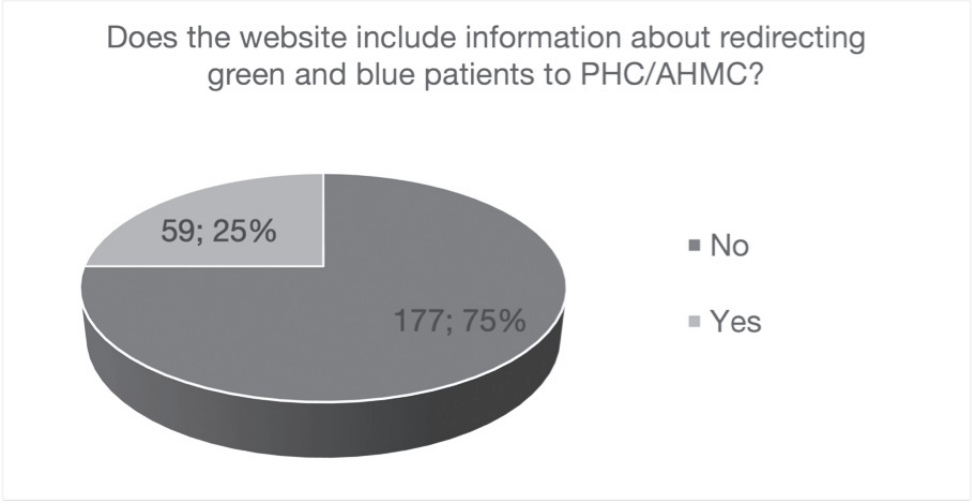

Fig. 1. The presence of information about the rules of redirecting green and blue patients to PHC and/or AHMC.

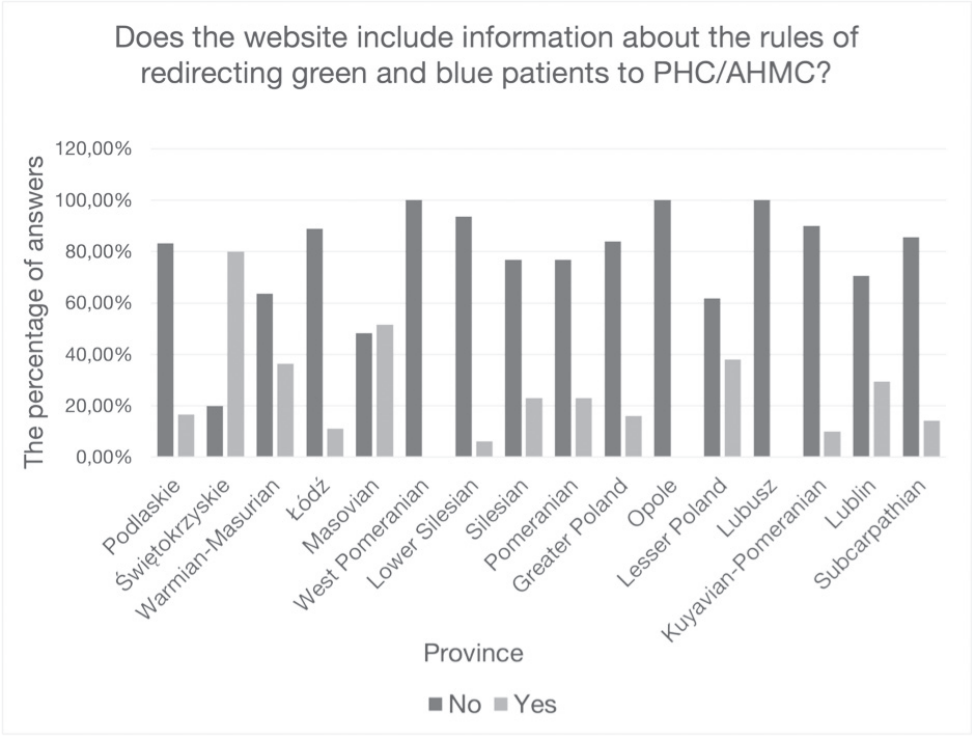

Fig. 2. The presence of information about the rules of redirecting green and blue patients to PHC and/or AHMC depending on the Province.

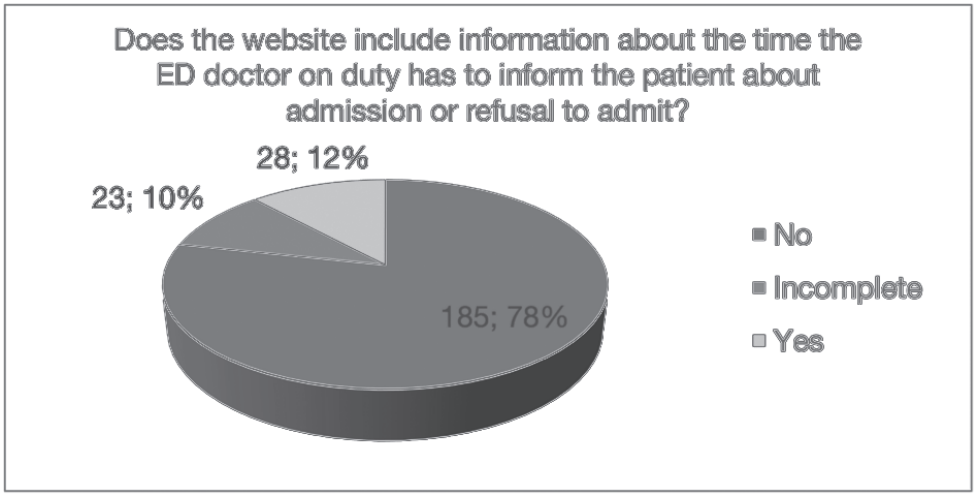

Fig. 3. The presence of information concerning the time during which ED doctors on duty have to decide about patient admission.

EDs in Opole and West Pomeranian Provinces with no hospitals presenting the information on the websites (Fig. 2).

Information concerning the maximum time the doctor on duty may take to make a decision concerning the admission of a patient to the hospital in which the ED is located or to refuse admitting the patient, and about the time a doctor of a specific department has to admit a patient was presented by 51 hospitals, including 28 which provided complete information and 23 which provided "incomplete" information according to the above specified criteria. On average, 78.43% hospitals provided no information, in 11.58% of hospitals the information was "incomplete" and in 9.99% it was complete (Fig. 3). The category "no" was prevalent in all 16 provinces, except Świętokrzyskie Province, which was characterized by 20% of EDs with "no", 50% with "incomplete" and 30% with complete information provided on the websites.

All EDs in Lubusz Province (100%) were labeled as category "no" (Figure 4).

DISCUSSION

Emergency Departments are the units of State Medical Rescue. They are specialized organizational units of hospitals and were established to provide rapid diagnostics, basic treatment and stabilization of the health status of individuals whose health is acutely threatened [1]. The organization and activity of Emergency Departments are specified in the law in the form of the Regulation of the Minister of Health dated from 27 June 2019 concerning Emergency Departments, issued on the basis of the Act dated from 8 September 2006 on State Medical Rescue [2, 3].

Emergency Departments are overfilled with the excessive number of patients both in Poland [4], and globally [5]. The overload results not only in the low comfort of work for the personnel or patient dissatisfaction, but also in increased mortality in patients who present to ED at the moment of such an overfilling [6]. The problem is not only linked to high presentation rates, but also to the inability to provide hospitalization in target departments for patients qualified for admission by ED doctor on duty [7]. The changes in the law introduced with the regulation of the Minister of Health aimed at:

- regulating the issue of redirecting patients with minor health problems from Emergency Departments to Primary Health Care facilities during their opening times and After Hours Medical Care at other times,
- the provision of easier patient transfer within a hospital through the necessity of specifying the maximum timeframe for making decisions concerning patient admission, which should limit longlasting stay in Emergency Department areas.

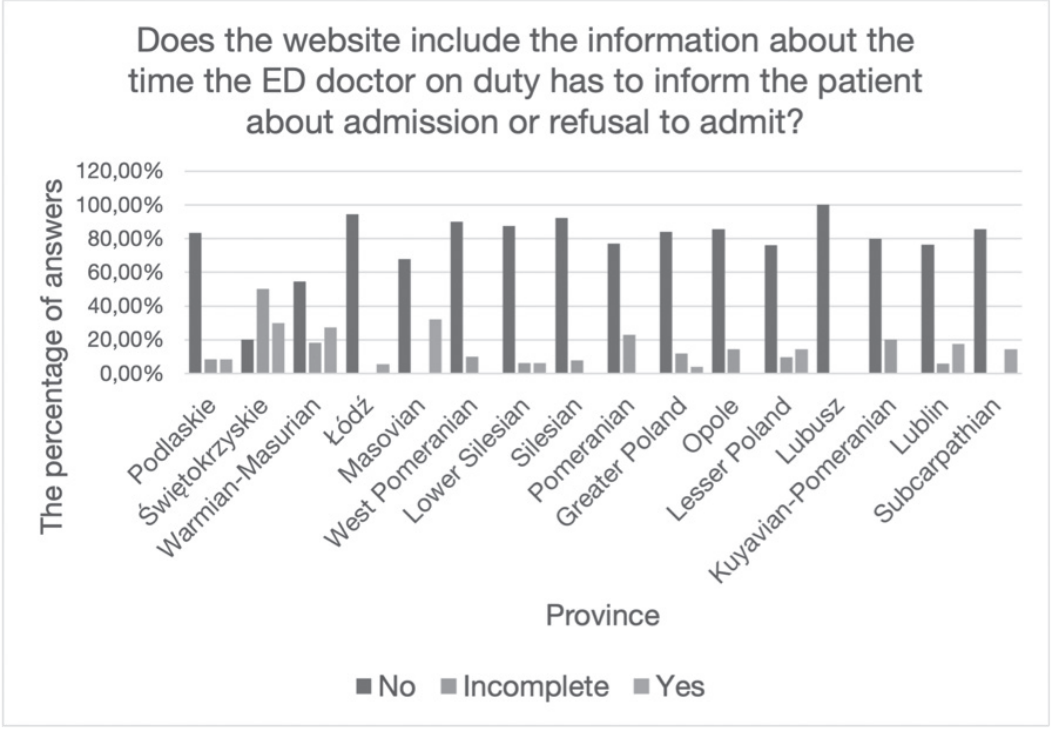

Fig. 4. The presence of information concerning the time during which ED doctors on duty have to decide about patient admission depending on the province.

Hospital or hospital department website may be an important source of health-related knowledge for patients [8]. Current and conceptually correct content of websites may be the ways in which a hospital or its unit promote health or perform educational tasks [9]. Polish research on hospital websites revealed the necessity of further intensive work to improve the completeness and quality of included content [10].

Current and conceptually correct information concerning the rules of ED activity provided on the website of the facility, especially as regards the possibility of redirecting a patient to PHC/AHMC, are the expression of the respect for patient rights resulting from articles 11 and 12 of the Act dated from 6 November 2008 on patient rights and Patient Ombudsman [11]. At the same time, the information will constitute an element of building patient awareness where they should seek medical assistance in less urgent situations. Refraining from providing such information may contribute to conflicts arising between ED medical personnel and patients and cause higher presentation rates of patients who do not require ED assistance.

Information about the time an ED doctor has to inform the patient about the admission gives the patient a chance of the reliable assessment of the therapeutic process to be undergone. It may also influence the choice of a health care facility. The patient should know how long he/she may have to stay in ED and when the final decision about further hospitalization should be expected.

To be scientifically reliable, it needs to be noted that on 29 June 2020 the Ministry of Health published a regulation which changed the previous regulation concerning Emergency Departments. The obligation of providing data concerning the rules of redirecting green and blue patients to PHC/AHMC facilities was delayed until 1 January 2021 [12]. However, when we were collecting data for the present study in April 2020 the requirement was still applicable.

CONCLUSIONS

1. The majority of hospitals failed to comply with the obligation to provide information required by the Regulation of the Minister of Health.
2. A significant percentage of hospitals which attempted at the realization of this obligation failed to provide complete information.

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CONFLICT OF INTEREST
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EFFECTIVENESS OF SUPRAGLOTTIC AIRWAYS MANAGEMENT AMONG PARAMEDICS

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Abstract

Aim: The aim of the study was to evaluate the effectiveness of supraglottic airways management by paramedics using selected methods in simulated conditions.

Material and methods: The study included a group of 115 professionally active paramedics working in various health care facilities in the Podkarpackie Province. Each subject was asked to open the airways using a laryngeal mask airway (LMA) and a disposable laryngeal tube (LT-D) in simulated conditions. The study assessed the effectiveness of the airway opening taking into account: average tidal volume of a single breath in ml, average minute tidal volume in ml, time of insertion in seconds, the need for a second attempt, pressure on incisors in N. The obtained results were statistically analysed, $p<0.05$ was considered statistically significant. The calculations were performed with the SPSS 20 software.

Results: The study showed that the time of inserting of LT-D is the same as the time of LMA (LT-D: 25.95s ± 7.89s *vs.* LMA: 24.78s ± 8.32s; $p>0.05$). The mean tidal volume of a single breath was significantly higher with the LMA compared to LT-D (LMA 633.24 ml *vs.* LT-D 579.68 ml, $p<0.05$). During LMA insertion, the pressure on incisors of 11.41N ± 6.22N was used, while in case of LT-D this pressure amounted to 13.15N ± 3.68N. Every fourth examined paramedic had problems with correct insertion of LT-D tube in accordance with the adopted algorithm.

Conclusions: The supralottic LMA and LT-D tools seem to be an effective and safe alternative of the airway management in case of life emergency.

Key words

laryngeal mask airway, laryngeal tube, airway patency, medical emergency

INTRODUCTION

Airway obstruction is a life emergency hindering or restricting proper delivery of oxygen to the body in order to maintain normal vital functions. The most common blockage locations of the upper respiratory tract in unconscious people are the soft palate and epiglottis. In turn, the main cause of ventilation disturbance in these patients is the collapse of the tongue on the back of the pharynx. The other factors resulting in this condition include: a foreign body, residual discharge, vomit, blood or swelling [1, 2]. Opening the airways is aimed at restoring free flow of respiratory gases in the states of sudden and immediate life emergency [3]. Ensuring the patient's proper ventilation is a priority for the Emergency Response Team. Various instrumental or non-instrumental methods and tools for clearing the airways may be used including endotracheal intubation (considered by many authors as the golden standard) and supraglottic airway restoration using LMA and LT-D [4, 5].

The Act on the State Emergency Medical Services of September 8, 2006 [6], indicating Emergency Response Team as a unit of the system, as well as the Regulation of the Minister of Health of December 16, 2019 [7], specify the scope of medical rescue actions that can be performed independently by a paramedic. They include i.e. instrumental restoration and protection of airway patency. The choice of the best method in real clinical conditions depends on the individual factors related to the patient, the causes of the obstruction, as well as the skills and experience of each paramedic. Although endotracheal intubation is still the best way to open the airway, when performed by an inexperienced paramedic it is associated with a low effectiveness rate, in contrast to supraglottic instruments (LMA, LT-D) [4, 8].

Although review of Polish and foreign literature related to emergency medicine identified some studies related to the effectiveness of LMA / LT-D in simulated conditions, no studies were found analysing the detailed ventilation parameters combined with a measurable observation of the technique of their implementation and compliance with the adopted algorithm. The use of the evaluative head model for intubation (BT-CSIE, BT Inc., 2015) in the present study may be a valuable extension of the state of knowledge in the discussed area.

THE AIM

The aim of the study was to evaluate the effectiveness of supraglottic airway management by paramedics using selected tools in simulated conditions.

MATERIAL AND METHODS

The study was approved by the Bioethics Committee at the University of Rzeszów (Resolution No. 2018/03/13l). They were carried out from November 2017 to July 2018, after obtaining prior consent to participate in the study. The measurements were carried out at the Regional Ambulance Station in Rzeszow and at the Center for Medical and Natural Sciences Research and Innovation, University of Rzeszów.

The study included a group of 115 professionally active paramedics (men) working in various health care facilities in the Podkarpackie Province. The average work experience was 10.13 ± 7.56 years and ranged from 1 to 40 years. In the case of half of the respondents, their work experience was below 9 years. Each paramedic participating in the study had basic knowledge and skills in the studied field, acquired during the professional development course for paramedics in the last 5 years. The following inclusion criteria were adopted: working as a paramedic, informed and voluntary consent to participate in the study, work experience over 1 year and work in the emergency medical system.

The study was performed using an advanced airway head evaluation trainer (BT-CSIE, BT Inc., 2015), enabling head tilt and jaw thrust manoeuvre, sniffing position, self-inflating bag ventilation and intubation. The model has sensors that inform about improper use of the laryngoscope by means of sound signals. Detection of head tilt application, jaw thrust manoeuvre and sniffing position, depth of intubation (deep / moderate / shallow) and gastric volume (in ml) were monitored on the tablet (PC-1EA).

Before starting the tests, each paramedic was acquainted with the stand and equipment. Each subject was asked to insert a laryngeal tube (LT-D, size 5) and a laryngeal mask airway (LMA, size 5) into the trainer. Then, ventilation was carried out (bag valve mask, capacity approx. 1475 ml, Compower, Poland) for 1 minute according to the possessed knowledge and skills. Head tilt was assumed as the starting point for a single test. The angle at which the head was tilted was recorded, the presence of pressure on the incisors and jaw thrust maneuver were observed, correct performance of all check-list items were checked. After the LMA/LT-D was inserted, the paramedic started emergency ventilation for 60 seconds. The first properly performed breath was the end of the time of fitting the alternative and the beginning of the ventilation time. After one minute, the investigator (a trained medical professional) signalled the end of the task. The following parameters were measurably assessed: average tidal volume of a single breath in ml, number of ventilations per minute, average minute tidal volume in ml, time of insertion in seconds, the need for a second attempt, pressure on incisors in N.

The algorithm for inserting LMA and LT, which is the original check-list, was compliant with the 2015 ERC Resuscitation Guidelines [1]. These included: opening the airways, tilting the head back, opening the mouth, inserting the LMA / LT-D held like a "pen" guided along the index finger until it stops, proper cuff sealing.

The obtained results were analyzed using tests assessing the differences between the studied groups. Due to the presence of a dependent variable on the quantitative scale, an independent variable on the qualitative scale, and the lack of normality of distribution (assessed by the Shapiro-Wilk test), non-parametric analyzes were used: Mann-Whitney U test. The level of statistical significance was adopted at $p<0.05$. Calculations were carried out using the IBMSPSS Statistics 20 package.

RESULTS

Table 1 compares the effectiveness of opening the airways with LT-D and LMA. It has been shown that the mean time of LT-D insertion in the first attempt is comparable with the time of LMA insertion (25.86 ±7.88 s *vs*. 25.18 ±9.07 s; p=0.532). Successful insertion of LT-D in the first attempt was made by almost 69% of respondents, while LMA was performed by 99% of paramedics. The pressure on the incisors has been shown to be lower when using LMA vs. LT-D (9.17 ±6.59 N *vs*. 13.15 ±3.68 N; p=0.076). A significantly higher mean tidal volume of a single inspiration was also observed using LMA *vs*. LT-D (633.24 ±113.70 ml *vs*. 579.68 ±146.21 ml; p=0.001) and higher minute volume for LMA *vs*. LT-D (8319.77 ±2638.57 ml *vs*. 7588.67 ±2642.37 ml; p=0.002).

The study analysed the compliance of individual elements of the LMA and LT-D insertion algorithm with the checklist. High percentage of repeatability of individual activities of the algorithm components were observed for LT-D and LMA amounting to 80-90% for both methods. Only the element related to the insertion of the laryngeal tube until the resistance was performed by three out of four respond-

Table 1. Comparison of the effectiveness of opening the airway with LT-D and LMA.

Parameter	LT-D			LMA			P
	N	[%]	SD	N	[%]	SD	
Time (s) 1st attempt	79	68.7	25.86 ± 877.88	114	99	25.18 ± 9.07	0.532
Time (s) 2nd attempt and the following	36	31.3	25.81 ± 9.84	1	1	1.12.2000	-
Pressure on the incissors (N)	66	57.4	13.15 ± 3.68	115	100	9.17 ± 6.59	0.076
Head tilt (degree)	115	100	50.61 ± 17.99	115	100	49.57 ± 20.99	0.336
Average tidal volume of a single breath(ml)	115	100	579.68 ± 146.21	115	100	633.24 ± 113.70	0.001*
Number of ventilations per minute	115	100	13.12 ± 3.27	115	100	13.29 ± 4.24	0.945
Minute tidal volume (ml)	115	100	7588.67 ± 2642.37	115	100	8319.77 ± 2638.57	0.002*

Significates differences at $p<0.05$ between groups was denoted by *

Table 2. Correct execution of the check-list elements in the LT-D and LMA insertions.

LT-D	No		Yes	
	N	[%]	N	[%]
Opening the upper airways	15	13.0	100	87.0
Opening the mouth	21	18.3	94	81.7
Inserting the tube	17	14.8	98	85.2
Till the moment of resistance	34	29.6	81	70.4
Held like a "pen" guided	15	13.0	100	87.0
Proper cuff sealing	9	7.8	106	92.2
LMA				
Opening the upper airways	21	18.3	94	81.7
Opening the mouth	24	20.9	91	79.1
Inserting the mask	13	11.3	102	88.7
Till the moment of resistance	16	13.9	99	86.1
The mask guided along the index finger	19	16.5	96	83.5
Proper cuff sealing	9	7.8	106	92.2

ents. The exact numerical and percentage values of the individual components of the algorithm are presented in Table 2.

DISCUSSION

The present study analysed the effectiveness of supraglottic airway management performed with selected tools (LT-D and LMA) by paramedics working in the National Medical Rescue system in simulated conditions. The results obtained in our study are similar to the results presented in the world literature, at the same time confirming lack of difficulties and relatively short time of inserting both tools (approx. 25 seconds) [9, 10]. In the analysed studies, the effectiveness of LMA was estimated at the level of 95-99% [10-12]. In Norwegian clinical trials conducted among paramedics, 86.7% of LT-D insertions observed were performed in less than 30 seconds, with an overall success rate of 85.3%, of which 74.4% were effective in the first attempt [13]. Bernhard et al., comparing the effectiveness of LT-D and LMA in hospital conditions, obtained the success rate of the first attempt of both tools at the level of 77.0-78.7%, with the success index of the first and subsequent attempts at the level of 92.2%-97.7%. Compared to LT-D, LMA had better cumulative success rate during the insertion in the first and the following attempts [14]. Our study confirmed higher effectiveness of the LMA insertion than LT-D (the effective LMA insertion in the first attempt was 99%, while LT-D 69%).

When both devices were used, the pressure on the incisors was low, 9.17 ± 6.59 N for the LMA and 13.15 ± 3.68 for the LT-D respectively. In the case

of similar analyses, both for standard endotracheal intubation with the use of Laryngoscope blades and specialized devices to facilitate it, the authors showed that the forces generated on the incisors are higher, 72.8 N or even 100 N [15, 16].

The mean tidal volume was then analysed during artificial ventilation after opening the airway. A higher mean tidal volume was demonstrated for LMA (633.24 ml) and LT-D (579.68 ml). Studies conducted on German nurses of Intensive Care Units showed high mean tidal volumes for LMA (790 ml) and LT-D (752 ml) [17], with the tidal volume recommended by the ERC of 6-7 ml/kg (500-600 ml) [4] obtained test results in our study should be treated as similar. The use of a tidal volume that is too small may result in a decrease in oxygen saturation and worse ventilation of the patient. However, it should be remembered that hyperventilation of the patient during CPR leads to a number of consequences that affect both its success and complications after the return of spontaneous circulation [18, 19].

An important aspect of supraglottic airway management in life emergency is its repeatability and compliance with the accepted protocols in order to maximize the effectiveness and safety of the patient. In our study, an attempt was made to analyse the components of the LMA and LT-D insertion algorithm in simulated conditions. Despite obtaining high repeatability of actions within the framework of individual treatment algorithms, one in four respondents found a problem with the insertion of LT-D until resistance was felt (29.6%). In the absence of other studies analysing this parameter, based on our practical experience, it can be assumed that the described problem may be the result of the LT-D shape (narrow pharyngeal and oesophageal LT-D cuff against the wide LMA cuff), which often results in ineffective insertion due to asymmetrical sliding in case LT-D is not lead in the palate midline. In studies on a living organism using LT-D [13] other technical problems and complications were also discussed, such as the problem of sealing the cuff, provoking or aspiration of vomit or dislocation of the tube. It should be noted, that despite the described difficulties, the results of our and other researchers' studies suggest that the use of LMA and LT-D still seems be an important alternative to intubation in the event of cardiac arrest. What should be also highlighted is the fact that foreign studies do not report any significant differences in the patient's survival rate until discharge in the case of using supraglottic airway management compared to endotracheal intubation [20].

CONCLUSIONS

LMA and LT-D seem to be effective and safe tools for opening the airways in case of immediate life emergency. Higher effectiveness and greater safety of LMA than LT-D was found in terms of the number of attempts to insert LMA and LT-D, the pressure on incisors and compliance with the recommended treatment algorithm.

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WHITE BLOOD CELLS RATIOS IN PATIENTS WITH ACUTE CORONARY SYNDROMES IN ASSOCIATION WITH HYPERTENSION AND DIABETES MELLITUS

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Abstract

The aim: The purpose of this study was to evaluate of white blood cells ratios in patients with ACS in association with arterial hypertension and 2 type Diabetes Mellitus.

Material and Methods: In this observational cohort trial we observed of 184 patients with ACS. All patients were randomized into four groups: 1st group – 42 patients with ACS without AH or DM; 2nd group – 56 patients with ACS and previous AH; 3rd group – 42 patients with ACS and 2 type DM; and 4th group – 44 patients with ACS and AH and DM. We studied of leukocytes count and their subpopulation ratios: neutrophils to lymphocytes ratio (NLR), neutrophils to monocytes ratio (NMR), neutrophils to lymphocytes+monocytes ratio (N/LMR), lymphocytes to monocytes ratio (NMR).

Results: The mean white blood cells count was significant higher in patients with ASC, compared with control group ($p<0.001$). In patients with ACS the elevated NMR and NLR were observed: 15.04 ± 1.28 vs 11.09 ± 0.43 in control group ($p<0.05$), and 3.34 ± 0.20 vs 2.60 ± 0.06 ($p<0.05$), respectively. No significant differences between WBC ratios were revealed in observed patients with ACS with or without AH and/or DM.

Conclusion: ACS is characterized of raised NLR and NMR which could be indicators of poor prognosis.

Key words

acute coronary syndrome, white blood cells, hypertension, diabetes mellitus

INTRODUCTION

Each year, about 1.1 million patients are hospitalized with an acute coronary syndromes (ACS) event in the United States [1]. Although the overall incidence of ACS appears to be declining, the direct and indirect costs associated with treating patients with ACS and its downstream sequelae, including congestive heart failure and repeat revascularization, remain a medical and economic burden worldwide.

Evidence now indicates that inflammation contributes considerably to the initiation and progression of atherosclerosis and an active inflammatory processes may trigger plaque rupture and enhance the risk of coronary thrombosis leading to a clinical ischemic event. Due this conception over the past two decades, there has been increasing interest in discovering novel therapeutic agents for reducing residual risk among patients with ACS, including ST-segment elevation myocardial infarction (STEMI), non–ST-segment myocardial infarction (NSTEMI), and unstable angina [2].

Interest in characterizing inflammatory markers that predict clinical events have dominated clinical investigation. White blood cell (WBC) count is considered a marker of inflammation measured on routine hemograms, and earlier studies demonstrated an association between WBC and MACE in patients with ACS. Thus, in TACTICS-TIMI 18 (Therapy with an Invasive or Conservative Strategy-Thrombolysis In Myocardial Infarction 18) trial in patients with unstable angina or NSTEMI the WBC count was associated with impaired epicardial and myocardial perfusion, more extensive coronary artery disease (CAD), and higher six-month mortality. After adjustment for traditional risk factors and other biomarkers, assessment of WBC count can be used to stratify patients across an eightfold gradation of six-month mortality risk [3]. Similarly, in the Thrombolysis In Myocardial Infarction (TIMI) 10A and 10B trials among patients with acute myocardial infarction (AMI) elevation in WBC count was associated with reduced epicardial blood flow and myocardial perfusion, thromboresistance (arteries open later and have a greater thrombus burden), and a higher incidence of new congestive heart failure and death [4].

There are some controversial data about prognostic role of WBC ratios in patients with ACS.

THE AIM

The purpose of this study is to evaluate of white blood cells ratios in patients with ACS in association with arterial hypertension and 2 type Diabetes Mellitus.

MATERIAL AND METHODS

The study was performed in accordance with the Helsinki Declaration and Good Clinical Practice Guideline. It was approved by the local ethics committee and written informed consent was obtained from all patients. In this observational cohort trial we observed of 184 patients with ACS. The diagnosis was verified by laboratory and instrumental methods according to European Society of Cardiology guidelines (2017, 2020) [5, 6]. All patients were randomized into four groups: 1st group – 42 patients with ACS without AH or DM; 2nd group – 56 patients with ACS and previous AH; 3rd group – 42 patients with ACS and 2 type DM; and 4th group – 44 patients with ACS and AH and DM. 30 apparently healthy persons were included into control group. We studied of leukocytes count and their subpopulation ratios: neutrophils to lymphocytes ratio (NLR), neutrophils to monocytes ratio (NMR), neutrophils to lymphocytes+monocytes ratio (N/LMR), lymphocytes to monocytes ratio (NMR).

Categorical variables are presented as percentages, whereas continuous variables are presented as mean (M) and standart error of mean (m) if normally distributed, or as median and interquartile range (Me [IQR]), if not. Categorical variables were compared by the χ^2 test and continuous variables by the t test or the Mann-Whitney U test. A p value of <0.05 was considered statistically significant. All tests were 2-sided. Analyses were performed with Statistica system software, version 12.0.

RESULTS

The mean age of all observed patients with ACS was 64.6±11.9 years; 93 (50.5%) were males and 91 (49.5%) females among them (see table 1). ACS without persistent ST segment elevation was diagnosed in 44 (23.9%) cases; instead ACS with persistent ST segment elevation – in 140 (76.1%) cases. 63 (34.2%) patients were identified as current smokers.

ACS with persistent ST segment elevation more often was presented as anterior-lateral myocardial infarction with persistent ST segment elevation (STEMI) – in 70 (50.0%) cases. Other walls of left ventricle were injured in 39 (27.9%) cases – inferior wall, in 21 (15.0%) cases – anterior wall, and in 10 (7.1%) cases necrosis was localized on anterior and lateral parts of left ventricle.

The mean white blood cells count was significant higher in patients with ASC, compared with control group: 8.23 [6.50; 9.40] vs 5.49 [5.20; 5.70] ($p<0.001$).

In patients with ACS the elevated NMR and NLR were observed: 15.04±1.28 vs 11.09±0.43 in control group ($p<0.05$), and 3.34±0.20 vs 2.60±0.06 ($p<0.05$), respectively (Table 1).

No significant differences between WBC ratios were revealed in observed patients with ACS with or without AH and/or DM (Table 2).

Table 1. White blood cells ratios in observed persons.

Parameter	Observed persons	
	Patients with ACS, n=184	Control group, n=30
NMR	15.04±1.29*	11.09±0.43
LMR	5.76±0.58	4.39±0.12
NLR	3.34±0.20*	2.60±0.07
N/LMR	2.34±0.13	2.14±0.06

Notes: * $p<0.05$

Table 2. White blood cells ratios in patients with ACS.

Parameter	Patients with ACS, n=184			
	ACS, n=42	ACS+AH, n=56	ACS+DM, n=42	ACS+AH+DM, n=44
NMR	18.56±4.65	14.63±1.45	14.03±1.67	13.93±1.74
LMR	7.63±2.57	5.25±0.47	6.12±0.67	5.48±0.52
NLR	3.28±0.37	3.46±0.26	2.94±0.39	2.97±0.49
N/LMR	2.41±0.21	2.39±0.18	2.21±0.21	2.12±0.23

Notes: p>0,05

DISCUSSION

WBC ratios is an important predictors of patients with acute or chronic diseases survival [7]. Thus, in medicine NLR is used as a marker of subclinical inflammation. In recent trial with 250 consecutive STEMI patients presenting acutely for revascularization NLR determined as predictors of short- and long-term mortality (OR = 1.05, p = 0.011), and both short-term (≤ 30 days) and long-term (≤ 2 years) mortality were predicted with Kaplan-Meier survival curve separation best stratified by a NLR cut off value of 7.4 [8]. In our trial the elevated NLR was observed in patients with ACS.

In last meta-analysis, with enrolment of 5 studies comprising 4343 patients to investigate the prognostic value of the LMR in patients with ACS, lower LMR was associated with higher long-term mortality/MACE in patients with ACS [9]. No difference in LMR parameters between patients with ACS and healthy persons was observed in our trial.

Patients with ACS showed of elevated NMR. Established, that Average values of NLR were significantly higher in patients with AMI in relation to patients with UA, indicating the importance of this inflammatory marker in discrimination of clinical forms of ACS. A positive correlation was established between NLR and markers of myocardial necrosis, and between NLR and CRP, indicating the importance of NLR in the assessment of the extent of the myocardial lesion and in inflammation intensity assessment in ACS [10]. Last meta-analysis of 8 studies with 9406 patients indicated that elevated pretreatment NLR was a poor prognostic marker for patients with recent ACS in predicting medium to long-term mortality/MACEs (OR 1.26, 95%CI 1.13–1.41). This analysis showed that higher pretreatment NLR value was associated with higher in-hospital mortality in ACS patients (OR 6.39, 95%CI 1.49–27.38, p < 0.001); and NLR value of 5.0 maybe a cut-off value for ACS risk [11].

CONCLUSION

ACS is characterized of raised NLR and NMR which could be indicators of poor prognosis.

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LONG TERM OUTCOME PREDICTION IN STEMI/NSTEMI PATIENTS BY MEANS OF THE MODEL CONSISTING OF SIMPLE CLINICAL PARAMETERS

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Abstract

Aim: Our study aimed to identify the clinical variables associated with long-term mortality after MI and to construct a simple, easy to use clinical practice model for the prediction of 5 year mortality after MI.

Material and Methods: This is a prospective 5-year observation study of MI patients admitted to the Department of Cardiology at the Copernicus Memorial Hospital in Lodz in 2010 and 2011. The data were collected during hospitalization and again after a period of 1 and 5 years. A multi-factor multi-level Cox regression model was constructed to investigate the impact of clinical factors on long-term survival.

Results: 92 patients (39 STEMI, 53 NSTEMI) were included in the study and their data were used to construct a Cox regression model with satisfactory fit (R 2 =0.7945). Factors associated with a decrease in 5-year risk are: age (1.06, 95%CI: 1.01-1.11), SYNTAX score (1.05, 95%CI: 1.02-1.08), WBC level (1.16, 95%CI: 1.08-1.26), and glycemia at enrollment (1.01, 95%CI: 1.01-1.01). Higher values of HDL at enrollment were associated with a decrease in 5-year risk (HR=0.97, 95%CI: 0.93-0.99).

Conclusion: The model we created is a valuable tool that is useful and easy to employ in everyday practice for assessing the 5-year prognosis of patients after MI.

Key words

coronary artery disease, prognosis, mortality, myocardial infarction, acute coronary syndrome

What is new

The study presents the new model for prediction of 5-year mortality after myocardial infarction. This model is based on simple clinical parameters and may by applied in everyday practice.

INTRODUCTION

Between 85-90 thousand people were diagnosed with a myocardial infarction (MI) in Poland every year during the period 2009-2012. In the following years 323.400 people were hospitalized due to MI [1]. Despite advances in treatment, MI is still associated with significant mortality, especially in long-term observation. In-hospital mortality is higher in patients with STEMI than in those with NSTEMI (7% *vs*. 3-5%). Mortality after 6 months reaches similar values in both groups (12% for STEMI *vs*. 13% for NSTEMI) [2]. The mortality in patients with NSTEMI after 4 years is twice as high as in STEMI [3].

Individual assessment would be useful to establish prognosis for patients with a high risk of death after MI. It would help to initiate the most appropriate intensive preventive strategies in selected patients

THE AIM

Our study aimed to identify simple clinical variables associated with long-term mortality (5 year) after MI and to construct a simple model for the prediction of 5 year mortality.

MATERIAL AND METHODS

The paper presents a prospective 5-year observation study of patients with MI admitted to the Department of Cardiology at the Copernicus Memorial Hospital in Lodz in 2010 and 2011. Patients with cardiogenic shock (Killip-Kimbal class IV) or fibrinolytic therapy were

not included in the analysis. The data were collected during hospitalization. Patients were assessed in the 1 and 5 year follow-up. Only patients for whom data on 5 year survival was available were included in the study. The study was approved by the Bioethics Committee (RNN / 188 / LURB). Written consent on participation in the study was obtained from each subject.

CLINICAL ASSESSMENT AND DEFINITIONS

Diagnosis of MI and the factors analyzed were defined according to the standards of the ACC Clinical Data Standards document.

MI was classified as: STEMI or NSTEMI.

Past medical history was collected, including acute coronary syndrome, stroke / TIA, diabetes, hypertension, atrial fibrillation or flutter, current tobacco smoking activity, alcohol consumption, physical activity, and type of work performed. Information on family history of cardiovascular diseases, previous use of drugs, strong stress factors before hospitalization was also obtained. Physical activity was defined as performing at least moderate physical effort of 2.5 hours per week (e.g., walking). Patients not performing such physical exertion were described as physically inactive. Type of work was determined by patient self-reports, defined as sitting or physical. Alcohol consumption was classified as alcoholism, abstinence or occasional drinking. Occasional drinking in males was defined as consumption of no more than 6 standard units (60 g 100% alcohol) per week. For females,

Table 1. Overall summary for the STEMI and NSTEMI groups, with median, IQR and p -value of U Mann-Whitney test.

	STEMI			NSTEMI			p-value
	Median	25%	75%	Median	25%	75%	
AGE	65	57	76	74	61	79	0.7773
SYNTAX SCORE	16.5	10	24	18.5	13	25.5	0.3933
TRIGLYCERIDES mg/dl	130	93	178	111	85	168	0.5534
HIGH-DENSITY LIPOPROTEINS mg/dl	43	37	53	45	34	51	0.7161
LOW-DENSITY LIPOPROTEINS mg/dl	109.6	78	143.8	103.2	63.8	130.6	0.2636
COMPLETE CHOLESTEROL mg/dl	168	149	213	169	130	203	0.2552
CREATINE AT ENROLLMENT mg/dl	0.91	0.74	1.00	1.11	0.94	1.35	0.0006
GFR ml/min	84.01	63.78	103.05	57.76	44.66	77.03	0.0004
HR AT ENROLLMENT bpm	75	66	90	80	70	98	0.2065
HR AT DISCHARGE bpm	70	60	75	65	60	75	0.8075
SYSTOLIC PRESSURE AT ENROLLMENT mmHg	130	120	157	150	130	165	0.0289
DIASTOLIC PRESSURE AT ENROLLMENT mmHg	80	70	90	82	80	90	0.2058
PULSE PRESSURE AT ENROLLMENT mmHg	50	40	69	60	50	70	0.0271
MEAN ARTERIAL PRESSURE AT ENROLLMENT mmHg	96.5	86.5	111.4	105.74	96.5	113.1	0.0747
SYSTOLIC PRESSURE AT DISCHARGE mmHg	110	102	120	120	114	130	0.0060
DIASTOLIC PRESSURE AT DISCHARGE mmHg	70	65	75	70	69	80	0.1837
PULSE PRESSURE AT DISCHARGE mmHg	40	35	50	50	40	55	0.0624
MEAN ARTERIAL PRESSURE AT DISCHARGE mmHg	83.91	78.22	89.8	89.8	81.45	93.51	0.0250
EJECTION FRACTION (ECHO) %	51	43	54	56	41	63	0.1536
TROPONINE T (HIGHEST VALUE) mg/dl	2.72	1.06	5.6	0.55	0.22	1.03	0.0001
CRP AT ENROLLMENT mg/l	5.9	2.44	9.7	5.12	1.39	60	0.7913
WBC 103 /µl	10.4	7.98	13	9.17	7.26	11.6	0.2358
RBC 106/µl	4.6	4.06	4.96	4.3	3.87	4.9	0.1595
HGB g/dl	14	12.7	15	13.4	12	14.3	0.1203
HCT %	41	37	43	39	34	41.7	0.0846
PLT 103 /µl	207	189	270	208	183	244	0.7489
MPV fl	10.3	9.9	11.1	10.7	10	11.4	0.2965
GLICEMIA AT ENROLLMENT mg/dl	152	119	200	149	122	225	0.6354

GFR – glomerular filtration rate, CRP – C Reactive Protein, HCT – hematocrit, HGB – hemoglobin, HR – heart rate, MVP – mean platelet volume, PLT – platelet count, WBC – white blood cell count.

occasional drinking was defined as not more than 4 standard units (40 g 100% alcohol) at a time [4].

Physical examinationincluded body weight and height, BMI, heart rate, systolic and diastolic blood pressure, pulse pressure, and the degree of heart failure according to the Killip-Kimbal classification. The standard 12 leads ECG was recorded. Significant ST-T changes were defined as the elevation of the ST segment at point J in two adjacent leads with a cut-off point ≥ 1 mm (0.1 mV) in all leads except V2-V3 for which cut-off points were used: ≥ 2 mm (0.2 mV) in men ≥ 40 years old; ≥ 2.5 mm (0.25 mV) in men < 40 years old; and ≥ 1.5 mm (0.15 mV) in women regardless of age. A significant reduction in the ST segment and changes in the T wave were considered to be horizontal or oblique downward depression of the ST segment by ≥ 0.5 mm (0.05 mV) in two adjacent leads and / or negative T waves > 1 mm (0.1 mV) in two adjacent leads with a dominant R wave or R / S ratio > 1.

Laboratory tests were performed at the Synevo Analytical Laboratory of the Copernicus Memorial Hospital in Lodz with Roche Diagnostic apparatus CobasIntegra 800 and Cobas 6000 e601/e501 and Roche reagents. Immunochemistry tests were performed with a Cobas E411. The blood cell count was performed with a Sysmex XE-2100 camera. Blood cell count, biochemistry, including glucose, creatinine, urea, troponin T, CKMB (Creatine kinase-MB) and C-reactive protein (CRP) were determined at the time of admission.

On the second day of hospitalization, the fasting concentration of total cholesterol, high density lipoprotein – cholesterol (HDL-cho) and triglycerides (TG) were measured and the concentration of LDL fraction was calculated using the Friedewald formula.

The transthoracic echo (TTE) was performed by a trained clinician using Philips iE33. Ejection Fraction of Left ventricle (LV) EF was calculated from a 2D image by the Simpson method [5].

Coronary angiography was performed in all patients (urgently for STEMI). Urgent coronary angiography in NSTEMI (< 2 hours) was performed on patients at very high risk. Coronary angiography and coronary angioplasty were performed with the use of a Philips AlluraXper FD 20. Patients were qualified for conservative treatment, ad hoc coronary angioplasty, Heart Team consultation, and coronary artery bypass grafting (CABG) on the basis of angiography.

The anatomical complexity of coronary artery disease was determined using SYNTAX scale. Premature parental coronary artery disease (angina pectoris, previous MI, angioplasty, CABG) was defined as the occurrence of a validated parental event prior to an offspring baseline examination and before the age of 55 years in a father or the age of 65 years in a mother [6].

At the time of discharge from the hospital, the number of days of hospitalization was determined. One year after discharge from the hospital, data on survival, reoccurrence of cardiovascular disease-related incident (MI, stroke), rehospitalization, smoking habits, physical fitness determined by the NYHA scale, and angina pectoris determined by the CCS scale were obtained. Information concerning patient survival was obtained at a five-year follow up.

STATISTICAL ANALYSIS

The assumption of normality was tested with the Shapiro-Wilk test. Differences between STEMI and NSTEMI patients were investigated using non-parametric statistical methods (U Mann-Whitney test). To investigate the impact of clinical factors on long-term survival, a multi-factor multi-level Cox regression model was constructed. Due to a skewed distribution of ages between the STEMI and NSTEMI groups, survival analyses were performed on both unadjusted

Table 2. Summary of variables included in the final model – beta values with the standard error, p-value of Cox regression, HR with 95% confidence interval.

	BETA	STANDARD ERROR	P-VALUE	HR	95% CI
AGE	0.0625	0.0216	0.0038	1.0645	1.01 – 1.11
SYNTAX SCORE	0.0485	0.0162	0.0027	1.0497	1.02 – 1.08
WBC LEVEL	0.1521	0.0402	0.0002	1.1643	1.08 – 1.26
GLICEMIA AT ENROLLMENT	0.0100	0.0024	0.0001	1.0100	1.01 – 1.01
HDL AT ENROLLMENT	-0.0344	0.0169	0.0420	0.9662	0.93 – 0.99
ATRIAL FIBRILLATION	0.4992	0.2555	0.0508	2.7140	0.99 – 7.39
PHYSICAL ACTIVITY	-0.3936	0.2082	0.0587	0.4551	0.20 – 1.03

HDL – high density lipoproteins, WBC – white blood cell count.

and age-adjusted time of survival. Determination of the categorical factors used for the multi-level Cox regression analysis was based on variable importance from the random forest regression for survival time, with a cut-off value of 40%. To elucidate the effect of collinearity, a subset of variables was selected based on the correlation matrix and their clinical application. The model was constructed with the backward stepwise feature selection method. The accuracy of the obtained model was evaluated with Martingale increment errors plots.

The statistical analyses were performed using Rstudio, Statistica 13.1 and Microsoft Excel software. Two-tailed p values lower than 0.05 were deemed statistically significant.

RESULTS

A prospective observation of 92 patients was performed – 39 diagnosed with STEMI and 53 with NSTEMI. A general summary of the patients is available in Table 1.

Compared with STEMI, NSTEMI patients had higher levels of creatinine (1.11 vs. 0.91 mg / dL; P < 0.001), lower GFR (57 vs. 84 mL / min; P < 0.001), higher systolic pressure at enrollment (150 *vs.* 130 mmHg; P = 0.03), higher systolic pressure at discharge (120 vs. 110 mmHg; P < 0.01), higher pulse pressure (60 vs. 50 mmHg; P = 0.03) and higher mean arterial pressure (89.8 vs. 83.9 mmHg; P = 0.03). STEMI patients had significantly higher levels of troponin T (2.72 vs. 0.55; P < 0.001).

Overall survival was plotted for STEMI and NSTEMI groups with and without age-adjustment (Fig. 1a-b). STEMI patients had significantly longer survival, regardless of age adjustment (P = 0.03 and P = 0.047, with and without age adjustment, respectively).

Age distribution within STEMI and NSTEMI groups presented Fig. 1c-d.

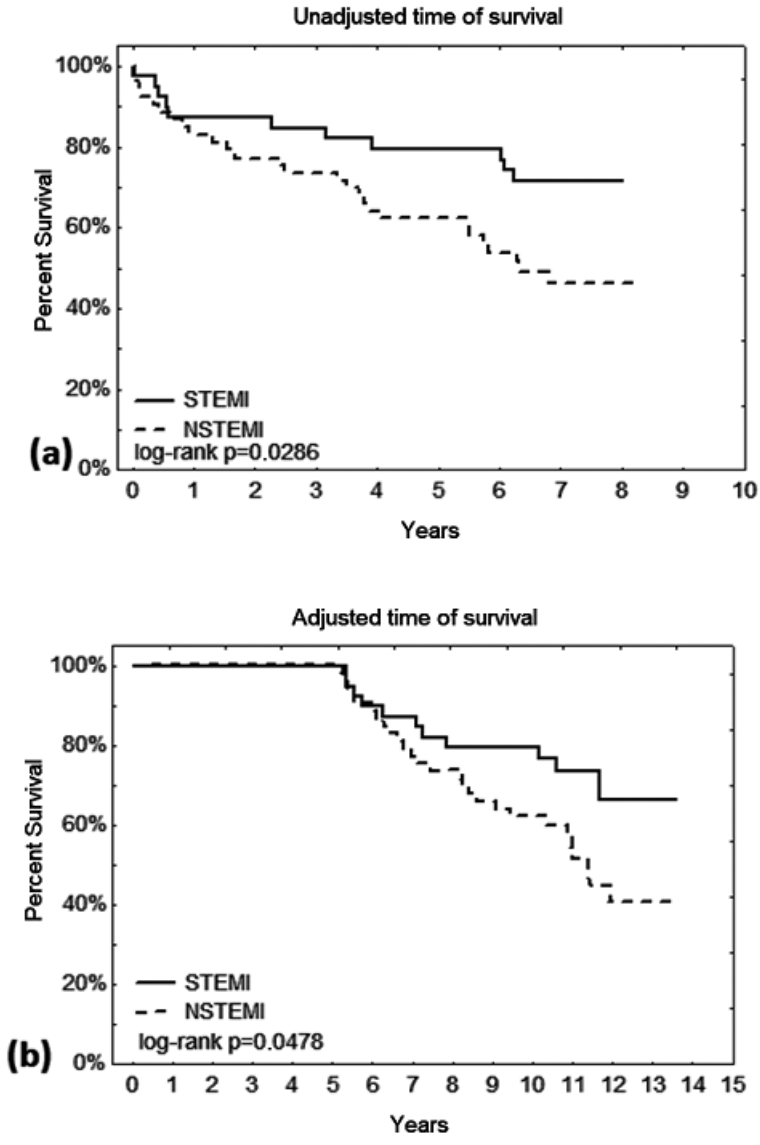


Fig. 1a, 1b. Survival analysis for STEMI and NSTEMI groups. Kaplan-Maier curves for STEMI and NSTEMI, unadjusted and age-adjusted.

To determine the impact of clinical factors on survival of the patients a Cox regression model was developed. After feature selection (Fig. 2 c-d), the final model included age, SYNTAX score, white blood cell count, blood glucose level at enrollment, high-density lipoprotein level at enrollment, presence of atrial fibrillation, and physical activity of the patient (Table 2).

The final model was evaluated with respect to its coefficient of multiple determination and Martingale increment errors plots (Fig. 2a, 2b). The model has a satisfactory R-squared value of 0.7945 (Table 3).

To further investigate the model, Kaplan-Maier and cumulative hazard functions were plotted to compare the effect of physical activity on long-term patient survival. Physical activity was a significant factor in length of survival (Fig. 3a-d).

DISCUSSION

In the light of the high mortality after MI, it is important to find risk factors identifying patients with the highest risk of early death. To estimate mortality in STEMI and NSTEMI, the following scales are available: Grace (Grace RiskScore) [7] and TIMI Risk Score (Antman). [8] They determine the risk of 30 day mortality, 1 year mortality, and 3-year risk of mortality in new versions. The Grace score contains: age, HR, systolic blood pressure, creatinine level, cardiac arrest at admission, ST deviation, abnormal cardiac enzymes, and Killip class. TIMI Risk Score contains: age ≥ 65, 3 ≥ CAD risk factors, known CAD (stenosis ≥ 50%), ASA use in past 7 days, severe angina (≥ 2 episodes in 24 h), ST change ≥ 2

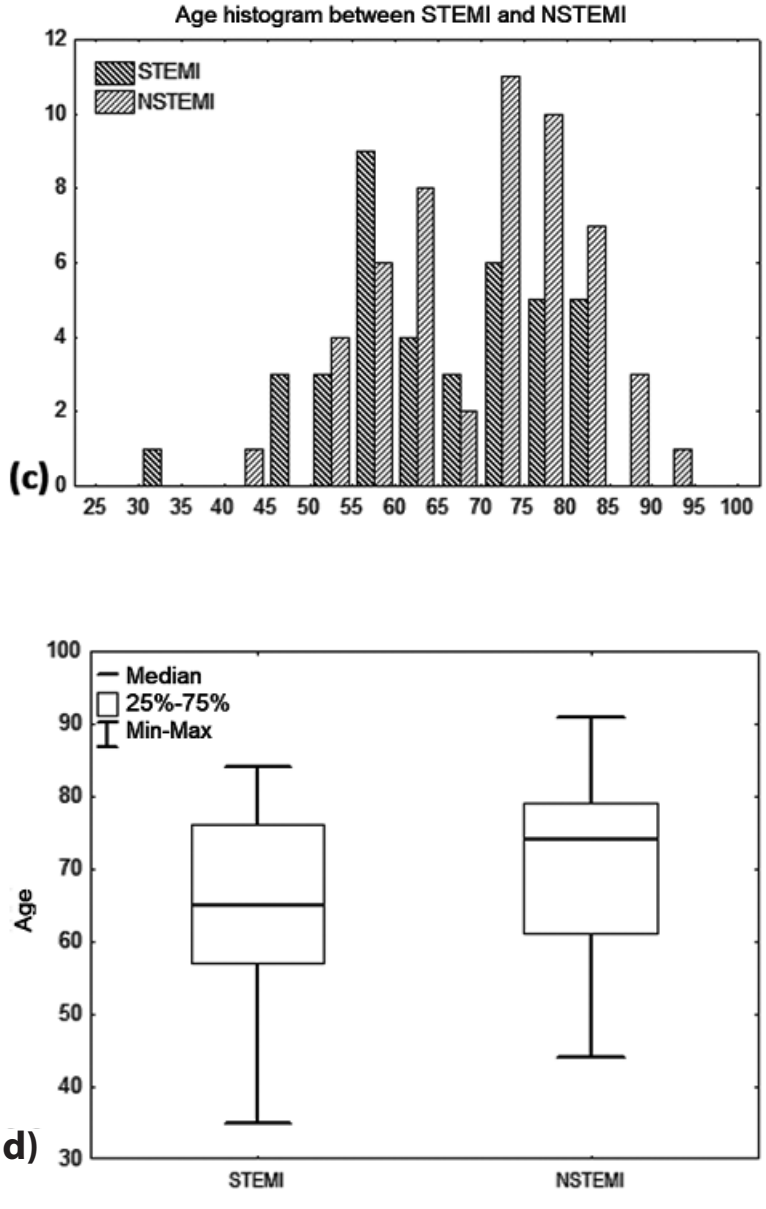


Fig. 1c, 1d. Age distribution within STEMI and NSTEMI groups – bar plot and box-plot .

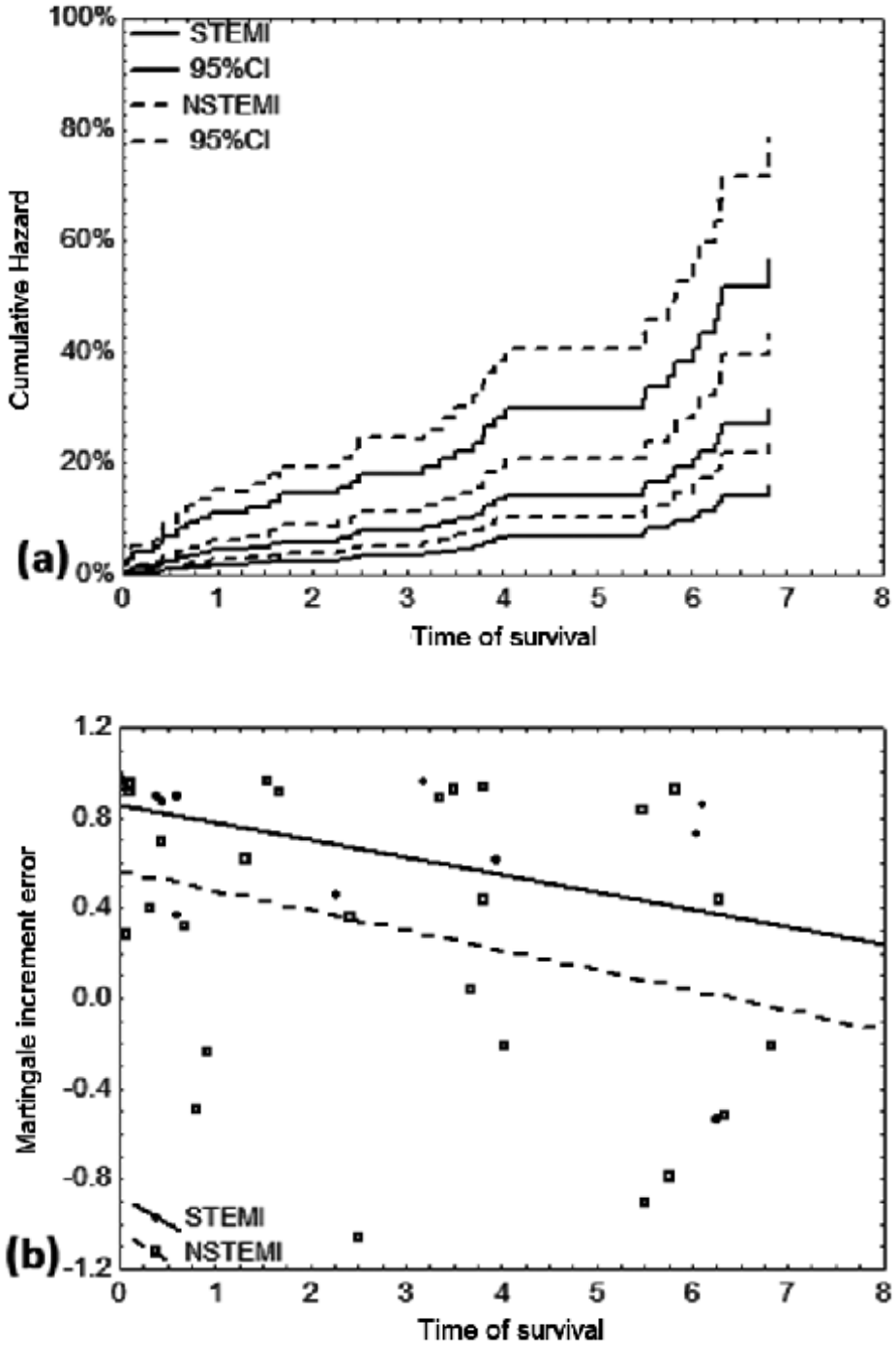


Fig. 2a, 2b. Model construction and final model summary. a) Cumulative-hazard *vs.* time plot for STEMI and NSTEMI groups. b) Martyngale increment errors plot.

mm, and a positive cardiac marker. The our model contains only age as a feature that is consistent with the GRACE and TIMI Risk Scores.

In our study we tried to find factors that are the most strongly associated with negative prognosis after MI. Our analysis was restricted to only STEMI and NSTEMI patients.

Our model, ASWGH-AF-Activ, included the following clinical features: Age, SYNTAX Score, WBC, Glycemia on admission, HDL-cholesterol level, Atrial Fibrillation, and physical activity, which have all been shown to influence long-term outcome after MI.

Age is a recognized risk factor for the development of cardiovascular diseases and an independent prognostic factor in acute coronary syndromes (ACS) [9]. Elderly patients are less frequently treated in accordance with ACS guidelines [10]. This is due to concerns about the higher risk of side effects of the treatment methods, especially bleeding complica-

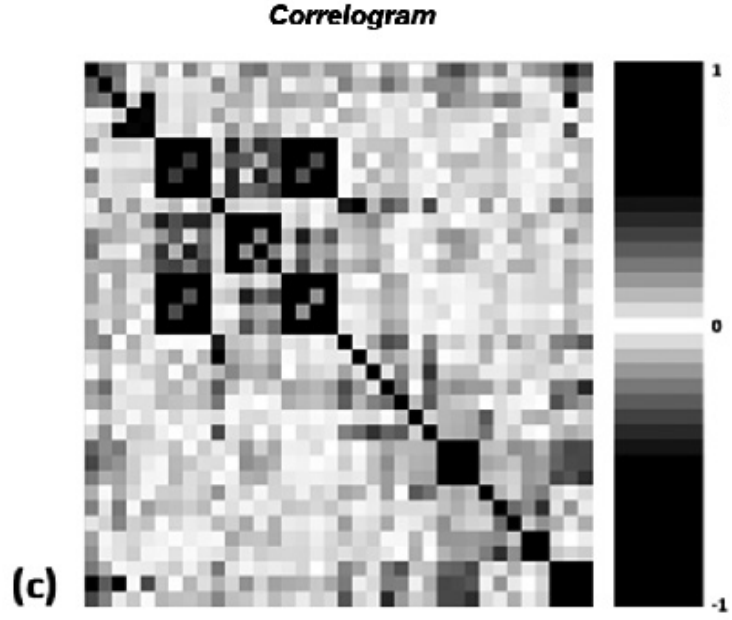
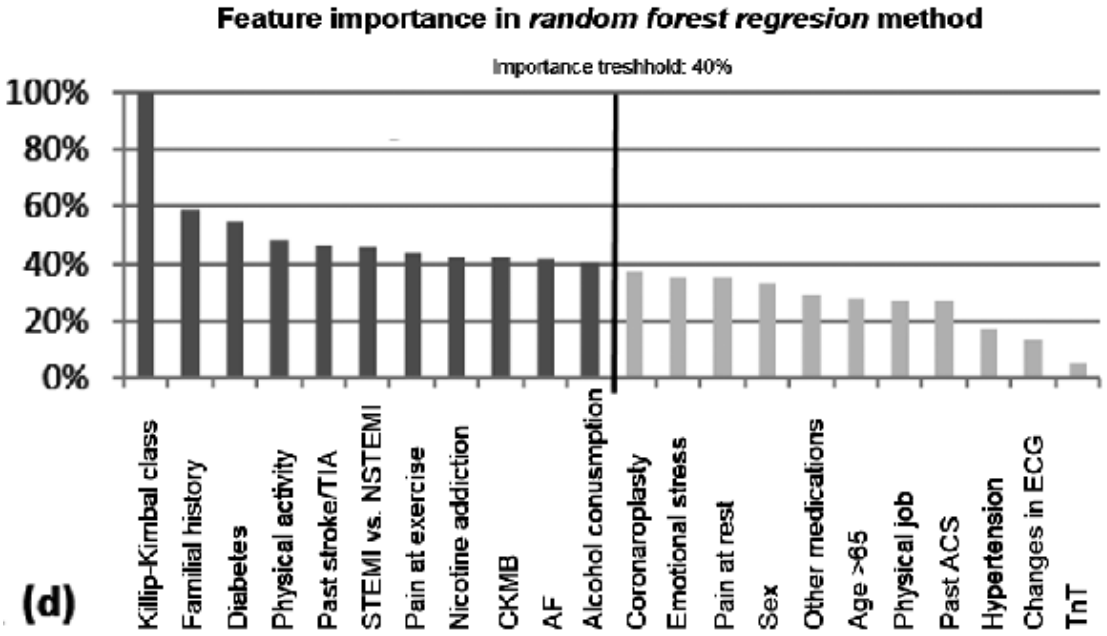


Fig. 2c, 2d. Correlation matrix for continuous variables and variable importance in random forests estimation of survival time. Cut-off value for variable importance was> 40% presence in 300 generated random regression tress.



tions observed in this population [10]. However, the benefits of full invasive treatment and optimal medical therapy, particularly antiplatelet drugs outweigh this risk.

Many studies have shown a link between increased leukocyte count and ischemic heart disease as well as mortality in the general population [11-17]. In addition, the effect of leukocytosis on the incidence of peri-infarct complications, development of heart failure, and short as well as long-term mortality after MI is known [18-25]. The prognostic effect of leukocytosis is explained, among others, by thrombolytic resistance associated with changes in microcirculation [26], hypercoagulability [27], cardiotoxicity induced by proinflammatory cytokines and the no-reflow phenomenon [28]. Leukocytosis in MI is associated with the inflammatory process initiated by tissue necrosis that leads to scarring. This suggests a direct correlation between the amount of leukocytosis with the size of myocardial necrosis, which has

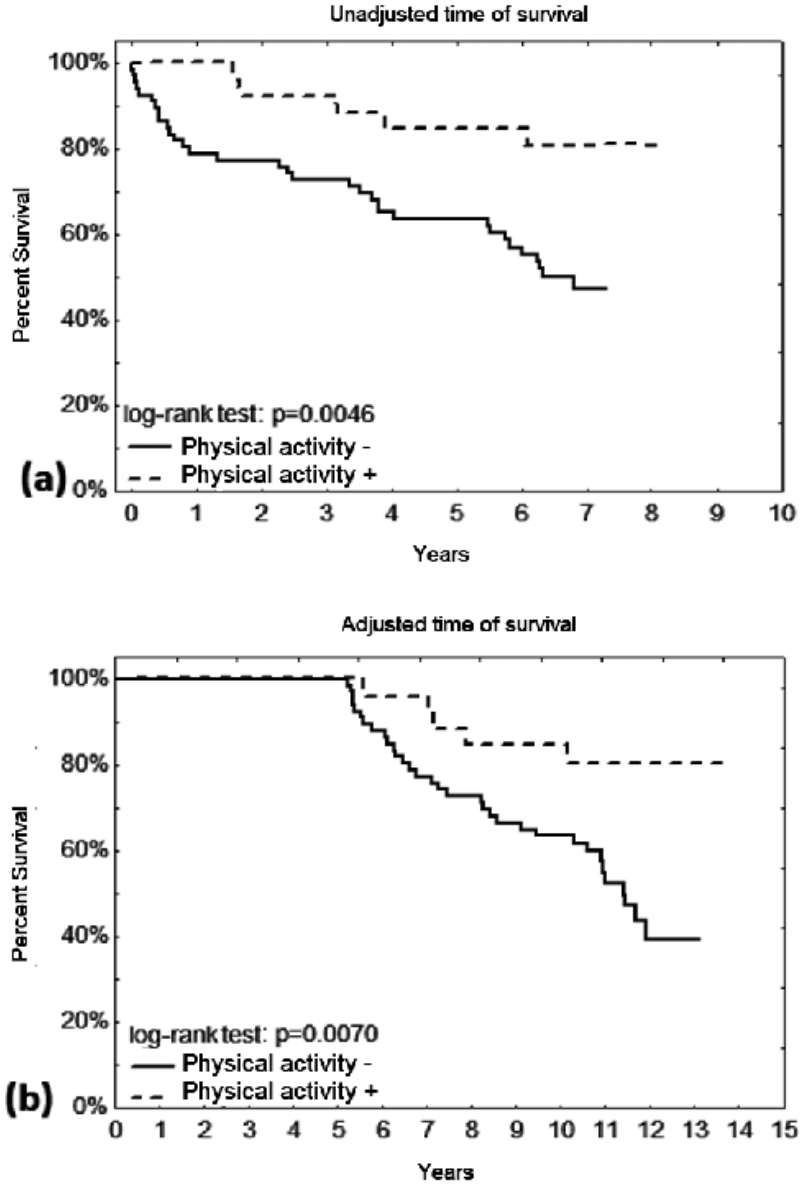


Fig. 3a, 3b. Impact of physical activity on patients' survival. Kaplan-Maier curves for unadjusted and age-adjusted survival time, respectively, compared with log-rank test.

been demonstrated in experimental studies [29-31].

Low HDL-cholesterol levels together with abdominal obesity, hypertriglyceridemia, high blood pressure and hyperglycemia indicate metabolic syndrome. MT Roe et al. demonstrated that patients with low and very low HDL-cholesterol levels were more often diagnosed with multivessel coronary artery disease, while coronary artery angiography revealed more often no changes in coronary arteries in patients with normal or high HDL-cholesterol levels [32]. In addition, he observed that patients with very low HDL-cholesterol levels (10-29 mg/dl) were more likely to have ACS at a young age. More often they were men with metabolic syndrome. Nevertheless, data on the protective effect of high HDL-cholesterol levels on atherosclerosis are still uncertain [33].

Patients treated with statins, with low LDL-cholesterol and low HDL-cholesterol, concomitantly, still have a higher risk of cardiovascular events despite optimal lipid-lowering therapy [34, 35]. According to current guidelines [36] the best results of increasing HDL-cholesterol concentration by up to 10% are achieved by lifestyle modification, that is weight reduction, adequate physical activity, smoking cessation, and reduction of alcohol consumption.

The peri-infarct hyperglycemia has been researched in numerous studies that revealed that it significantly worsens short- and long-term prognosis in patients with acute MI [41-44]. It did not matter whether these patients had previously been diagnosed with diabetes or not. It has been shown that the prognosis for patients with MI and hyperglycemia without a previous diagnosis of diabetes is similarly bad and even worse than the prognosis for patients with previously diagnosed diabetes [45]. The effect of the sympathetic system, pre-catecho-

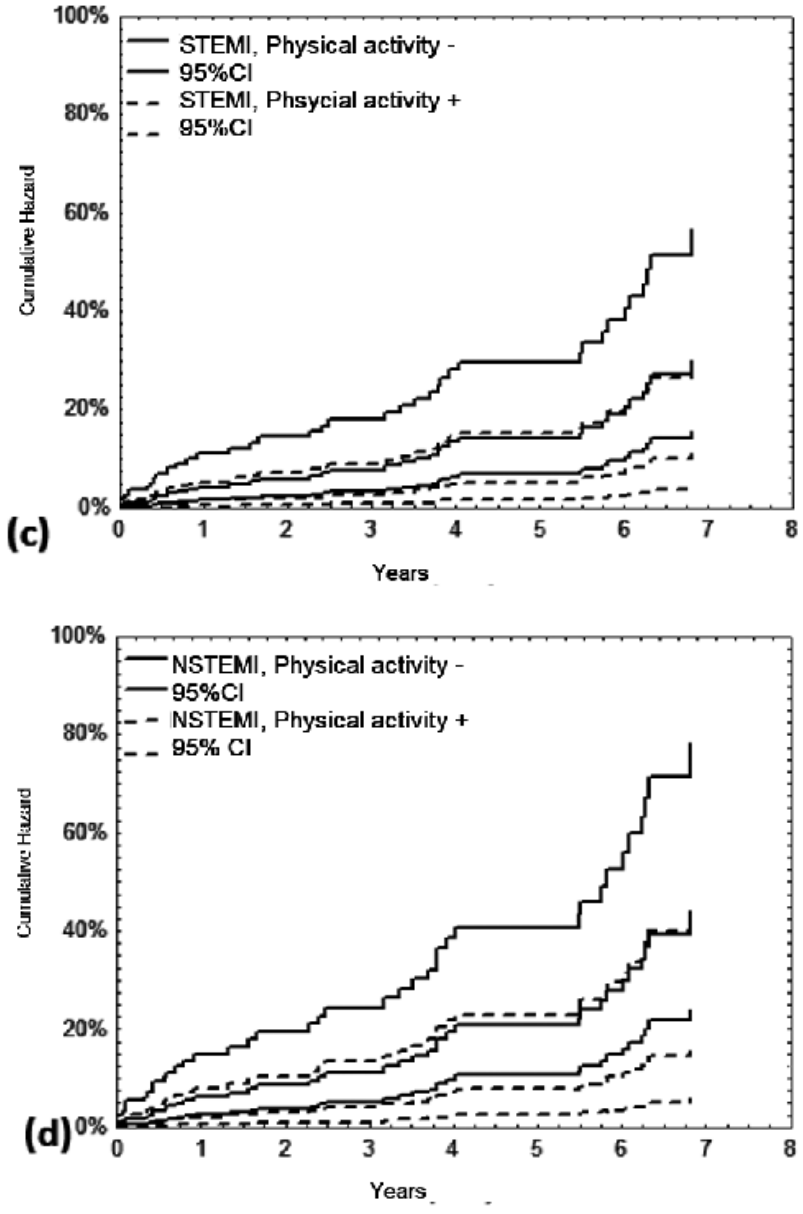


Fig. 3c, 3d. Impact of physical activity on patients' survival. Cumulative hazard regression curves for physical activity effect on STEMI and NSTEMI groups.

Table 3. The final model fitness summary – R-squared, Log-likelihood and Akaike information criterion.

	R2	-2Log L	AIC
MODEL SUMMARY	0.7945	263.02	277.02

lamine-lipolysis and myocardial energy imbalance is postulated as an explanation for the increased mortality and malignant arrhythmias due to hyperglycemia [46]. Timmer et al. [47] observed that hyperglycemia in the acute phase of MI is responsible for the increase of the incidence of impaired coronary blood flow prior to reperfusion treatment. Iwakura et al. [48] identified a strong correlation between the no-reflow phenomenon after angioplasty and hyperglycemia. Consistent with the results of the study by R. Sanjuan et al. [49], we have found that peri-infarction hyperglycemia is a strong factor predicting mortality in MI.

Numerous trials have investigated the prognostic value of AF in MI [50]. Meta-analyses found an increased risk of death in patients with AF and recent MI, especially if its onset was recent and had not been previously recognized [54-52]. AF worsens the short and longer term prognosis in MI, irrelevant whether it is a newly diagnosed peri-infarct arrhythmia or an arrhythmia that has long been established.

Physical activity of at least moderate intensity

has a documented effect on mortality reduction. Regular physical activity reduces the risk of developing obesity, type 2 diabetes, lipid disorders, and hypertension. The mechanisms underlying this impact are not fully understood. Changes in the fibrinolytic system, endothelial function and autonomic nervous system are postulated mechanisms. According to the results of the Jorge et al. [53] and the GREECS [54] studies, physical activity reduces the risk of recurrence of a cardiovascular incident.

LIMITATIONS AND STRENGTHS

Limitations of our study are: the single center, small number of patients and limited number of features considered in the model. However, on the other hand, reduction in the number of variables avoided complexity of the model and made it more easy to use.

Advantages of the study include its prospective nature and focus on clinical parameters that are routinely assessed in clinical practice and easily available. The model was developed in a real world sample with MI who were treated with contemporary, modern strategies. In contrast, the most widely recommended model, the TIMI risk score, was derived and validated among patients treated with a fibrinolytic strategy, which is rarely used today.

CONCLUSIONS

The clinical variables selected and included in our model (Age, SYNTAX, WBC, Glycemia on admission, HDL-cholesterol level, Atrial Fibrillation, and Physical activity) have a documented impact on the survival of patients after MI. The model we created is a valuable tool that is useful and easy to perform in everyday practice for assessing the five-year prognosis of patients after MI. Clinician's critical evaluation of patient's prognosis using different tools, optimized for short- and long-term survival, should be advised to provide optimal care of the MI patient.

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

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DOI: 10.36740/EmeMS202103108 **REVIEW ARTICLE**

THE ROLE OF PHYSICAL THERAPY IN THE INTENSIVE CARE UNIT

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Abstract

Recent years have seen intensive development of ICU treatment protocols. Today it is possible to treat patients who in the past would not have had a chance of survival. People under the care of the unit typically suffer from cardiovascular or respiratory failure. Therefore, the aim of this paper is to discuss the basic techniques used by physiotherapeutic staff and the contribution they make to the treatment of patients at the ICU. In our article, we analyzed the risks associated with long-term hospitalization and the characteristics of the ICU patient, and presented the ways in which a physical therapist can improve the patient's health. We have identified the main goals of ICU physical therapy and specified the intention with which specific physiotherapeutic procedures are introduced. The physical therapist should be part of a medical team whose goal is for the patient recover as quickly as possible. The role of the physical therapist in the ICU is not only to help the patient to improve in the shortest time possible, but also to prevent the undesirable effects of hypokinesia and long-term treatment in the ICU.

Key words

physiotherapy, critical care, ICU, early mobilization, respiratory therapy

INTRODUCTION

Intensive therapy is a new, modern field of medicine. Progress has made it possible to treat and save the lives of patients who previously would not have had a chance of survival. Nevertheless, the development of life-sustaining methods creates new problems that must be faced by staff in intensive care units (ICUs). ICUs treat patients who have suffered shock, ones who have undergone extensive surgery, as well as those with multi-organ injuries, severe sepsis, respiratory failure (a large number of such patients are victims of the current SARS COV-2 epidemic), and patients in the course of the exacerbation of chronic diseases. Due to the progress in the treatment of chronic diseases, the age of ICU patients is steadily increasing. Treatment in ICUs is a life-saving procedure, however, due to the nature and invasiveness of the methods necessary for effective therapeutic management, it generates a number of complications. It is not always possible to eliminate these completely, but it is necessary to make extensive efforts to maximally reduce their impact. The aim of treatment in the ICU is not only to save the patients' lives, but also to enable them to return to a general condition that would be as close as possible to that from before the disease. To reach this goal, it is necessary to both prevent and treat the physical and neuropsychological consequences of ICU stay which impede the return to normal functioning. Early rehabilitation has an impact on the duration of mechanical ventilation, on mortality and the length of stay at the ICU and in hospital.

THE AIM

The aim of the paper is to discuss the main techniques used by physiotherapeutic staff and the role they play in the treatment of patients.

REVIEW AND DISCUSSION

ICU PATIENTS ARE SPECIAL DUE TO THE EXTREME SEVERITY OF THEIR ILLNESS

The most common group of disorders treated in ICUs is the failure of two inextricably linked systems: the circulatory and respiratory ones. Therapy is often complicated by renal failure, which, if it cannot be controlled pharmacologically, requires the inclusion of renal replacement techniques [1, 2]. Severe conditions make it necessary to constantly monitor the patient with electronic medical equipment, which records not only the basic parameters, such as ECG, arterial pressure and arterial blood saturation, but also assesses advanced hemodynamic and respiratory parameters.

All such methods of treatment, combined with a severe and often critical condition of the patients, make it necessary for them to stay in bed for many days,

sometimes even months. This is facilitated by analgesics, sedatives and often skeletal muscle relaxants used in procedural sedation protocols. Most patients require oxygen therapy and breathing support. Mechanical ventilation by definition differs from normal physiological breathing, while its long-term operation is connected with a number of complications. Invasive forms of monitoring the patient's condition and the need to use numerous peripheral venous access catheters for the intravenous administration of drugs means that breaks in the skin increase the risk for infection. Moreover, enteral and parenteral nutrition with balanced formulas may not be sufficient to maintain the patient's normal energy requirement. With increased catabolism, there is progressive cachexia, loss of plasma proteins, gradual loss of muscle mass and a general waning of strength, which over time can be observed even with the naked eye. It should always be borne in mind that exercise and rehabilitation increase human metabolism and the need for oxygen.

Poor blood supply to the skin combined with the inability to independently change position in bed mean that patients are at risk of developing bedsores. The patient's age and comorbidities are independent risk factors for ICU complications. Sarcopenia is a particularly important risk element in geriatric patients.

When starting the treatment of severe sepsis, trauma or respiratory failure, prophylaxis and treatment of the immobilization effects resulting from ICU therapy should be implemented immediately, because only a comprehensive approach to therapy can lead to not only discharging patients from the ICU, but also make it possible for them to return to normal functioning outside the hospital and to live in society.

Physical therapy should be a permanent element of ICU treatment, which is by definition a multidisciplinary procedure, while the physical therapist should be an integral part of the treatment team.

It has been proven that early rehabilitation in ICUs is safe in patients connected to a ventilator or undergoing extracorporeal membrane oxygenation (ECMO), as well as those in the course of renal replacement therapy, ones with circulatory failure, as well as in patients with injuries and increased intracranial pressure [3].

The criteria for starting and stopping rehabilitation should be clearly defined. Physical activity, the type of exercises, their frequency and intensity should be adapted to the patient's clinical condition, as well as to the schedule and organization of work in the unit. A different kind of rehabilitation program should be implemented for a patient who can cooperate, while an unconscious or agitated patient requires a different approach.

Adverse events such as: extubation, removal of a feeding tube, removal of peripheral venous catheters, hemodynamic disturbances, desaturation, patient fall – can be prevented by careful monitoring and involving numerous staff in the rehabilitation process. Knowledge of the pathophysiology and mechanics of complications, good communication and a friendly atmosphere among members of the treatment team are also important. Appreciating the role of early mobilization and rehabilitation, as well as organizing an interdisciplinary team are key to successful therapy.

The aim of the paper is to identify the problems of physical therapy procedures in ICU patients and to indicate the most important aspects involved in such treatment.

WHAT ARE THE DANGERS THAT AN ICU PATIENT IS EXPOSED TO FROM THE POINT OF VIEW OF A PHYSICAL THERAPIST?

The tissue that is damaged first as a result of immobilization is the skin. It is a protective layer that separates the body from the external environment, protects the muscles and internal organs, and insulates physiological processes from the influence of the external environment. It forms both a mechanical and chemical barrier. Its role in thermoregulation and maintaining proper water and electrolyte balance is also important.

Factors leading to skin damage:

1. Disorders of peripheral circulation causing damage to the skin caused by deteriorated blood supply
2. Not changing body position or doing so too rarely, which leads to the formation of bedsores in places exposed to pressure (especially around the sacrum, the heels, the elbows and the occiput)
3. Soiling the skin with urine and feces (C), which causes its irritation [4]
4. The dressings necessary for protecting postoperative wounds and securing peripheral venous catheters, as well as glued ostomy bags – causing irritation and dermatoses known as MARSI – Medical Adhesive-Related Skin Injuries (5)

In severely ill patients, immobilized especially in the course of sepsis, there is a phenomenon of damage to the nervous and muscular systems, which consists of three syndromes:

1. septic encephalopathy,
2. critical illness polyneuropathy,
3. critical illness myopathy.

Theories have been put forward that all these pathologies may be caused by transient hypoxia resulting from microcirculation disorders and by the effects

of toxic metabolic byproducts, the level of which increases in a septic patient [6, 7]. It has been suggested that in the formation of these disorders a role is played by free radicals, glucose metabolism (hyperglycemia) and the adverse effects of the drugs being administered (corticosteroids, striated muscle relaxants). The level of analgosedation is also important. Mental and emotional disorders, psychomotor agitation, hostility and reluctance to accept treatment, as well as some emerging psychotic disorders, hallucinations and delusions are a serious problem at the ICU.

Disorders of consciousness and cognitive deficits usually begin to manifest themselves when trying to gradually awaken the patient [8]. Before that, if they occur, they are masked by the effects of sedatives. The suspicion of such a syndrome occurring often emerges only after a relative improvement in the patient's condition, when delayed recovery and other cognitive disorders cannot be explained by any tangible signs of damage to the central nervous system.

Delirium is diagnosed in 20% to 89% ICU patients [9, 10]. The main method of limiting this phenomenon is prevention [11] – achieved primarily by adequate sedation (administered so as to maintain effective analgesia), while maximally limiting the use of beznodiazepines. In addition to such basic activities as taking care of sleep hygiene in a conscious patient, it is important to ensure that patients can use their glasses, hearing aids, have an orientation in time and space, and are able to keep in touch with their families. Introducing early rehabilitation and implementing a comprehensive program in this field reduces the patients' emotional and psychological disturbances and helps them feel less disabled [12).

Early mobilization of the patient seems to be the most important factor of effective management [9]. It is defined as support in passive and active exercises of the patient and results in reducing the frequency and duration of delirium [13-16].

The importance of early mobilization of the patient in the prevention and treatment of delirium is evidenced by the fact that not only the interventions themselves, but also the time of day at which they are performed may affect the development of this complication, and indirectly the duration of ICU treatment. Early mobilization, regardless of the time when it is performed, is safe and does not cause serious complications in therapy [17].

It is defined as support in passive and active motion exercises of the patient and results in reducing the frequency and duration of delirium [13-16].

Critical illness polyneuropathy is a syndrome of diffuse damage to both sensory and motor fibers. This condition results in a decrease of muscle strength, which hinders convalescence, but also – if it involves the respiratory muscles, it slows down the return to full respiratory efficiency. Sensory disturbances occur as a result of damage to sensory neurons. Polyneuropathy, especially in combination with inadequate analgesia, may lead to the development of hyperalgesia and the emergence of chronic pain syndromes that are difficult to treat.

Critical illness myopathy is a generalized muscle weakness that occurs in many forms, ranging from mild paresis to severe quadriplegia involving respiratory muscles.

Due to their numerous comorbidities and severe general condition, ICU patients run an increased risk of both venous thromboembolic and hemorrhagic complications [18]. Regardless of pharmacotherapy, these can be limited by preventing the patients' immobility through early rehabilitation and attempts to position them upright [19].

Respiratory failure affects the vast majority of ICU patients. Mechanical respiratory support has many negative consequences. The need to create and maintain the so-called intraglottic or subglottic artificial airways for some time – leads to the elimination of natural barriers hindering the translocation of pathogens to the respiratory tract [20]. In addition, bacterial translocation is also easier due to the lack of an efficient cough reflex. The evacuation of secretions from the respiratory tract is impaired both by treatment (maintaining an adequate level of sedation) and by the weakening of the respiratory muscles, including the diaphragm. Mechanical ventilation contributes to the flaccidity of the respiratory muscles. The resulting increased pressure in the airways damages the alveoli. The latter are also impaired by ventilation with high oxygen concentrations. The artificial respiratory tract, mechanical ventilation and the accompanying deep sedation (especially with the addition of muscle relaxants) lead to the retention of secretions in the airways, secondary infection and the development of VAP (Ventilator Associated Pneumonia), which on average occurs after 48-72 hours of ventilator therapy and is a serious complication [21-23].

The aims of respiratory therapy at the ICU:

1. To limit the outbreaks of atelectasis, to improve the evacuation of secretions
2. To maintain the volume and recruitment of alveoli
3. To improve the compliance efficiency of mechanical ventilation
4. To strengthen the respiratory muscles
5. To facilitate disconnection from the ventilator.

6. To limit complications related to the patient's stay in the ICU.

Appropriately carried out, systematic physical therapy throughout the patient's stay in the ICU has a significant impact on achieving such goals. It is an element of the overall multidisciplinary treatment [24-26].

THE MAIN GOALS OF PHYSICAL THERAPY IN THE PREVENTION OF COMPLICATIONS AND THE TREATMENT OF ICU PATIENTS

In many clinical situations and in the course of numerous diseases, the rehabilitation procedure is started during the convalescence period, after the end of the main treatment. In the case of critical states, rehabilitation activities begin simultaneously with other kinds of therapy [27].

Exercise and treatment initiated in the early stage of treatment at the ICU are aimed at counteracting muscle weakness and atrophy of the motor system, improving respiratory efficiency and peripheral circulation. A whole range of measures referred to as anti-edema and anti-bedsore prophylaxis is involved. The upright positioning of the patient is to help restore the natural mechanisms of maintaining arterial blood pressure, and thus its flow to the organs, and to prevent thromboembolic complications.

If patients are in a serious condition, passive exercises are administered, provided there are no obvious contraindications. These can be performed when the patients' muscular strength or consciousness does not make it possible for them to move a given joint actively or in conditions of complete muscle denervation, e.g. after a spinal cord injury or peripheral nerve damage. Passive exercises can be performed even without the conscious participation of the patients – if they are unconscious or deeply sedated. These exercises help maintain the length, flexibility and contractility of muscles, preserve the state of the ligaments and the correct range of motion in the joints. They maintain proprioception and exteroception and stimulate the metabolism in tissues. During passive exercises, the so-called muscle pump is activated – exerting variable pressure on venous blood vessels and lymphatic vessels forcing blood towards the heart, reducing venous and lymphatic stagnation and thus also preventing the risk of edema and blood clots. Changes in body position in conjunction with passive exercises reduce the formation of bedsores and counteract trophic skin disorders.

One of the oldest forms of physical therapy is massage. It restores normal muscle tone by reflex, promotes the improvement of tissue nutrition by improving the arterial blood supply and facilitates the outflow of venous blood and lymph [28]. There are different types of massage, including segmental, tensegrity, lymphatic, deep tissue massage, point massage and connective tissue massage. Each of them can be used by a physical therapist depending on the indications.

Similar effects are achieved by the therapy of myofascial trigger points, in which various forms of pressure are used on selected places in the muscle tissue and the fascia [29].

Changing the patient's body position during ICU therapy has recently taken on a new dimension. In cases of severe respiratory failure in the course of COVID-19 infections, patients have often been positioned and ventilated in the prone position (in addition to gas exchange in the lungs being simultaneously supported in other ways) [30-31].

The concept of ventilation in the so-called "prone position" is not new; it has long been used in the severe form of ARDS (Acute respiratory distress syndrome) [32, 33] and has been shown to improve the mechanics of ventilation and hemoglobin oxygenation. The COVID-19 pandemic with severe courses of hypoxemic respiratory failure led to an increase in the number of patients undergoing treatment in this way [34-37].

Respiratory failure is one of the most common reasons for hospitalization in the ICU. Tracheal intubation, initiation of ventilator therapy, and subsequent ventilation with high oxygen pressures and concentrations help save the patients' lives, but also carry the risk of the complications described above. Properly conducted physical therapy, i.e. the so-called respiratory physical therapy, or "chest physical therapy" designed to treat and limit respiratory system dysfunctions, enhances the results of treating respiratory failure.

The exercises and breathwork done with the patient consist of:

1. Learning how to do deep breathing and using motivational spirometry
2. Training the respiratory muscles
3. Changing body position
4. Hyperinflation
5. Mechanical discharge of secretions.

It is difficult for the patient who has been intubated and thus deprived of the possibility to cough to evacuate secretions from the respiratory tract. Secretions not only block the airways, but also provide an environment for microbial growth, generating the development of infection. Suction of secretions

is one of the elements of respiratory tract hygiene, however, it is not very efficient from the clinical point of view, because only the main bronchi can be cleaned mechanically. Airway cleaning using a suction catheter causes damage to the epithelium of the airways and, in many cases, to bleeding.

Besides suction, so-called postural drainage (PD) is used. It is based on placing the patient in a position that promotes the natural outflow of secretions. The region of the respiratory tract that has been affected should be above the hilum of the lung, which allows the secretion to flow freely from the small bronchi to the large ones and further to the trachea by means of making use of gravity.

In many diseases, the patient's tolerance to changes in body position may be very limited, which makes it difficult to use this method. The evacuation of secretions can be stimulated by tapping, vibration techniques using a device generating vibrations and the technique of the so-called rib springing.

Rib springing is a segmental massage technique. It is used to relieve tension in the respiratory muscles (the diaphragm, as well as intercostal, thoracic, subcostal and transverse thoracic muscles), improve the elasticity of the chest and the blood supply and the flexibility of the lungs. It involves compressing the lower ribs during exhalation and a sudden release of pressure when inhalation begins. Management should be correlated with inhalation and the evacuation of secretions. Patients requiring special care during enrolment are those with fractured ribs and spine, with pneumothorax, with numerous emphysema, after head injury and after burns.

The above prophylactic measures are used to keep patients in a condition that allows them to be mobilized and upright at the early stages of the recovery phase [38].

The following early-start program has been developed. It consists of 5 steps. Good tolerance of the treatments carried out makes it possible to go on to the next stage:

1. Breathwork – passive exercises and changes in body position
2. Raising the headrest and putting the patient in the inverted Trendelenburg position. This is an element of hemodynamic preparation
3. Supported sitting position in bed
4. Initial seated position – the patient sits down in the so-called "full chair position" with feet on the floor
5. Getting up and walking.

When following this program, attempts should be made to position the patients upright as early as possible. First the head of the bed is gradually lifted, until the angle approaches 90 degrees. If there are no alarming symptoms, especially in the form of a deterioration of hemodynamic parameters (tachycardia, bradycardia, arrhythmias, increase or decrease in blood pressure, increased sweating, reporting chest pain or discomfort), then patients can sit with their feet down.

At the ICU, such procedures require the involvement of numerous staff and many resources. Nevertheless, if there are no absolute contraindications, they should be performed routinely. The tubing that connects the patient to the ventilator, the wiring used for monitoring, multiple punctures, and the infusion lines leading to them – make these maneuvers much more difficult. It is important to carefully consider modifications of analgesia and sedation to reduce the patients feeling discomfort and pain resulting from repositioning.

Early work on changing the position of the patient is intended to maintain or restore the patient's muscle tone and strength to the extent that it is possible to maintain an upright body position. This applies primarily to the deep muscles of the torso, the role of which is to maintain and control body posture both at rest and in motion [31]. These muscles are quickly weakened and atrophied in patients who stay in the supine position for a long time, especially in the course of severe and debilitating diseases. The restoration of core stability mechanisms makes it possible for patients not only to effectively stand upright, but also lays the groundwork for the further steps, so they can go on to the subsequent activation points and return to full fitness after discharge from the ICU [39, 40].

Rehabilitation treatment of seriously ill patients is not limited to ICU procedures. It is important to carry out structured activities to make it possible for people to return to everyday functioning at home. Long-term ICU treatment results in the development of physical and emotional disabilities leading to acquiring PICS (Post Intensive Care Syndrome), which is characterized by the development or exacerbation of physical impairment, mental disorders, and cognitive and social impairment. According to the latest research, over half of the patients discharged from ICU suffer from this syndrome [41].

The goals of physical therapy for this group of patients were defined as follows: improving the patient's quality of life, reducing pain, improving functional efficiency, enhancing everyday functioning (improving muscle strength and efficiency, including respiratory muscles) [42].

CONCLUSIONS

Rehabilitation procedures, as well as the earliest mobilization of patients, are no less important than other therapeutic measures in terms of optimal functioning after discharge from the ICU and from the hospital.

Working with a critically ill patient requires the involvement of a significant number of medical personnel. A single physiotherapist, even one who works for the ICU on a regular basis, is a highly insufficient situation. Comprehensive rehabilitation procedures require planning, assessment of the patient's vital signs, consultation with a doctor, and then the implementation of the subsequent steps described above – starting from passive exercises and changing body position, then maintaining the patient's sitting position, and then gradually progressing to upright standing and starting to walk. Such treatments require the cooperation and commitment of the entire ICU team. The serious condition of the patient is not a contraindication to rehabilitation procedures. If the patient meets certain criteria, mainly in terms of circulatory and respiratory parameters, an early initiation program can and must be started.

Emphasis should be placed on maintaining the continuity of rehabilitation in patients who finished treatment at the ICU. This applies not only to those who are still hospitalized, but also to people who have been discharged and are at home.

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CONFLICT OF INTEREST

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PNEUMONIA IN THE COVID-19 ERA – EMERGENCY ROOM PHYSICIAN'S PERSPECTIVE. PART II – DIAGNOSIS AND THERAPY

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Abstract

In case of suspected pneumonia, as part of the work of the physician at the Emergency Department, imaging examinations and laboratory testing, including microbiological tests, can be used to confirm diagnosis. However, all diagnostic options have their limitations. Clinical and laboratory signs are nonspecific in most patients and are frequently present in other severe conditions. Biomarkers, have more value in ruling out particular etiology of infection than in establishing a definitive diagnosis. Similarly, errors in radiological interpretation occur relatively frequently. However, despite these limitations it is important that patients at high risk of severe course of disease and death receive appropriate diagnostic and therapeutic support from the suspicion of infection. The assessing of pneumonia severity is critical to make decisions regarding patient management, in particular, it is needed to decide on: site-of-care, scope of tests needed, urgency of the therapy, type of therapy.

Viruses are an important cause of pneumonia and require early recognition. As a result of the global SARS-CoV-2 pandemic, patients with clinical symptoms suggestive of pneumonia are treated with the highest attention. According to instructions by the Polish Ministry of Health, the principles of triage and separation should be adapted taking into account a suspicion of Covid-19. It is important to test patients for the presence of the virus. The indications for testing as well as virological methods vary from the beginning of the pandemic, depending on the epidemiological situation. The current pandemic makes it even more difficult to manage patients with pneumonia.

Key words

antibiotics,
community acquired pneumonia,
Covid-19,
emergency department

INTRODUCTION

According to current guidelines of the Infectious Diseases Society of America (IDSA) and the American Thoracic Society (ATS), the indication for community-acquired pneumonia (CAP) management on an outpatient basis or at the ward, including the intensive care unit, is based on the observation of clinical symptoms and analytical and microbiological test results.

It is important that patients at high risk of severe course of disease and death receive appropriate diagnostic and therapeutic support from the suspicion of infection at the Emergency Department (ED) until the end of antimicrobial therapy and radiological follow-up. The possibility of continuing therapy outside the hospital reduces the exposure to stress, healthcare associated bacterial infections (hospital-acquired infections), which often involve multidrug-resistant bacteria, and exposure to viruses [1, 2].

In clinical practice, health assessment scales are used to support therapeutic decisions for identifying patients at high risk of death. The best known and validated indices in immunocompetent adults include: the CURB-65 severity score (Table 1) and Pneumonia Severity Index; PSI (Table 2). Those scales enable the assessment of pneumonia severity and risk for death. They are helpful when assessing patient's eligibility for hospital treatment. They have good predictive results in the initial stratification of patients with CAP [1, 3-6].

When access to laboratory tests is limited, the decision regarding the type and site of care can be made on the basis of the shortened CURB-65 scale (without the determination of urea) [1, 5]. PSI exhibits higher predictive power with regard to death during the next 30 days. The mentioned indices are not used for assessing the need for intensive care unit (ICU) admission. In this case, hypotension requiring vasopressors or respiratory failure requiring mechanical ventilation is a significant criterion (strong recommendation, low quality of evidence). For patients not requiring vasopressors and respiratory support, the use of IDSA/ATS 2007 minor severity criteria and clinical picture is recommended (conditional recommendation, low quality of evidence). Minor and major criteria are listed in the Table 3. It has been shown that mortality among patients with severe CAP who

Table 1. The CURB-65 Severity Score [adopted from Sirvent JM et al.; 2013].

Clinical feature	Points
Confusion	1
Urea > 7 mmol/L	1
Respiratory rate ≥ 30	1
Systolic blood pressure ≤ 90 mmHg or diastolic blood pressure ≤ 60 mmHg	1
Age over 65 years	1
CURB-65 score	**Points**
Low risk (outpatient treatment)	0–1
Moderate and high risk	≥ 2

Table 2. Pneumonia severity index [adopted from Sirvent JM et al.; 2013].

Factor		Score
patient age	male	Age
	female	-10
long-term care facility resident		+10
Accompanying disease		
neoplastic disease		+30
liver disease		+20
congestive heart failure		+10
cerebrovascular disease		+10
chronic kidney disease		+10
Symptoms at diagnosis		
acute psychosis		+20
breathing rate ≥ 30/min		+20
systolic pressure < 90 mmHg		+15
body temperature < 35°C or ≥ 40°C		+15
heart rate ≥ 125/min		+10
Laboratory measurements		
arterial blood pH < 7.73		+30
blood urea nitrogen ≥ 30 mg/dL		+20
serum sodium < 130 mEq/L		+20
serum glucose > 250 mg/dL		+10
hemoglobin < 9 mg/dL		+10
partial pressure of oxygen < 60 mmHg		+10
pleural effusion		+10

PSI group	PSI score	Risk
I	age < 50, none from comorbidities, physical and laboratory findings	low risk
II	≤70	
III	71–90	
IV	91–130	high risk
V	>130	

Table 3. Prediction of hospital mortality by the individual IDSA/ATS minor criteria [adopted from Sirvent JM et al.;2013 and Phua J et ala.; 2009].

Validated definition includes either one major criterion or three or more minor criteria
Minor criteria
respiratory rate ≥ 30 breaths/min
PaO_2/FiO_2 ratio ≤ 250
multilobar infiltrates
confusion/disorientation
uremia (blood urea nitrogen level ≥ 20 mg/dL)
leukopenia (white blood cell count < 4,000 cells/μL)
thrombocytopenia (platelet count < 100,000/μL)
hypothermia (core temperature < 36°C)
hypotension requiring aggressive fluid resuscitation
Major criteria
septic shock with need for vasopressors
respiratory failure requiring mechanical ventilation

are transferred to ICU after admission to the hospital ward is greater as compared to those admitted directly to the ICU from the ED. This higher morbidity may be partly associated with the progression of inflammation, but also with insufficient care and inaccurate diagnosis of severe disease [2, 7].

In one single-center retrospective study, including 681 laboratory-confirmed patients with Covid-19,

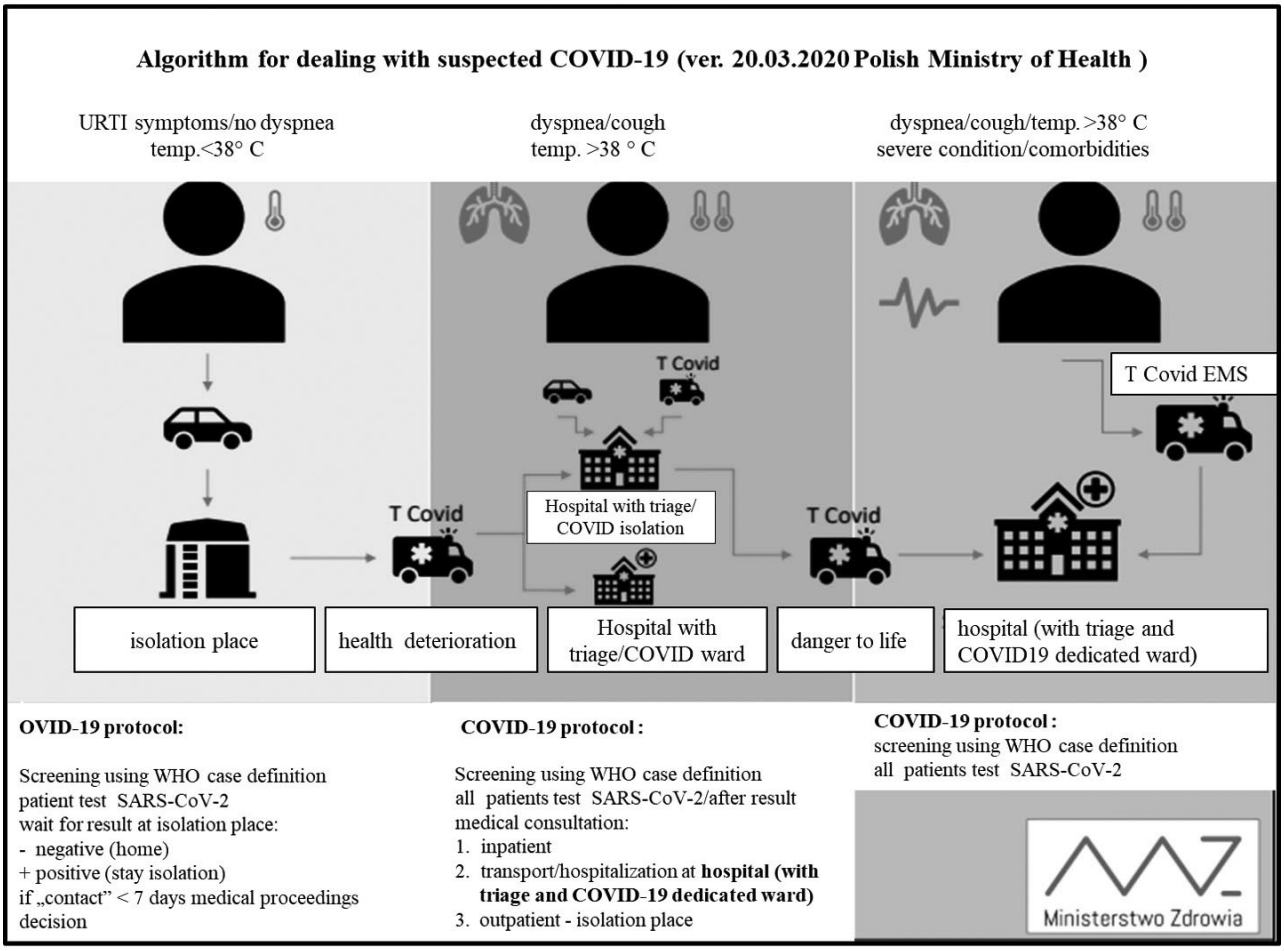

Fig 1. Algorithm for dealing with suspected COVID-19 (ver. 20.03.2020 Polish Ministry of Health) [adopted from Algorytm postępowania w sytuacji podejrzenia Covid-19 wersja 20.03.2020 r. Ministerstwo Zdrowia (online) 2020].

showed that PSI is a powerful tool for predicting mortality in patients with Covid-19 and performed significantly better than CURB-65. The authors concluded that during the outbreak, PSI can help physicians to stratify patients on admission [8].

THE AIM

The proper diagnosis and treatment of pneumonia in a patient in the ED remains a challenge to a clinician. The aim of this study are:

1. to review of diagnostic methods for the diagnosis of pneumonia with an indication of their limitations and cost efficiency,
2. characteristics of pneumonia severity scores, and their utility in the treatment planning.

REVIEW AND DISCUSSION

TRIAGE

The requirement of patient assessment upon registration at the ED (triage), which is applicable from 2019, is not used in making treatment decisions and assessing the risk of death in pneumonia patients, but it enables to determine the urgency of healthcare services. Initial patient assessment includes:

1. measurements of body temperature, blood pressure, pulse, saturation, respiratory rate, glycemia, body weight,
2. assessment of consciousness level using the Glasgow or Alert Verbal Painful Unresponsiveness (AVPU) scale,
3. assessment of pain severity,
4. performing an electrocardiogram (ECG) [2, 9, 10].

In addition, in the current epidemiological situation related to the identification of SARS-CoV-2 local transmission in Poland, according to instructions by the Ministry of Health, the principles of triage and separation should be adapted taking into account a suspicion of Covid-19. This approach is aimed at prompt identification of a potential Covid-19 case and limiting the risk of infecting other patients and staff (Fig. 1.)[11].

DIAGNOSIS OF PNEUMONIA

There are four areas of diagnostic activities that are important in diagnosing pneumonia, which include:

1. establishing the presence of symptoms of lower respiratory tract infection in the patient,

2. establishing the presence of radiological lesions on the imaging examination (CT or X-ray),
3. identifying presumptive pathogen in a sample collected from the patient (from the upper respiratory tract, blood),
4. monitoring the clinical course corresponding to pneumonia and treatment response [1, 12].

As part of the work of the physician at the ED, clinical and radiological diagnosis is feasible, laboratory tests assessing respiratory function and inflammatory markers can be ordered, and samples for microbiological testing can be collected. Turnaround time for the microbiological test identifying a microorganism and antimicrobial susceptibility test is several days; therefore, information from the microbiology lab is not available to the ED physician in many cases. Similarly, monitoring of the clinical course and treatment response is only possible during hospitalization at the ward.

CLINICAL DIAGNOSIS

In general, clinical diagnosis of pneumonia does not present any problem, if the symptoms are classic. Criteria for defining CAP include signs and symptoms which are indicative of acute lower respiratory tract infection and opacities on chest X-ray that are not related to non-infectious causes (e.g. pulmonary edema, pulmonary infarction).

Typical clinical picture of severe CAP which is presented in academic books comprises the following symptoms: fever (≥38°C), chills, sweats, chest pain, cough (sometimes with expectoration of purulent sputum), and dyspnea with increased respiratory rate. Physical examination shows local dull percussion note, fine crackles, increased vocal fremitus over the area of inflammatory infiltrate (absent over areas of pleural effusion), and sometimes bronchial breath sound [1, 9, 13, 14].

Non-infectious diseases which may be suggestive of CAP or co-exist and manifest in pulmonary infiltrate and cough include: congestive heart failure with pulmonary edema, pulmonary embolism, pulmonary hemorrhage, atelectasis, aspiration or chemical pneumonia, drug-induced lung lesions, lung cancer, vasculitis, acute bronchiectasis, interstitial lung diseases (e.g. sarcoidosis, asbestosis, hyperreactive pneumonia, cryptogenic organizing pneumonia), endocarditis and acute respiratory distress syndrome [1, 12, 15].

CAP can vary in intensity, from mild inflammation to severe form with sepsis and respiratory failure. The intensity of symptoms is directly related to the intensity of local and systemic immune response. Cough is a frequent symptom; however, as an isolated symptom, it has a low predictive value in diagnosing pneumonia. Pulse oximetry is recommended in patients with dyspnea/difficulty breathing revealed as part of the triage procedure, since hypoxia is an important diagnostic sign with therapeutic implications. The assessment of blood oxygenation is necessary for determining respiratory failure [9]. Diagnostic difficulties are encountered in particular in the elderly who often present with pneumonia symptoms at the ED. Advanced age increases the risk of pneumonia because of impaired defense mechanisms and comorbidities, and in consequence, they often present at ED. The disease starts with high fever only in 33–60% of elderly patients. Own experiences and literature indicate that typical signs in the elderly individuals may include: sudden change in activity levels (fatigue), falls, weakness, decreased appetite, urinary incontinence, confusion, tachypnea and tachycardia [1, 12, 16, 17]. Currently, there are no international guidelines for the management of critically ill patients aged over 80 years with CAP to support physicians in decision-making [12].

Diagnostic accuracy of pneumonia on the basis of clinical symptoms and signs is insufficient. The clinical diagnosis of CAP is radiologically-confirmed only in 49–57% of patients. Putting it the other way round, up to 25% of patients with CAP diagnosed at the ED are ultimately discharged with another diagnosis [1].

As a result of the global SARS-CoV-2 pandemic, patients with clinical symptoms suggestive of pneumonia are treated with the highest attention. It has been found in observational studies on patients with mild or moderate Covid-19 disease which occurs in about 80% of patients infected with SARS-CoV-2, that the most common symptoms of infection include headache (70.3%), loss of smell (70.2%), nasal obstruction (67.8%), cough (63.2%), asthenia (63.3%), myalgia (62.5%), rhinorrhea (60.1%), gustatory dysfunction (54.2%), and sore throat (52.9%). Fever was reported by 45.4%. In addition, diarrhea, nausea and vomiting develop in more severe presentations [18, 19]. The listed symptoms are non-specific and they may be present in pneumonia of different etiology [16].

IMAGING EXAMINATION

Pneumonia suspected at the ED can be confirmed by chest imaging. Papers published before 2020 often presented a stance that many of those examinations were unnecessary. Unambiguous indications for chest X-ray at the ED were lacking. The decision was left to a clinician with a comment that X-ray order may be postponed until absolute indications (e.g. immunosuppression, tuberculosis, or antibiotic therapy

failure) emerge [9, 13, 20]. Imaging examination may suggest etiology of infection to some extent [4]. Solid inflammatory infiltrate involving the segment with an air bronchogram in a portion of cases occurs in pneumococcal pneumonia. Multifocal lesions with a tendency for lysis and formation of multiple abscesses and thin-walled cysts which may be accompanied by spontaneous pneumothorax is suggestive of the staphylococci. Lesions in the upper lobes, mostly in the right one, with necrosis may be present in infection caused by *Klebsiella pneumoniae*. Tuberculosis infiltrate is usually seen in the upper lobes (apical and posterior segments); however, it may have atypical location in the lower lobes in about 30% [10, 14, 21].

Computed tomography (CT) shows greater sensitivity in recognizing parenchymal opacity in the lung tissue. It is used in the case of diagnostic difficulties and for differentiation from conditions with the course of disease similar to pneumonia, e.g. pulmonary embolism [9]. At present, during the SARS-CoV-2 pandemic, chest computed tomography has gained in importance. Lesions in both lungs are present in the majority of patients with COVID-19 pneumonia. The most frequent CT findings are bilateral patchy shadows and ground-glass opacities (areas of hazy opacity) and consolidations of the lungs (fluid or solid material in compressible lung tissue), multilobe involvement and focal lesions (patches, stripes, or nodules) are very characteristic as well.

CT shows that lesions are more patchy than oval and are more likely to be localized in the periphery than in the center of the lungs [22-25]. Ground-glass lesions may also be seen in CMV infection, mycoplasmal pneumonia and pneumonia caused by *Pneumocystis jiroveci* [21, 25-27]. The lung image on CT in patients with Covid-19 is currently analyzed by many researchers. Reports appeared that pathological lung lesions were not found during the first 2 days of disease in 56% of patients [23]. They could be seen only approximately at day 10 from the onset of symptoms [24]. Subsequent reports indicated that ground-glass lesions are most prominent after 0-4 days from the onset of symptoms, and as disease progresses, crazy-paving patterns (i.e. irregular-shaped paved stone pattern) develop additionally, followed by increasing consolidation of the lungs [23, 24]. Researchers point out that CT scan offers higher sensitivity (86-98%) and better false negative rate as compared to a molecular RT-PCR test. However, as mentioned before, it has low specificity, because lesions in Covid-19 overlap with lesions in patients with pneumonia of different etiology. Alternative diagnoses should be considered in patients with initial diagnosis of pneumonia, in whom pulmonary infiltrates resolve quickly. Pulmonary infiltrates are primarily caused by the accumulation of leukocytes in the alveolar space and usually persist for several weeks. Pulmonary infiltrate that resolves within one day may be caused by fluid accumulation in the alveoli (pulmonary edema) or collapse of alveoli (atelectasis) [25].

LABORATORY DIAGNOSIS OF PNEUMONIA

Complete blood count and blood chemistry results confirm the presence of inflammation. The most important inflammatory markers, which can be determined at the ED in short time, include: C-reactive protein (CRP), procalcitonin (PCT) and leukocyte (WBC) levels. High WBC levels with predominance of neutrophils are suggestive of bacterial infection (>15,000/mm^3). However, the level of WBC depends on the phase of infection, therefore, neither its sensitivity, nor its specificity is sufficient to allow decision about the strategy for antimicrobial therapy at the ED. The level of lactate dehydrogenase can be used as a marker of pneumocystis pneumonia (*P. jiroveci*). High CRP levels are typical of bacterial infections (e.g. pneumococcal pneumonia), while lower levels (<20 mg/L) occur in viral infections and those caused by e.g. mycoplasmas [1, 4]. The level of PCT undergoes more dynamic changes in bacterial infection – it shows a rapid increase within 6 to 12 hours, and then a sudden drop, when bacterial infection is controlled by the host immune system and antimicrobial therapy. The level of PCT is decreased in patients with viral infection because of the release of interferon-γ, and in view of its higher sensitivity it can be helpful in making decisions about the implementation or discontinuation of antibiotic therapy [1, 5]. The PCT level within the range 0.1-0.25 μg/L indicates that the likelihood of bacterial infection is low to very low; therefore, the antibiotic therapy is not recommended. However, it is recommended that repeat PCT determination at 6-12 hours and revision of the decision to administer an antibiotic on this basis should be considered. The level within the range 0.25->0.5μg/L indicates that the likelihood of bacterial infection is high to very high. The implementation of antibiotic therapy and PCT level monitoring during subsequent days are recommended. Persistent high levels point to treatment inefficacy and their decrease by 80-90% may be an indication for discontinuation of antibiotic therapy [4, 5, 14].

Data published in 35 observational research papers enable to conclude that elevated CRP levels above the reference value occurred in 57.40% (1,494/2,603) of Covid-19 patients, and elevated PCT levels were

found in 12.20% of patients. In addition, statistically higher levels of those biomarkers were seen in severe versus non-severe patients; CRP (3.04-fold; 61 *vs*. 20 mg/L), PCT (2.00-fold; 0.15 *vs*. 0.07 ng/mL). Leukopenia developed in 21.92% (363/1,656) of patients, and lymphocytopenia in 29.02% (886/3,053) [28].

According to the current guidelines, analysis of literature and own experiences, the collection of samples for microbiological testing (bacteriology, mycology, and virology tests, except tests for SARS-CoV-2) in individuals with suspected pneumonia at the ED is not mandatory. Current indications for microbiological testing were developed by IDSA and ATS in 2019. Since the guidelines were developed before global SARS-CoV-2 spread, they don't take into account microbiological diagnostics allowing the identification of patients infected with new coronavirus. The IDSA/ATS recommendations for microbiological testing in adults with suspected CAP without any innate and acquired immunity impairment are as follows:

1. routine microbiological testing of sputum (i.e. bacterioscopy or microbiological culture) is not recommended in outpatients,
2. lower respiratory tract samples for microbiological testing should be collected from in-patients:
   a. with severe pneumonia before antimicrobial therapy is started, who were treated for methicillin resistant *Staphylococcus aureus* (MRSA) or *Pseudomonas aeruginosa* infection,
   b. treated previously for MRSA or *P. aeruginosa* infection, mostly due to respiratory tract infection,
   c. who were hospitalized or treated with parenteral antibiotics within the past 90 days.

A stance on the microbiological testing of blood sample is similar. Although the strength of those recommendations is stated as strong or conditional, the quality of evidence is very low in each case. Thus, there are no high quality evidence indicating that routine microbiologic diagnostic tests significantly impact the quality of care and course of infection in those patients. As far as blood sample testing is concerned, a stance has been adopted that no reliable studies have been carried out so far to compare the results of treatment in groups of patients with and without microbiological blood testing at admission. It has also been noted that the efficacy of cultures in patients with mild or moderate CAP is low, from 2% (for outpatient therapy) to 9% (for in-patients). Moreover, the test result rarely changes empirical therapy. However, experts draw attention to the fact that any delay in detecting rare pathogens in the case of severe CAP may have disastrous consequences. Therefore, the potential benefit from microbiological examination of a blood sample is significantly larger when turnaround time is 24 to 48 hours The rationale for the recommendation for blood cultures in the case of suspected or previous MRSA and *P. aeruginosa* infection is the same as for sputum [20].

Indications for blood sample testing when severe CAP is suspected include: admission to an intensive care unit, cavitary infiltrates, leukopenia, alcoholism, chronic liver failure, asplenia (anatomical or functional), positive result of pneumococcal urinary antigen test, and pleural effusion [6]. The test can be done in the case of travel-related suspected infection (endemic pathogen) or ineffective outpatient treatment [29].

Sputum is material of limited diagnostic value due to difficulty in obtaining the valuable sample (preanalytical errors; contamination and physiological microbiota). The efficacy of sputum as diagnostic material varies depending on microorganism species, and is significantly lower after antibiotic therapy is started [1, 20]. Anyway, microbiological testing has many supporters. The identification of microorganism responsible for CAP with antimicrobial susceptibility assessment enables to narrow the spectrum of antibacterial therapy (de-escalation) or change empirical therapy on the basis of antibiogram. Moreover, laboratory test results allow for the monitoring of epidemiological situation which is the basis for the development of empirical antimicrobial therapy algorithm. To balance the fact of lacking evidence to support routine sputum testing and efficient antibiotic therapy, a decision about whether to order or not sputum microbiological testing is left to clinicians by experts. Such decision can be made on the basis of clinical symptoms, local epidemiological data and antibiotic policy [18].

Classic techniques used in clinical laboratories enable to culture bacteria and fungi and test antimicrobial and antifungal susceptibility; they are expensive, time-consuming and may generate false negative results (susceptibility of microorganisms to *in vitro* conditions). Molecular techniques are not widely available. In general, they are used in laboratories with higher reference. They are very sensitive, and that is why they can bring false-positive results and do not allow the differentiation of infection from colonization.

Rapid point-of-care tests (POCs) are also available (e.g. diagnosis of influenza, infection with RSV, adenovirus and detection of pneumococcal and legionella

antigen in the urine), which may take 15 to 60 minutes to obtain a result. They can detect or only exclude a specific pathogen in the patient with CAP symptoms [1, 20, 30]. Therefore, microbiological test results should be interpreted taking into account the patient's condition, radiological examination and results of other laboratory tests. Experts suggest that pneumococcal urinary antigen tests should not be done on a routine basis in adults with CAP (except for those with severe CAP), and urinary antigen tests for *Legionella pneumophila* serogroup 1 should be used only when epidemiologically justified or in adults with severe CAP [20]. In Poland, the incidence of legionellosis is low. Epidemiological reports showed that about 70 cases were reported annually in recent years [31].

Since CAP can be caused by various pathogens, techniques showing specificity for a single microorganism are of limited importance in diagnosing CAP. The test for SARS-CoV-2 detecting viral ribonucleic acid (RNA) in upper respiratory tract swab samples, which was implemented in Poland in March 2020. During the initial months of the pandemic, the test was mandatory in each patient at the ED. Current guidelines of the World Health Organization (WHO) and the European Centre for Disease Prevention and Control (ECDC) assume that all symptomatic individuals and individuals without any clinical symptoms, but epidemiologically linked to infection outbreaks should be tested. According to the WHO and ECDC definition, clinical diagnostic criterion is the presence of at least one of the following symptoms: cough, fever, shortness of breath, sudden loss of smell/taste. According to experts, there is no rationale for testing all asymptomatic persons admitted to the hospital. Long time to result, test specificity (80-100%), and incubation window do not allow to eliminate the hospital admission of an infected individual [32].

At present, the use of molecular diagnostic tests targeting at least 2 different regions of the SARS-CoV-2 genome, including one specific to the virus, is recommended by WHO. The assay uses real-time polymerase chain reaction with reverse transcription (RT-PCR) and the sequences of SARS-CoV-2 E and N2 genes are identified. Specific viral genome sequences are looked for in the nasopharyngeal swab or aspirate. When the patient's condition is deteriorating, transtracheal aspirates (TTA) or bronchoalveolar lavage (BAL) and non-induced sputum are used as material for SARS-CoV-2 testing. A positive test result indicates the presence of SARS-CoV-2 RNA, but infection with other viruses or bacteria cannot be excluded. The definite cause of disease may not be established on the basis of the positive result. A negative result does not mean in every case that the SARS-CoV-2 RNA is not present; thus, it should not constitute the only basis for deciding on the patient treatment and type of care. Current knowledge of the time when virus can be detected in Covid-19 cases is very limited. That is why it is difficult to exclude Covid-19 on the basis of one negative result only. Both negative and positive results need to be interpreted taking into account patient clinical assessment, results of other diagnostic tests and medical and epidemiology history. All positive results should be reported to appropriate health authorities in accordance with the applicable requirements. Accreditation has been implemented by the Ministry of Health, which confirms the competence of laboratories to perform the *in vitro* qualitative detection of the SARS-CoV-2 RNA in respiratory specimens [33-35]. In order to enable a more effective use of molecular tests and due to the significant increase in the incidence of Covid-19 in Poland, tests for the detection of SARS-CoV-2 antigens (so called rapid diagnostic tests; RDTs) have been allowed. Antigen-detection diagnostic tests (Ag-RDTs) are designed to detect viral proteins produced by replicating virus in respiratory secretions. They are ease-of-use, rapid and inexpensive. In accordance with the recommendations of the WHO Ag-RDTs allow to early detection of the most Covid-19 cases in appropriate settings. Ag-RDTs are most likely to perform well in patients with high viral loads which usually appear in the presymptomatic and early symptomatic phases of the illness. Those kind of test can be the basis for diagnosis, especially in the case of diagnostics of symptomatic patients carried out in admission rooms or hospital emergency departments [36].

Current guidelines for microbiological diagnosis of infection with influenza virus in patients with CAP coincide with the diagnostic guidelines for the general population. Tests can be used in individuals with suspected influenza during the high-influenza period. At present, they are not recommended during the low-infection period. The rationale for this diagnostics is the possibility of implementing efficient antiviral therapy [20]. Both nose and throat swab and bronchoalveolar lavage can be used as material for the testing. Currently, rapid influenza diagnostic tests (RIDTs) and more sensitive molecular techniques (RT-PCR) are used for the identification of influenza viruses, with the latter recommended for the confirmation of infection with influenza virus in the case of severe upper respiratory tract disease. This assay can provide information about the influenza virus subtype and susceptibility to antiviral drugs [37, 38].

Table 4. The Start Smart, Then Focus treatment algorithm [adopted from Start Smart – Then Focus Antimicrobial Stewardship Toolkit for English Hospital; 2015].

Start Smart	Then Focus
Do not start antimicrobial therapy unless there is clear evidence of infection. Take a thorough drug allergy history. Initiate prompt effective antibiotic treatment within one hour of diagnosis (or as soon as possible) in patients with severe sepsis or life-threatening infections. Avoid inappropriate use of broad-spectrum antibiotics. Comply with local antimicrobial prescribing guidance. Document clinical indication (and disease severity if appropriate), drug name, dose and route on drug chart and in clinical notes. Include review/stop date or duration. Obtain cultures prior to commencing therapy where possible (but do not delay therapy). Prescribe single dose antibiotics for surgical prophylaxis where antibiotics have been shown to be effective. Document the exact indication on the drug chart for clinical prophylaxis.	Reviewing the clinical diagnosis and the continuing need for antibiotics at 48-72 hours and documenting a clear plan of action – the 'antimicrobial prescribing decision'. The five 'antimicrobial prescribing decision' options are: **STOP** antibiotics if there is no evidence of infection, **SWITCH** antibiotics from intravenous to oral, **CHANGE** antibiotics – ideally to a narrower spectrum – or broader if required, **CONTINUE** and document next review date or stop date, good practice recommendations for outpatient parenteral antimicrobial therapy (OPAT). It is essential that the review and subsequent decision is clearly documented in the clinical notes and on the drug chart where possible e.g. stop antibiotic.

MANAGEMENT OF PNEUMONIA

The assessment of pneumonia severity of the patient at the ED is fundamental to decisions made with regard to treatment. In particular, it is needed to decide on:

1. site-of-care (home, hospital, or intensive care unit),
2. scope of tests needed,
3. urgency of the therapy,
4. type of therapy (choice of antimicrobial drug and route of administration) [1].

As mentioned before, two most commonly used pneumonia severity scores are PSI and CURB-65. It has been recognized that appropriate and early (measured in hours) antibiotic therapy is associated with better prognosis. Supportive treatment for pneumonia at the ED includes supplemental oxygen and airway augmentation. The administration of an antibiotic within one hour of presentation is recommended in patients with accompanying symptoms of severe sepsis. Empirical therapy with a broad-spectrum antibiotic should be started at an early stage of disease, while awaiting microbiological testing results.

At present, the initiation of combination therapy with a beta-lactam antibiotic (e.g. amoxicillin with clavulanic acid, ampicillin with sulbactam or third-generation cephalosporins) and a macrolide antibiotics (azithromycin or clarithromycin) is recommended when pneumonia is suspected. Moreover, the pharmacokinetic/pharmacodynamic analysis is required to optimize antimicrobial dosing regimens. Antibiotic concentrations should be monitored on an as needed basis [39]. Current antibiotic resistance patterns among bacteria should be taken into account in the therapy. Antimicrobial therapy failure can be associated with acquired antimicrobial resistance in bacteria. Penicillin-resistant strains of *Streptococcus pneumoniae*, ampicillin-resistant strains of *Haemophilus influenzae*, *Staphylococcus aureus* resistant to methicillin (MRSA) or vancomycin (VRSA), *Acinetobacter baumannii* and *P. aeruginosa*, which are a rare cause of CAP and acquire resistance to carbapenems, and *Enterobacteriaceae* (e.g. *Klebsiella pneumoniae*) resistant to carbapenems and third-generation cephalosporins present the greatest therapeutic problem [1, 40].

Time from the onset of disease to the start of antiviral treatment is a decisive factor in planning the treatment in the patient with pneumonia caused by influenza virus. Clinical benefits from using neuraminidase inhibitors (oseltamivir, zanamivir, peramivir) are the greatest when treatment starts within 48 hours of the onset of symptoms [29]. For the remaining viruses, causal antiviral therapy, including therapy for Covid-19, is not available. The approach presented in Start Smart – Then Focus to Antimicrobial Stewardship Toolkit for English Hospitals is very helpful in the case of each infectious disease (Tab. 4). It applies not only to antibiotics, but also to antiviral and antifungal agents. The use of principles contributes to the patient safety and quality of care improvement and limits the emergence and spread of resistance to antimicrobial agents [1, 41].

CONCLUSIONS

Diagnosing pneumonia, which is a disease of complex etiology, presents a challenge to a physician. Imaging examinations and laboratory testing, including microbiological tests, can be used to confirm diagnosis. However, all diagnostic options have their limitations. With lacking unambiguous tools and algorithms, subsequent decisions regarding antimicrobial therapy are hindered. In addition, in connection with the SARS-CoV-2 epidemic, date from Emergency Departments can help to improve the care of patients with pneumonia and compile expert recommendations and national regulations.

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DIFFICULT DECISIONS ON THE CESSATION OF EMERGENCY MEDICAL TREATMENT – THE LAZARUS SYNDROME IN THE PRACTICE OF PARAMEDICS

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Abstract

Cessation of emergency medical treatment on the basis of symptoms of clinical death and unclear indicators of death can result in numerous adverse phenomena. The currently available medical literature contains descriptions of cases of people with cardiac arrest in whom life function returned several minutes after emergency medical treatment was ceased. In the course of their work, paramedics must be aware of the existence of the auto-resuscitation phenomenon known as the Lazarus syndrome. Although the instance of the phenomenon remains exceptionally low, the possible consequences of an unrecognised case can be devastating. This can result in complaints of professional malpractice, negative reports in the media, as well as mental health issues among medical personnel and patients' relatives. Medical response team procedures in the case of cessation of emergency medical treatment must contain elements that minimise the possibility of auto-resuscitation, also known as the Lazarus syndrome, from occurring.

Key words

heart arrest, malpractice, mental health

INTRODUCTION

Although the act on the National Emergency Medical Services has been in force for over 14 years, there are still many crucial issues related to emergency medical services in Poland that it does not resolve. Problems related to certifying death and ceasing emergency medical treatment have existed since the National Emergency Medical Services system was brought into being. In the light of current legal provisions, according to the Regulation of the Health Minister of the 20th April 2016, the head of a basic medical response team can cease emergency medical treatment on the basis of an assessment of the patient's condition. In some situations, this decision can be difficult, and it must be taken on the basis of analysis of many factors, including: the documented wishes of the patient, the period of time from when sudden cardiac arrest occurred to the commencement of basic/advanced emergency care, the accompanying biological rhythm, pre-existing conditions and the length of time resuscitation itself has been conducted. Considering the above factors, the decision cannot be taken too hastily. The appearance in a patient of certain signs of death in the form of post-mortem blotches or rigor mortis dispels any doubts as to the decision on the cessation of emergency medical treatment. The situation becomes more complicated if the cardiac arrest was due to a pulmonary embolism, poisoning, hypothermia or if the patient has a pacemaker. What is more, the decision on ceasing intensive treatment must be the result of all possibilities for treatment at the scene being exhausted. During advanced resuscitation, any reversible causes that led to the cardiac arrest must be kept in mind and treated.

Cessation of emergency medical treatment on the basis of unclear symptoms of clinical death and earlier, questionable signs of death can lead to the occurrence of the adverse phenomenon of auto-resuscitation, also known as the Lazarus syndrome.

THE AIM

The aim of this article is to analyze the problem of the auto-resuscitation phenomenon known as the Lazarus syndrome at the emergency medical treatment.

REVIEW AND DISCUSSION

THE LAZARUS SYNDROME

The Lazarus syndrome or Lazarus phenomenon is defined as the spontaneous return of circulation in a cardiac arrest patient after emergency medical treatment has been ceased. Signs of life can appear in patients physically determined as deceased both in hospital and under out-of-hospital conditions. The return of bodily functions usually occurs several minutes after the decision has been taken to cease emergency medical treatment. The name for the syndrome comes from the figure of Lazarus in the Bible, whom Christ resurrected three days after his death [1-3].

The authors of the first publication describing a case of auto-resuscitation were Linko et al. in 1982 [4], while ten years later, Bray introduced the term Lazarus syndrome to medical literature. The team of researchers who published research into the phenomenon conducted a search of the PubMed and Medline medical databases, as well as Google Scholar. They showed that from the time the first article was published, that is between 1982 and 2019, 65 identical cases were reported and described around the world [1]. Taking into consideration such a low number of reports, it is easy to come to the conclusion that the scale of the phenomenon is considerably underestimated. This is indicated by numerous studies conducted amongst medical personnel in Europe and elsewhere around the world. An analysis conducted by Gerard et al. in 2013 showed that almost 45% of French doctors had experienced a case of auto-resuscitation in their clinical practice. The study included 100 French paramedic doctors [5]. Similar results were found in the Netherlands on the basis of a questionnaire completed by 311 intensive care doctors. Over a third of the doctors who returned the questionnaire had come across the auto-resuscitation phenomenon in their work [6]. No less interesting are the results of research conducted in Canada, which showed that as many as 38% of intensive care doctors had witnessed the phenomenon in their work [7].

It can be supposed that the low number of reported cases of so-called Lazarus syndrome is principally due to concerns about the medical and legal consequences. The occurrence of the phenomenon after resuscitation efforts have been ceased gives rise to the question whether the resuscitation was not halted too early. At this point in time, there is no precise data in Poland describing the scale of similar events, although taking into account reports in the media and the press about the return of signs of life in persons who had been declared deceased, it can be assumed that the syndrome also occurs in our country. Medical personnel, including paramedics, may face this problem in the course of their professional duties. While carrying out their many duties, conducting a high number of interventions and coping with the limitations to out-of-hospital care, personnel must also ensure a consistently high level of emergency medical treatment, conscious that the Lazarus syndrome exists and can cause a series of legal consequences.

CAUSES OF THE LAZARUS SYNDROME

The causes for the occurrence of the Lazarus syndrome are not entirely understood. The available medical literature mentions and describes several factors that can increase the likelihood of the phenomenon. The first factor that is highlighted by many authors is incorrect ventilation, which leads to hyperinflation of the lungs [1-3, 7, 8, 12]. European Resuscitation Council guidelines recommend conducting ventilation during sudden cardiac arrest at a rate of 10 breaths per minute with the volume of the breathing mixture at 6-7 ml/kg of ideal patient body weight. Incorrect manual or mechanical ventilation conducted too rapidly leads to lung hyperinflation. This may occur in any patient, but is particularly notable in patients with chronic obstructive pulmonary disease. Insufficient expiratory time leads to excess amounts of air remaining in the lungs, which in turn can lead to high end-expiratory pressure. Auto-PEEP is usually caused by so-called air trapping, that is difficulty in exhalation of air from the airways during expiration. This gradual increase in pressure in the chest leads to reducing venous return to the heart, and a lower venous return results in a reduction in cardiac output. Severe auto-PEEP is comparable to a cardiac tamponade.

The next cause relates to the possible accumulation of peripheral puncture medications. Lower venous return due to an increase in pressure in the chest can delay the delivery of medications to the central circulatory system. In the same way, antiarrhythmic medications accumulate in the peripheral circulatory system and are quickly absorbed after a drop in pressure in the chest, that is after the cessation of emergency medical treatment [1, 8, 9].

Due to the principal cause of sudden cardiac arrest in adults being cardiovascular diseases, especially ischemic heart disease, one possible factor for auto-resuscitation can be perceived here. Certain authors highlight that some cases of spontaneous return of circulation are the result of the displacement of embolic material in the coronary vessel due to highly effective chest compressions conducted earlier, which increased the pressure in the coronary vessels [2, 9].

Among other causes, we should mention electrolyte imbalance, especially potassium imbalance in the form of hypo/hyperkalaemia. Potassium is mainly present in intracellular fluid, with only 2% found in extracellular fluid. The correct extracellular potassium ion concentration is kept strictly between 3.5 and 5.0 mmol/l. Potassium ion homeostasis plays a key role in maintaining the resting membrane potential of each cell and neuromuscular function. Rising acidosis during sudden cardiac arrest causes an increase in potassium ion concentrations as a result of their displacement from the intracellular to the extracellular space [10,11]. Hyperkalaemia can play a considerable role in the delayed return of spontaneous circulation. Conductive system cells may not react to correct treatment. Arrhythmias such as ventricular fibrillation or pulseless ventricular tachycardia may not respond to defibrillation. The available medical literature presents a description of the case of a 68-year-old man with cardiac arrest due to severe hyperkalaemia. For 100 minutes, advanced emergency treatment was conducted on the patient with little success, and not until the patient was connected to haemodialysis did vital functions return. The patient returned to full health with no neurological impairment [11].

HOW TO LIMIT THE POSSIBILITY OF THE LAZARUS SYNDROME OCCURRING DURING CESSATION OF EMERGENCY MEDICAL TREATMENT

Knowing that the Lazarus syndrome exists, it is important to focus on following the guidelines regarding advanced resuscitation. During cardiopulmonary resuscitation, particular attention should be paid to correct chest compression and adequate ventilation, especially for cardiac arrests that occur in patients with chronic obstructive pulmonary disease or asthma. To limit the possibility of lung hyperinflation occurring, the patient should be ventilated with a breathing volume of 6-7ml/kg of ideal body mass, not actual body mass, at a rate not exceeding 10 breaths per minute. If symptoms appear that suggest air-trapping may have occurred, it is recommended that the compression be halted for around 10 seconds. During resuscitation a capnometer should be used to measure the CO_2 partial pressure in the exhaled air. The result is directly correlated with the flow of blood through the lungs, thanks to which it is also possible to monitor the effectiveness of chest compressions. The range of acceptable values for the concentration of carbon dioxide during cardiac arrest have not yet been determined, but patients with low values below 10 mmHg usually have a poor prognosis. A sudden increase in values starting at around 10-20 mmHg and rising to the correct level of 35-45 mmHg can be the first sign of spontaneous circulation [12].

Death is not a single event but a process stretched over time. Electrical activity in the heart muscle may appear several minutes after emergency medical treatment has been ceased. From the moment the decision is taken to cease emergency medical treatment, signs of any electrical activity in the heart should be continually monitored for a period of 10 minutes. It should be explained to the patient's family that the patient is still being monitored in order to confirm above all doubt the lack of vital signs. After cessation of intensive treatment, the level of carbon dioxide can also be monitored by delaying the removal of the intubation tube or its alternative (laryngeal mask, laryngeal tube or i-gel). After 10 minutes of observation for any electrical activity in the heart, as well as measurement of carbon dioxide levels, it is also recommended to listen for heart sounds, assess the reaction of the pupils to light and check the corneal reflex.

The Lazarus phenomenon is rare, but bears extremely serious consequences. The decision to cease emergency medical treatment should take care to minimise the possibility of the phenomenon occurring. Haste is never well-advised, but unfortunately it accompanies paramedics every day in their work. It is one of the elements that sometimes leads to a wrong decision being taken or to the implementation of incorrect procedures. We must remember that the decision to cease emergency medical treatment should be followed by an additional 10 minutes after which final confirmation of the lack of vital signs can be made.

CONCLUSIONS

The algorithm below can be used for confirming the possibility of ceasing emergency medical treatment during CPR:

1. Continued asystole for over 20 minutes despite consideration of all reversible causes of sudden cardiac arrest
2. Decision to cease emergency medical treatment – print the asystole protocol
3. Observation of the patient by monitoring the ECG curve, measurement of end-expiratory carbon dioxide using a capnometer after 10 minutes. If there are any doubts, extend the observation for a further 10 minutes
4. Listen to the heart sounds, assess the reaction of the pupils to light, check the corneal reflex
5. Final decision to cease emergency medical treatment
6. When completing the documentation, add an entry about observation of the patient immediately after emergency medical treatment was ceased.

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CASE STUDY

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HYPEROSMOLAR HYPERGLYCEMIC STATE (HHS) – THE MANAGEMENT IN THE EMERGENCY DEPARTMENT

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Abstract

Introduction: The hyperosmolar hyperglycemic state (HHS) poses a direct threat to the health and life of the patient. It is most common in patients with type 2 diabetes, and it is associated with high mortality. For this reason, HHS requires a quick diagnosis and implementation of the correct treatment. Mortality due to HHS ranges from 5% to 16%. It is about ten times higher than in diabetic ketoacidosis. This is due to the underlying cause of hyperglycemia, the severity of dehydration, and often the advanced age and comorbidities.

The aim: The study aimed to develop the correct management strategy for the medical staff in the Emergency Department (ED) for a patient with the suspected HHS.

Material and methods: The research material was obtained from the analysis of the patient's medical records during his stay in the ED and from the emergency medical card and the order of the EMS team to dispatch to this 62-year-old patient due to the deterioration of verbal and logical contact and unassessed glucose values. The study used an individual case study method.

Results: Combating hyperglycemia, replenishing water deficit, correcting electrolyte disturbances, as well as diagnostics and initial therapy of comorbidities are the priorities in providing medical care to a patient with suspected HHS.

Conclusions: The medical staff in the ED followed guidelines on HHS management.

Key words

hyperosmolar hyperglycemic state, acute complications of diabetes

INTRODUCTION

Despite the significant progress in diabetes treatment in recent years, acute hyperglycemic states are still a current and significant problem in terms of the diagnosis as well as treatment of diabetes. These conditions include the hyperosmolar hyperglycemic state (HHS), ketoacidosis, and lactic acidosis. HHS can be a complication of type 1 and type 2 diabetes, but it is significantly more common in patients with type 2 diabetes. HHS cases are also reported in children [1]. The basis for the development of HHS is the relative insulin deficiency in relation to the increased demand and the increased production of hormones opposing insulin, e.g., glucagon, catecholamines, cortisol, and growth hormone. Under the influence of these hormones, glycogenolysis and gluconeogenesis in the liver are stimulated, as well as glucose consumption in peripheral tissues is reduced. Both mechanisms increase serum glucose levels. The most common causes of HHS development are infections (mainly urinary tract infections and pneumonia), acute cardiovascular events (acute coronary syndrome, stroke), non-compliance, delayed diagnosis of diabetes, and prolonged treatment-free periods. Other reasons include the use of certain medications (glucocorticosteroids, thiazides), initiation of treatment with antipsychotics [2, 3], consumption of large amounts of alcohol [4], and neuroleptic malignant syndrome in a patient undergoing diabetes treatment [5].

THE AIM

The study aimed to develop the correct management strategy in a patient with the suspected HHS.

MATERIAL AND METHODS

The research material was obtained from the analysis of the patient's medical records during his stay in the Emergency Department (ED) and from the emergency medical card and the order of the Emergency Medical Services team to dispatch to this 62-year-old patient due to the deterioration of verbal and logical contact and unassessed glucose values. The study used an individual case study method.

CASE REPORT

The basic Emergency Medical Services team was dispatched to a patient whose family had noticed a significant deterioration of verbal-logical contact

for several days, polydipsia, polyuria, and elevated blood glucose values of about 400-500 mg/dL in measurements with a home glucose meter. According to a history taken with his family, the patient had not taken the recommended insulin doses for several days. In the physical examination, the patient was in a moderately severe general condition, with impaired verbal-logical contact, confused, autopsychic-oriented, and not completely allopsychic-oriented. The patient was circulatory and respiratory efficient: blood pressure was 118/81 mmHg, regular heart rate was 154/min, the number of breaths was 28/min, and blood glucose level was undetectably high. In addition, leg edema, massive trophic changes with ulceration on the left leg, and a diabetic foot syndrome with left foot necrosis were revealed. After being brought to the ED, the patient was in a serious condition, conscious, without verbal-logical contact. Auscultation over the pulmonary fields revealed alveolar murmur exacerbated on both sides, crackles on both sides at the base, breath numbers of 35-40/min, and SaO2 of 97%. Heart rate of 160/min was regular. The abdomen was soft and painless on palpation, with no peritoneal symptoms. Peristalsis was present. In a neurological examination, no significant deviations were observed. Lower limb findings were as above. In laboratory findings were as follows: WBC 23.56*103/μL, NEU 18.96*103/μL, PLT 558*103/μL, HGB 17.1 g/dL, glucose 81.99 mmol/L, urea 34.51 mmol/L, creatinine 254 μmol/L, CRP 108.1 mg/L, GFR 23.1 mL/min/1.73 m2, high-sensitive troponin T 33 ng/L, potassium ions 6.37 mmol/L, chloride ions 85.3 mmol/L, sodium ions 128.1 mmol/L, AST 14 U/L, ALT 30.5 U/L. Capillary blood gas revealed pH 7.38, HCO3-16 mmol/L, PCO2 23.3 mmHg, PO2 52.1 mmHg. A trace amount of ketone bodies was revealed in the urinalysis. The effective plasma osmolality was above 320 mOsm/kg H2O. Chest X-ray and abdomen ultrasound showed no abnormalities.

The ED team raised HHS suspicion. The early-hospital management aimed to combat hyperglycemia, replenish the water deficit, correct electrolyte disturbances, and diagnose and treat comorbidities.

This procedure included:

1. During the ED stay (1 hour), the patient received 1000 mL of 0.9% NaCl
2. The initial dose of insulin was administered in the form of a bolus of 0.1 U/kg body weight
3. Intravenous insulin infusion was started at the rate of 0.1 U/kg/h under glycemic control
4. Immediate potassium supplementation was abandoned due to its concentration in blood serum
5. Low molecular weight heparin was administered in a prophylactic dose
6. The patient was closely monitored:
   - assessment of vital signs: blood pressure, pulse rate, number of breaths, level of consciousness, fluid balance every hour,
   - determination of capillary blood glycemia with a glucometer every 1 hour
7. Performing control laboratory and imaging tests.

After initial diagnostics at the ED, the patient was admitted to the Diabetes Department for further treatment.

DISCUSSION

The quick and correct diagnosis of HHS is the main task of the ED:

I. According to the definition, the HHS is characterized by glycemia of over 600 mg/dL (33.3 mmol/L), increased effective serum osmolality (> 320 mOsm/kg H2O) at a pH above 7.3, a bicarbonate concentration exceeding 15 mmol/L, and no or trace amounts of ketone bodies in the blood and urine [4, 6].
II. The mainstay of HHS treatment is adequate fluid therapy, which aims to fill the vascular bed and improve tissue perfusion. In addition, it lowers glycemia, inhibits hormonal counter-regulation, and increases the sensitivity of tissues to insulin. Hydration must be carried out intravenously. 0.9% NaCl solution is the recommended crystalloid [7].
III. HHS treatment is based on intravenous, continuous insulin administration under glycemic control. It should be administered until the acid-base balance parameters are equalized [8-10].
IV. The deficiency of sodium and chlorine in patients with HHS should be supplemented with 0.9% NaCl solution. Serum potassium levels should be monitored.
V. The HHS predisposes to disturbances in hemostasis and acute inflammatory response. This increases the risk of intravascular coagulation. Hyperglycemia and dehydration trigger a cascade of pro-thrombotic events. It is therefore recommended to administer low molecular weight heparin in a prophylactic dose subcutaneously.

CONCLUSIONS

The ED team followed the guidelines on HHS management. Correct diagnosis and implementation of appropriate treatment improve the patient's prognosis.

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

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STANOWISKO Z DNIA 1 CZERWCA 2021 R. KONSULTANTA KRAJOWEGO W DZIEDZINIE MEDYCYNY RATUNKOWEJ W SPRAWIE POSTĘPOWANIA U PACJENTA Z PODEJRZENIEM ZATRUCIA CYJANKAMI

STANDPOINT OF THE NATIONAL CONSULTANT IN THE FIELD OF EMERGENCY MEDICINE OF 1 JUNE 2021 ON THE MANAGEMENT OF A PATIENT WITH SUSPECTED CYANIDE POISONING

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Streszczenie

Zatrucia toksycznymi gazami stają się coraz bardziej powszechne. Ich źródłem może być m.in. dym pożarowy. Artykuł zawiera rekomendacje postępowania zespołów ratownictwa medycznego u pacjentów z podejrzeniem zatrucia cyjankami.

Słowa kluczowe

cyjanowodór, cyjanki, zatrucia, pożar

Abstract

Poisoning with toxic gases is becoming more and more common. It can be caused by fire smoke, among others. The article includes recommendations for the management of patients with suspected cyanide poisoning for emergency medical teams.

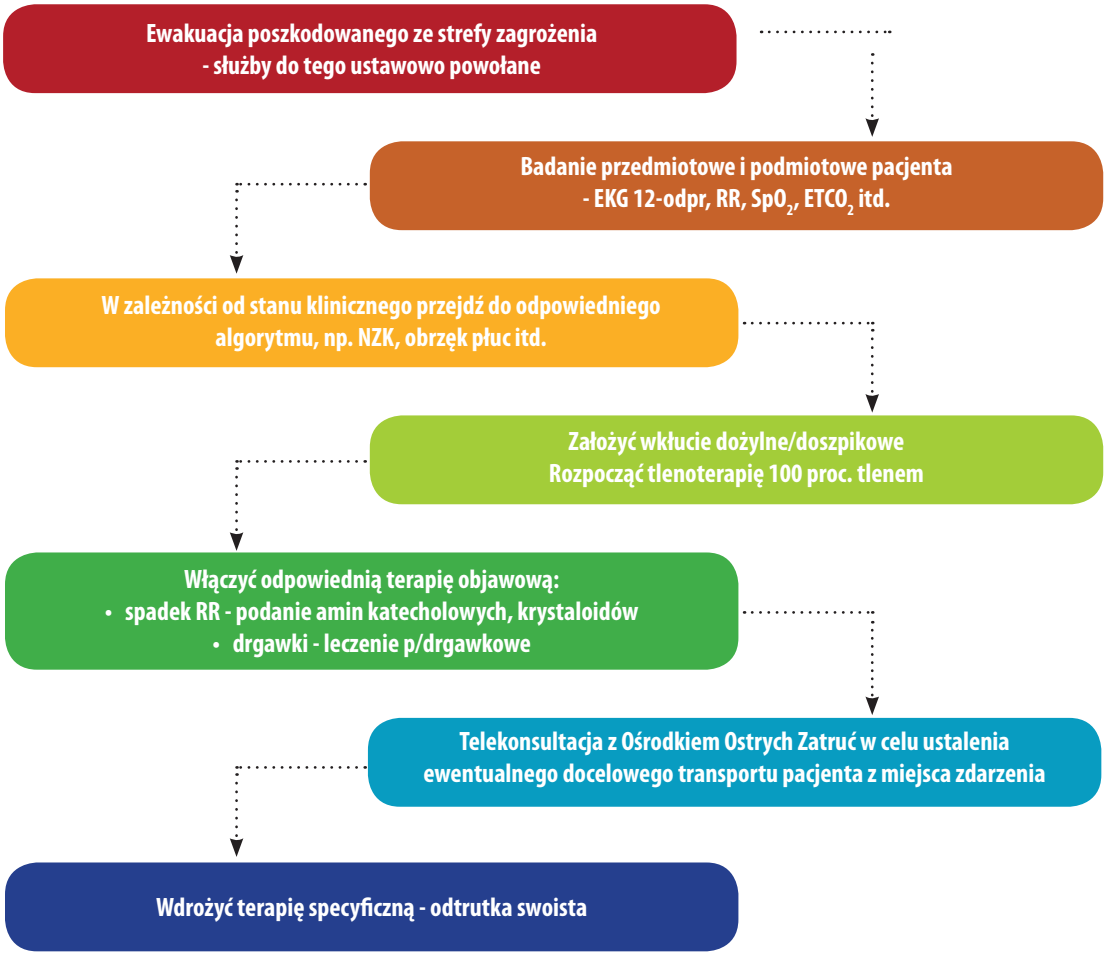
Key words

hydrogen cyanide, cyanides, poisoning, fire

WSTĘP

Według Światowej Organizacji Zdrowia zatrucia znajdują się na 4. miejscu jako przyczyna zgonów osób dorosłych na świecie. Szacuje się, że w następstwie ostrych zatruć umiera w kraju kilkaset osób rocznie [1, 2]. W Polsce co roku dochodzi do około 150 tys. pożarów, z czego 37 tys. dotyczy pożarów budynków. Każdego roku w naszym kraju z powodu pożarów umiera 500 osób, a kolejne 4 tys. odnosi obrażenia. Zdecydowana większość ofiar umiera nie na skutek obrażeń termicznych, lecz w wyniku zatrucia toksycznymi gazami. Statystyki pokazują, że jest to nawet 95% ofiar pożarów [3].

Ostre i bardzo ostre zatrucia cyjankami w dobie coraz częściej spotykanych przypadków spowodowanych poprzez wszechobecne tworzywa sztucznego, stanowią coraz to większy problem ekonomiczny, ale przede wszystkim medyczny. Źródłem narażenia na zatrucia cyjankami mogą być dym pożarowy, piroliza stosowana w tworzywach sztucznych czy zatrucia związane z uwolnieniem jonów cyjankowych [4]. Droga narażenia najczęściej jest wziewna, ale może też być doustna czy przez skórę. Działanie cyjanków polega przede wszystkim na łączeniu z trójwartościowym żelazem oksydazy cytochromowej będącej jednocześnie kluczowym elementem łańcucha oddechowego. Jony cyjankowe bezpośrednio powodują również uszkodzenie ośrodkowego układu nerwowego na drodze peroksydacji lipidów. Istotne dla klinicznego stanu pacjenta są okoliczności wystąpienia danego zatrucia, narastająca czasem bardzo ciężka duszność wraz z objawami dekompensacji układu oddechowego i wystąpieniem wstrząsu, drgawki czy w skrajnych przypadkach nagłe zatrzymanie krążenie. Gwałtowna dynamika narastających objawów szczególnie jest widoczna u osób narażonych na dymy pożarowe. Warto wspomnieć również o diagnostyce różnicowej, gdzie podobne objawy mogą wystąpić przy zatruciach tlenkiem węgla, tlenkiem azotu, siarki, amoniakiem czy chlorowodorem.



Ryc. 1. Rekomendacje postępowania zespołów ratownictwa medycznego u pacjenta z podejrzeniem zatrucia cyjankami

W praktyce klinicznej ważny jest element podejrzenia, który w szczególności dotyczy opieki przedszpitalnej, a w warunkach szpitalnych – badań laboratoryjnych. Bardzo ważne jest to, że brak potwierdzenia zatrucia cyjankami nie powinien opóźniać zastosowania specyficznego leczenia.

W związku z tym wydaje się być celowym, aby ujednolicić sposób postępowania zespołów ratownictwa medycznego w opiece przedszpitalnej w ramach funkcjonowania systemu Państwowe Ratownictwo Medyczne. Dlatego przedstawiam rekomendacje postępowania w takich przypadkach klinicznych (Ryc. 1.).

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