

EMERGENCY MEDICAL SERVICE

RATOWNICTWO MEDYCZNE



PERFECTIONISM AND BURNOUT IN HEALTH CARE PROFESSIONALS

**LIFEGUARDS' KNOWLEDGE RETENTION FOLLOWING AIRWAY
MANAGEMENT, VENTILATION AND OXYGEN ADMINISTRATION TRAINING**

**SELF-ASSESSMENT OF KNOWLEDGE OF EMERGENCY MEDICAL SERVICES
SYSTEM EMPLOYEES ON NEW PSYCHOACTIVE SUBSTANCES**

**MANAGEMENT OF THE EMERGENCY DEPARTMENT PATIENT WITH TOXIC
ALCOHOL POISONING**

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CONTENTS

ORIGINAL ARTICLES

Analysis of aggressive behavior towards healthcare workers before and during the SARS-CoV-2 epidemic in Poland. Part 2

Aleksandra Joanna Kuć, Daria Małgorzata Kubik, Klaudia Ewa Kościelecka, Wojciech Piotr Szymanek, Tomasz Męcik-Kronenberg, Dariusz Ceglarsz 203

Outcomes of penetrating cardiac injuries – a cardiac surgeon approach to 22 cases

Ali Cemal Duzgun, Ekin Ilkeli 213

Perfectionism and burnout in health care professionals

Marlena Robakowska, Anna Tyrańska-Fobke, Maciej Walkiewicz, Małgorzata Tartas, Daniel Ślęzak, Wioleta Tomczak, Łukasz Balwicki, Katarzyna Zorena, Sylwia Jaltuszewska 219

Lifeguards' knowledge retention following airway management, ventilation and oxygen administration training

Jakub R. Bielinski, Filip Jaskiewicz 225

Self-assessment of knowledge of emergency medical services system employees on new psychoactive substances – current status and development prospects

Łukasz Paweł Kacprzak, Jolanta B. Zawilska 232

Epidemiology of out-of-hospital sudden cardiac arrest happening in Brzozow county – pilot study

Sebastian Kowalski, Adrian Moskal, Mariusz Goniewicz 240

Influence of emergency medical students training on preparedness to perform paediatric life support

Jerzy Kiszka, Dawid Filip, Piotr Wasylik 244

REVIEW ARTICLES

Management of the Emergency Department patient with toxic alcohol poisoning

Barbara Porebska, Małgorzata Kaczmarek-Fojtar 253

Thyroid storm as a life-threatening condition in the practice of Emergency Medical Service teams

Agnieszka Ciastkowska-Berlikowska 260

Skin diseases caused by the SARS-CoV-2 virus and their increase during the use of personal protective equipment

Justyna Olszewska, Anna Charuta, Jerzy Ładny, Klaudiusz Nadolny 265

CASE STUDY

Recurrent syncope as a symptom of electrical storm – case presentation

Przemysław Skoczyński, Paweł Pochciał 271

VARIA

Life-saving procedures and cardiopulmonary resuscitation from the ancient history to the present day

Krzysztof Mitura, Daniel Celiński, Agnieszka Hawrylewicz-Łuka, Sławomir Pilip, Leszek Szpakowski, Marta Jarzębowska, Paweł Jastrzębski, Sławomir Dariusz Szajda 274

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

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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: Only 1% of healthcare workers indicated that they informed the Healthcare Aggression Monitoring Registry. A similar rate was observed during the pandemic. The predominant reason was "long waiting time".

Conclusions: Aggression being a relatively constant and unchanging problem in the healthcare system, 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 of these acts.

Key words

aggression,
healthcare workers,
epidemic,
respondents,
workplace

INTRODUCTION

Aggression is a common phenomenon in social life. Based on the clinical classification of aggression, instrumental, preventive, defensive, and impulsive aggression can be distinguished. The first form is a controlled reaction, initiated for a specific purpose, e.g., domination or intimidation. The opposite is the second form, characterized by uncontrolled, affective behavior in response to physical or verbal attacks from the environment [1]. The most frequently mentioned functions of aggression include discharging negative emotions to temporarily reduce tension and drawing attention to oneself to achieve one's requirements.

Aggression occurs and is common in the medical community as well. However, healthcare professionals rarely report incidents to specific services, resulting in tacit approval of the repetition of inappropriate patterns.

It is worth paying attention to what factors predispose to aggressive events and what consequences such action brings, not only legal but also affecting

the mental health of the victims. Therefore, it is essential to establish coherent guidelines to counteract aggression and its effects [2].

THE AIM

Many articles (summarized in the Discussion section) deal with the problem of aggression towards healthcare professionals. The study aimed to analyze the complexity of this phenomenon (the causes of such behaviors and their differentiation) and determine the consequences resulting from episodes of aggression. The authors also wanted information on reporting violence-related incidents and initiating proceedings against the perpetrator and possible outcomes.

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 first part of the form and some of the questions from the second and third parts on the form of violence, perpetrator, and frequency have been discussed in the first part of the article.

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 was 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.

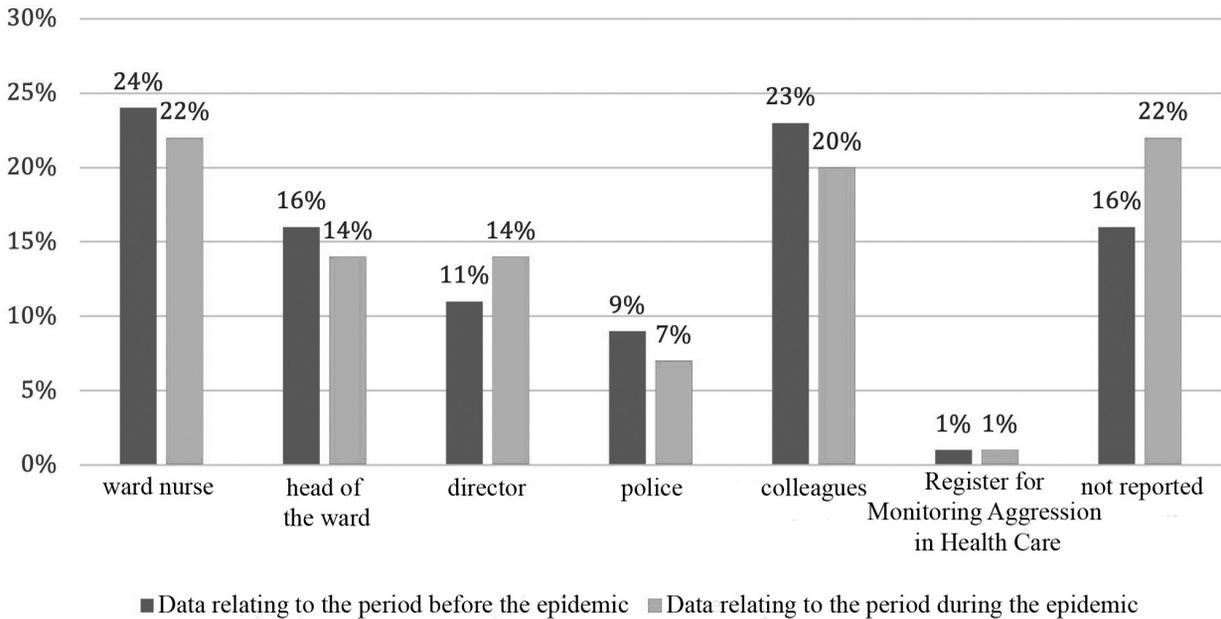


Fig. 1. Reporting rate of cases of aggression by healthcare workers before and during an epidemic, in percentage terms.

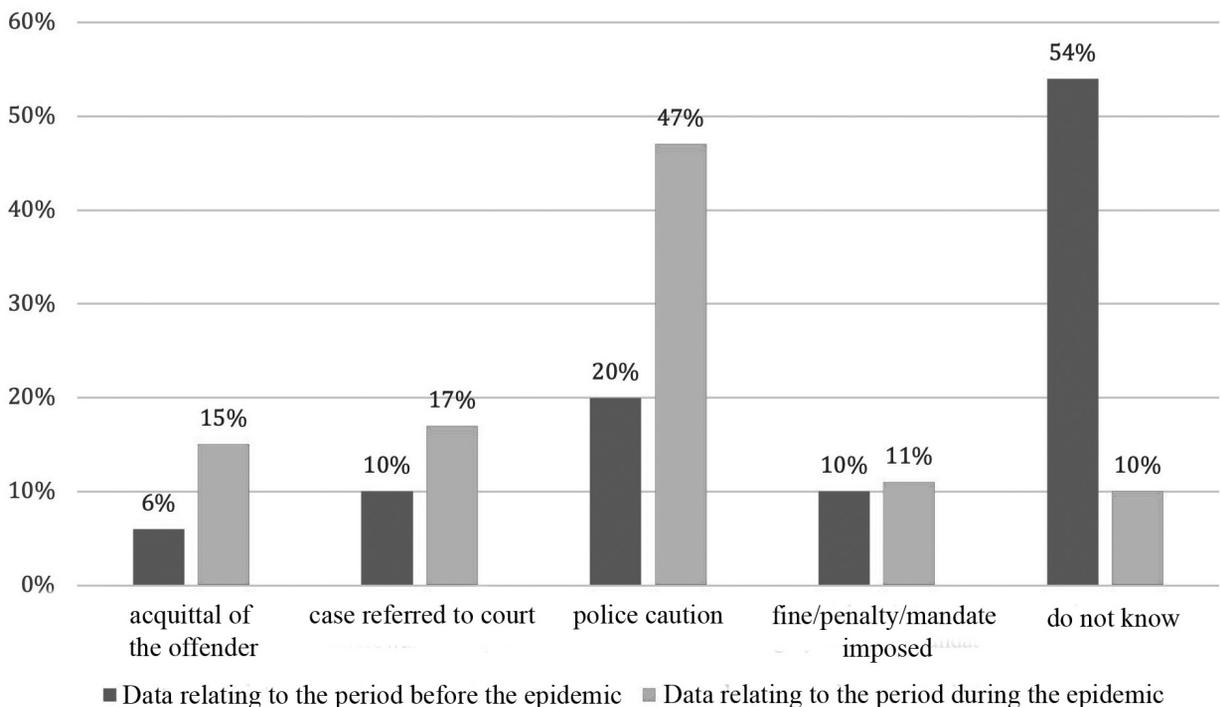


Fig. 2. The result of the initiated proceedings before and during the epidemic, in percentage terms.

RESULTS

The group of respondents consisted of 999 people – including 88% women and 22% men. It was characterized in the first part of the article: “Analysis of aggressive behavior towards healthcare workers before and during the SARS-CoV-2 epidemic in Poland. Part 1” in the Results section.

The declarations of the respondents regarding reporting episodes of aggression in two studied intervals are presented in Figure 1.

When asked whether the proceedings had been initiated, only 13% of the respondents confirmed, 15% did not know, and as many as 72% – denied it. In the pandemic period, the number of initiated cases slightly decreased (11%), and the number of cases that had not been examined was 69%. On the other hand, the number of respondents who did not know whether that had happened increased (20%).

In the questionnaire, we also asked about the result of the initiated proceedings. In the second examined period, the most significant increase was observed in instructions (by 27%) – Figure 2.

The next question in the questionnaire concerned the causes of aggressive behavior before and during the epidemic (Fig. 3).

A statistical analysis of the group of respondents was performed, both before and after announcing the epidemic state:

- the type of profession and the notification of an aggressive incident and the initiation of proceedings,

- a place of meeting aggressive behavior and the causes,
- the form of violence and the reporting and initiation of proceedings,
- the notification made, and the procedure undertaken,
- the initiated procedure and its result.

Statistical analysis was performed between the type of profession and the notification of the procedure to selected units (charge nurse, head physician, director, police, etc.), where statistical significance was obtained at the level of $p = 0.0000$.

The correlation between the profession and the initiated proceedings was also searched for. It was demonstrated in the following professions: a paramedic ($p = 0.0062$), a physiotherapist ($p = 0.0000$), a nurse ($p = 0.0003$), a midwife ($p = 0.0366$), a stretcher-bearer ($p = 0.0014$) and a medical clerk ($p = 0.0027$). After the epidemic was announced, it was observed in the following professions: a physiotherapist ($p = 0.0012$), a paramedic ($p = 0.0293$), and a medical clerk ($p = 0.0004$). The percentage of a given profession that claimed that no proceedings were initiated regarding the reported situation is presented in Table 1.

The relationship between the place of encountering inappropriate behavior and its reason was also analyzed. In the case of alcohol and stimulants, a statistically significant correlation was demonstrated for all the indicated places at all tested time intervals (except for the care and treatment facility). The answer “long waiting time” was statistically adjusted

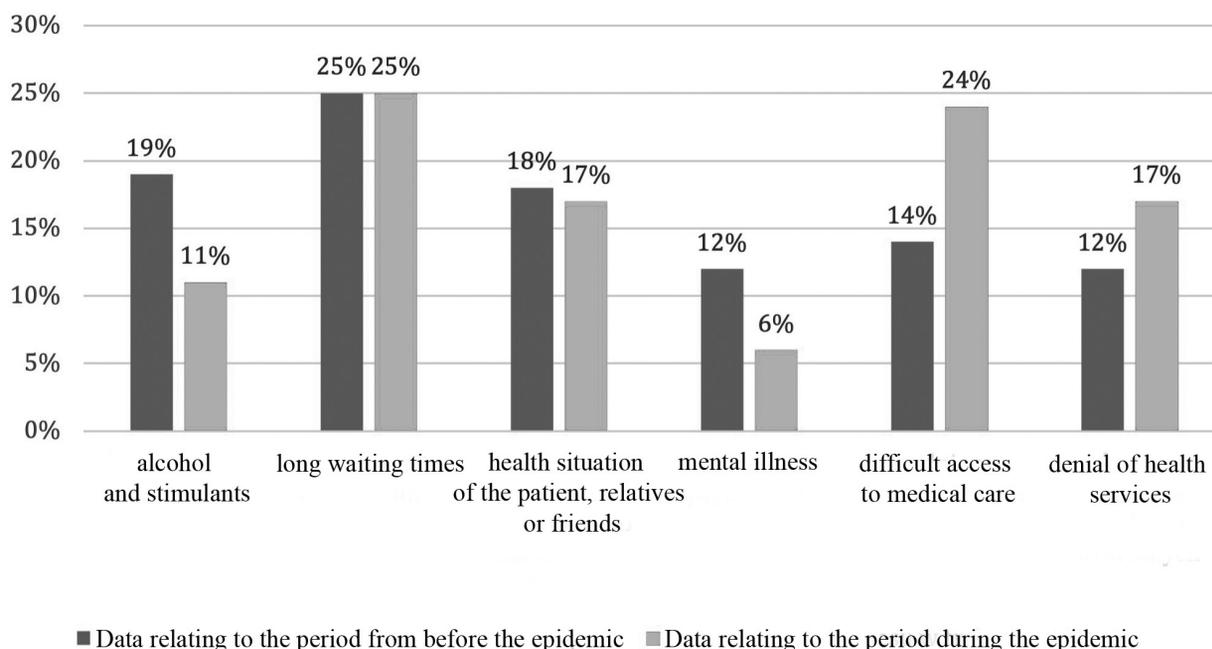


Fig. 3. The causes of aggressive behavior before and during the epidemic in percentage terms.

Table 1. Proceedings initiated depending on the occupation in percentage and statistical terms before and after announcing the epidemic state.

Profession	Percentage of representatives of a given profession who marked the answer "no proceedings instituted" before announcing the epidemic state.	Percentage of representatives of a given profession who marked the answer "no proceedings instituted" during the epidemic	Test probability (p) before the epidemic	Test probability (p) during the epidemic
Paramedic	61%	25%	$p = 0.0062$	$p = 0.0857$
Physician	74%	75%	$p = 0.16981$	$p = 0.1562$
Physiotherapist	71%	79%	$p = 0.0000$	$p = 0.0012$
Nurse	72%	71%	$p = 0.0003$	$p = 0.5539$
Midwife	75%	71%	$p = 0.0366$	$p = 0.4920$
Stretcher-bearer	13%	30%	$p = 0.0014$	$p = 0.0293$
Medical clerk	70%	50%	$p = 0.0027$	$p = 0.0004$
Medical guardian	75%	69%	$p = 0.4327$	$p = 0.6343$

Table 2. Comparison of the reporting rate of a given form of aggression in percentage terms before and after announcing the epidemic state.

Form of aggression	Percentage of respondents who did not report a given form of aggression before announcing the epidemic	Percentage of respondents who did not report a given form of aggression after announcing the epidemic
Insults	80%	80%
Threats	51%	59%
Cowing	63%	37%
Buffeting	7%	8%
False public accusation	24%	28%
Battery	2%	1%
Suffocation	0%	0%
Harassment	3%	3%
Public property damage	4%	5%
Private property damage	1%	2%

to the Emergency Department (ED), the emergency room, Emergency Medical Services (EMS) station, primary healthcare, and night and holiday medical healthcare. After March 20, 2020, it was additionally a hospital ward ($p = 0.0031$). The refusal to provide healthcare was also related to all places indicated by the respondents (excluding the psychiatric hospital and the care and treatment facility). For this variable, only significance in the care and treatment facility was not achieved during the epidemic period. It was similar in the case of difficult access to medical care – the only insignificant correlation was with the hospital ward and the care and treatment facility.

After the state of the epidemic was announced, it was not only associated with the psychiatric hospital and the care and treatment facility. The health situation of the patients, their relatives, or friends as the reason for aggression was related to such places as hospital wards, psychiatric hospitals, and the care and treatment facility. This situation changed during the epidemic, where a correlation was demonstrated between all the places mentioned by the respondents (except for the care and treatment facility, night and holiday medical healthcare, and primary healthcare). In the case of another answer – mental illness, statistical significance was proved with the ED, hospital

Table 3. Percentage comparison of initiated proceedings depending on the form of aggression before and after announcing the epidemic state.

Form of aggression	Percentage of initiated proceedings depending on the form of aggression before announcing the epidemic state.	Percentage of initiated proceedings depending on the form of aggression after announcing the epidemic state.
Insults	14%	12%
Threats	15%	14%
Cowing	14%	13%
Buffeting	20%	24%
False public accusation	14%	14%
Battery	37%	42%
Suffocation	59%	33%
Harassment	7%	21%
Public property damage	12%	27%
Private property damage	33%	10%

ward, EMS team, psychiatric hospital, and the care and treatment facility. In the case of the epidemic, it was also an emergency room and night and holiday medical healthcare.

Percentage analysis was also performed for the correlation of the place of aggression and its causes. In the case of the ED before and during the epidemic, the most frequently selected answer was “long waiting time” – 85% and 87%, respectively. A similar relationship was noticed in the case of the emergency room – 77% and 87%, respectively. As the main reason employees of the hospital ward gave the health situation of the patients, their relatives, or friends (58%), while after March 20, 2020 – “long waiting time” – 62%. As many as 88% of people working in the EMS teams in the first analyzed period considered alcohol and stimulants as the cause, while in the second analyzed period, as much as 90% indicated a long waiting time as the main reason. The medics indicated the same cause of aggression in primary healthcare – 73%. The situation was different after March 20, 2020 – 85% indicated that the most common reason was “difficult access to medical care”. The main reason both before and during the epidemic in the case of night and holiday medical healthcare was “long waiting times”, 79% and 89%, respectively.

A comparison was made of the percentage number of respondents who did not report a given form of aggression in the two examined time intervals (Table 2).

A statistical analysis of the relationship between the form of aggressive behavior and the initiated procedure was performed (Table 3). Statistical significance

was demonstrated for all types of violence, except for the public property damage ($p = 0.0887$) before announcing the epidemic and the private property damage ($p = 0.5187$) after announcing the epidemic.

Correlations between the reporting of aggressive behavior and the proceedings initiated, before and during the epidemic, were found in all examined variables (reported to the charge nurse, head physician, director, police, colleague, or colleagues, and the Healthcare Aggression Monitoring Register). Most of the reported cases and then proceedings that were initiated belonged to the police – 43%. 29% of cases were entered into the Register. The same percentage result was achieved in both analyzed periods. 27% and 23% of notifications, sent successively to the director, and the head physician, initiated the proceedings. In the case of the charge nurse and colleagues, it was 17% each. The situation was similar during the epidemic. After announcing the epidemic, almost half – 49% of the aggressive behaviors reported to the police initiated the investigation. In the case of the director and head physician, it was 28% and 27%, respectively. Subsequently, 16% and 15% of notifications received by the charge nurse and colleagues or colleagues initiated the proceedings.

The variable concerning the initiated procedure with its result was also analyzed. In all cases (acquittal, case brought to court, instruction, imposition of a ticket, penalty, or fine) both before and during the epidemic, statistical significance was achieved. Out of all initiated cases, only 8% of them ended with the acquittal of the perpetrator. 30% of proceedings

Table 4. The type of occupation and the percentage results of the proceedings instituted before and during the epidemic.

Profession	Acquittal	The case was brought to court	Instruction	A fine, penalty or mandate was imposed	Do not know
Physician	6%; 14%	6%; 18%	9%; 32%	7%; 18%	72%; 18%
Paramedic	8%; 24%	22%; 24%	12%; 41%	20%; 11%	38%; 0%
Medical guardian	13%; 22%	13%; 22%	13%; 44%	0%; 0%	61%; 12%
Physiotherapist	0%; 17%	0%; 17%	27%; 32%	9%; 17%	64%; 17%
Nurse	7%; 14%	13%; 14%	27%; 55%	8%; 11%	45%; 6%
Midwife	0%; 6%	0%; 12%	23%; 47%	7%; 6%	70%; 29%
Stretcher-bearer	14%; 29%	0%; 29%	14%; 13%	14%; 29%	58%; 0%
Medical clerk	4%; 18%	0%; 13%	17%; 56%	0%; 0%	79%; 13%
Pharmacist	13%; 0%	13%; 0%	13%; 0%	25%; 100%	36%; 0%

were answered as “the case referred to the court”. Most aggressors received an instruction – 36%, while 26% – a penalty, fine, or ticket. During the epidemic, the number of initiated proceedings decreased. The smallest number, only 8%, ended with the acquittal of the perpetrator. 28% were cases brought to court, and the instruction and mandate, fine or penalty were 46% and 18%, respectively.

The percentage analysis of the relationship between the type of profession and the result of the proceedings initiated before and after announcing the epidemic state was performed (Table 4).

DISCUSSION

The first part of the article has discussed many aspects, including the most frequent perpetrators of aggression, the frequency, which groups are most often subjected to violence, and its form. During the rest of the discussion, one should not forget about the causes of aggressive behavior. The aim of violence in the workplace, which is defined as the action of an individual or group of people who are not related to the workplace, is psychological or physical harm to employees [3]. Aggressive behavior is often caused by long-term suppression of emotions, mental and physical exhaustion, and failure to meet basic needs. Therefore, it should be stated that violence in the workplace is a multifaceted and complex phenomenon based on cultural, personal, and organizational factors [4-6]. To understand the behavior of aggressors, it is worth knowing the mechanisms of aggression. Duxbery et al. reported on three models: internal, where the factors causing it mainly concerned the mental state of a person behaving aggressively and their health condition; external, where the main

source was environmental factors, e.g., the principles of the ward functioning, and the last – situational one, conditioned by relations and interactions between medical staff and patients [7]. In-patients often react with frustration or aggression because their stay in hospital becomes a source of various concerns for them. It is a new reality. Suddenly, their lifestyle must change – from home to hospital. Also, medical treatments and procedures applied to the patient are often incomprehensible to the patient, and sometimes they are also not adequately explained. The author’s questionnaire showed that the most common cause of aggression is a long waiting time (25%) and alcohol or drugs (19%), and slightly less – the health situation of the patients, their relatives, or friends – (18%). Stimulants as the cause of violence are also indicated by other authors, adding boosters [8]. Subsequent researchers report that the most frequently indicated factors of aggression are waiting too long (15 cases), refusal to fulfill unjustified requests (66), or dissatisfaction with the service provided (37) [8]. On the other hand, from the perspective of Canadian doctors, they are a diagnosed with mental illness, difficult access to medical care, prior alcohol or psychoactive substance use, and poor socioeconomic conditions. 75% of the surveyed physicians experienced patients’ aggression. They also claim that they are the most vulnerable health care professional group to inappropriate behavior [9].

Other scientists divided the causes depending on the place of the incident. According to the analysis, the perceived pain, the influence of psychoactive substances (mainly alcohol), long waiting for the doctor were the leading causes of aggression in the ED. In the case of the ward, these were: long waiting for the

doctor, patient's pain, and mental disorders [10]. Other authors point out similarly – different diseases may affect different levels of demonstrated aggression, e.g., it is more common in psychiatric or emergency patients [11, 12].

Some researchers also try to understand the perspective of patients. Shafran-Tikval et al. point to the role of both patients and healthcare professionals in provoking acts of aggression. Healthcare professionals can, in many cases, prevent violence that arises from frustration, such as long waiting times. The behavior of medics can be divided into those that contribute to the generation of aggression, including high-pitched voice, condescension, or contempt, as well as responsible behavior, mitigating the conflicts arising between the patient and staff. Authors of the article “Violence against physicians and nurses in a hospital: How does it happen? A mixed-methods study” note, however, that there is still no education in the medical community on how to deal with aggressive patients [13].

It is also worth referring to the ongoing epidemic. According to the proprietary survey, the causes of aggressive events were dominated by long waiting times (25%) and difficult access to medical care (24% – an increase from 14%). These reasons were followed by a refusal to provide healthcare proceedings (17% – a rise from 12%). On the other hand, the use of stimulants or mental illness ranked lower than before announcing the epidemic. Factors that may cause irreversible changes in human mental health include psychosis, isolation, and stress [14]. It can be assumed that these variables may be an indirect cause of aggressive behavior, and undoubtedly, many people experience this type of feeling during an epidemic and social isolation. To confirm the relationship between frustration, which consists of many aspects, and aggression, a hypothesis was formulated that functions in psychology to this day – “The occurrence of aggressive behavior always presupposes the existence of frustration and, conversely, that the existence of frustration always leads to some form of aggression” [15].

It seems that most aggressors are unaware that healthcare professionals are public officials by law. In 2012, the Act on the Nursing and Midwife, Doctor and Paramedic Professions was amended. Under its rights, medics who perform official procedures are treated as public officials. A public official is defined in Art. 115 § 13 of the Criminal Code. This means that an active assault, violation of bodily integrity, or insult is associated with a fine or the penalty of deprivation or restriction of liberty. The chairwoman of

the National Trade Union of Nurses and Midwives considers it necessary to educate patients in the legal protection of nurses, midwives, doctors, and paramedics. The vice-president of the main board of the Polish Society of EMS indicates that reporting acts of aggression and exercising the rights provided for by the Act on medical professions is more frequent than before. However, many physicians are still unaware of their rights or do not have time to deal with such a report [8].

Attacked medical personnel react differently. In the proprietary survey, as many as 16% of respondents did not report an aggressive event anywhere. After March 20, 2020, this indicator increased by 5%. However, it can be noticed that medics most often ask for help from the charge nurse or colleagues. Another author points out similarly – the reactions of nursing staff after an episode of aggression included asking their superiors or colleagues for help, as well as sharp opposition and attempts to talk to clarify the situation [16]. However, in another study, as many as 61% of nurses saw no point in informing their employer about the aggressive event [17].

Interestingly, Anczewska notes that reports often did not contain descriptions of aggressive events, especially when they did not take drastic forms and did not repeat themselves [18]. One can speculate that this is the main reason for the low reporting of incidents to law enforcement agencies such as the police. However, it is worth mentioning the existence of the MAWOZ system – “Monitoring aggression in healthcare”, established by the Supreme Medical Chamber and the Supreme Chamber of Nurses and Midwives. Its purpose is to make it easier for doctors and nurses to report aggression cases in the workplace. Since the beginning of the system's operation, 255 notifications have been registered in it [8]. In the proprietary survey, 9% of respondents reported to the police, and only 0.5% informed the Register of Aggression Monitoring in Healthcare. After the state of the epidemic was announced, it was 7% and 1%, respectively.

Failure to react is silent consent to such behavior. Medical personnel should respond every time – bring civil lawsuits, report to law enforcement agencies. Often, patients force medical procedures or get to, for example, an ED faster, and medics, not wanting to expose themselves to their frustration and aggression, let go, allowing for repetition of such proceedings. Over 300 is the number of crimes in the healthcare system registered by the police each year. It seems that this is not a large scale, but one must bear in mind that these are official police statistics, i.e., they concern only reported cases [19].

The World Health Organization (WHO) reports that violence in the healthcare sector has a negative impact on healthcare professionals and the workplace atmosphere. It can lead to psychological damage to the victim, trauma, and even death. The WHO indicates that violence may reduce health services for the general public, resulting in higher healthcare costs [20]. Short-term effects may appear immediately after an aggressive event [21]. Anger, helplessness, and fear constitute the first emotional reaction to such an event [22]. There are also distant effects [21]. According to the sources, when confronted with aggression, traumatic stress, or post-traumatic stress disorder (PTSD) may develop [23]. Insomnia, irritability, and chronic anxiety are just some of the symptoms that can manifest in people affected by violence. This can result in burnout and medical malpractice, which in turn will lead to increased tension between the patient and medical staff. Other authors also confirm such observations. Aggression has a significant impact on the psyche of medical personnel who must struggle with it. Medics are exposed to stress, fear, and loss of dignity and joy in their profession [8]. Their self-confidence, self-esteem, or willingness to act are also disturbed [24]. The result of experiencing violence is a decrease in the level of motivation and commitment to work in a team exposed to such events, which has a negative impact on efficiency and effectiveness [25].

Many authors indicate not only the professional burnout of medics but also a much more serious consequence, which is the resignation from work [2,26]. According to a study by Rosenthal et al., 4.4% of healthcare professionals reported every case of physical or verbal violence in the last 12 months, including 13.5% of reported physical assault. Among these reports (it concerns both physical and verbal assault), 60.2% of respondents indicated the occurrence of at least one post-traumatic symptom, 9.4% – loss of job, while 30.1% thought about resigning from their professional career or job [27].

It is also worth mentioning how violence affects the private sphere of healthcare workers. According to the authors of the article “Work-Related Violence As A Predictor Of Stress And Correlated Disorders In Emergency Department Healthcare Professionals,” 87% of EMS personnel were victims of workplace violence by patients or their families. More than half of them indicated numerous consequences in the emotional sphere. One-third reported an impact on lifestyle changes – eating and sleep disturbances, increased tobacco consumption and social relations changes, avoidance of specific places, and social isolation [28].

It is puzzling that the next study noted that the overwhelming majority of medical personnel did not seek help, even though 20% of respondents indicated a change in their attitude to work after participating in an aggressive incident. 30% of respondents believe that they will not be able to cope with violence from patients in the future, and 71% of people would be willing to take courses on self-defense [23]. Self-defense courses are an interesting suggestion of the authors of the publication. Other authors also suggest training for healthcare professionals. They also consider informing staff about the impact of abandoning boundaries in contact with the patient or the lack of assertiveness in aggressive behavior as an essential aspect [17,18,29].

Interestingly, people who have shorter work experience are more likely to communicate their willingness to participate in classes showing how to deal with aggressive people at work than people working longer [23]. Other researchers also suggest similar solutions, point to the need to organize workshops and training with lawyers, psychologists, and the police to know how to react to aggression and what measures should be taken in such a situation. The organization of assistance to doctors in taking legal action against aggressors or encouraging them to administrative proceedings is another option [8]. The authors of many publications agree that recognizing, coping with aggression, incapacitating techniques, self-defense, the ability to conduct crisis intervention, and correct reporting and recording aggressive events are important [16, 17, 29].

However, there is a publication available, the authors of which have the opposite opinion. They suggest that training and education of medical personnel may not impact the occurrence of aggression in the workplace. Nevertheless, the actions taken increase a positive attitude and personal knowledge [30].

It is also worth mentioning the help for medics concerning the emotional sphere discussed earlier. Berent et al. claim that doctors would more often, if possible, use the help of a psychologist as opposed to nurses [2].

CONCLUSIONS

The causes of violence vary depending on the medical unit. However, the most important factor is the long waiting time.

It is disturbing that incidents of aggression are still the least frequently reported to a dedicated unit – the Register of Aggression Monitoring in Healthcare System.

Undoubtedly, the scale of the phenomenon of aggression is influenced by the growing tension among

healthcare workers and patients, caused by factors such as social isolation, accumulation of negative emotions, stress related to the epidemic, and limited access to medical facilities.

Aggression, which is a relatively constant and unchanging problem in the healthcare system, according to the authors, requires the development of new, more

effective solutions aimed at improving the situation of the victims. Encouraging staff to report aggressive behavior and actively supporting them in these activities could lead to more frequent legal consequences for aggressors, increasing the chance of greater respect for medical staff and disrupting the false sense of impunity in the perpetrators of such acts.

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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

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OUTCOMES OF PENETRATING CARDIAC INJURIES – A CARDIAC SURGEON APPROACH TO 22 CASES

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Abstract

Aim: Cardiac traumas are of great danger as they have life threatening potential. Although the patient may have normal vital signs at the time of admission the rate of mortality rate has been reported up to 69%. We believe that conducting the initial evaluation and early intervention by a cardiac surgeon may have an impact on decreased mortality.

Material and methods: This study has been conducted with 22 patients that have been admitted with cardiac trauma history. The subjects who were operated after applying to emergency service have been enrolled in this retrospective analysis. Individuals died due to cardiac arrest at admission have been excluded from the study. The subjects with penetrating cardiac injury who have undergone sternotomy or thoracotomy has been included in the analysis.

Results: At the time of admission 4 patients has been presented with shock and 2 patients had been administered resuscitation due to cardiac arrest. The gun shot wound cases were 27% (n=6) and of these cases 3 of them were alive while the remaining 3 died. The stab wound cases were 73% (n=16) with a higher survival rate of 75% (n=4/16). Thoracotomy has been conducted less than sternotomy as the rate was 13.6% (n=3) versus 86.4% (n=19). The overall rate of mortality has been found as 32% (n=7).

Conclusion: According to the results of this study one can say that conducting initial intervention to cardiac trauma patients by a cardiac surgeon reduced the rate of mortality and morbidity.

Key words

Cardiac trauma,
sternotomy,
thoracotomy,
mortality

INTRODUCTION

Cardiac traumas are of great danger as they have life threatening potential. Although the patient may have normal vital signs at the time of admission the rate of mortality is high. Penetrating cardiac trauma mainly affects young males and usually occurs due to a gunshot, stab injury [1]. In geographies of war and terror shrapnel or similar explosives may be added. The developing civilisation, transporting and health care systems the survival rates are assumed to ameliorate [2, 3].

Chest traumas should be handled with care as there is a high degree of suspicion for cardiac injuries and the rate of mortality is considerably high in these cases. On the other hand the incidence of penetrating wounds are increasing over the globe [4]. In many hospitals and health facilities, the cardiac surgeons can only be found during working hours and despite the life threatening potential in most of the situations the cardiac surgeon is usually not the first physician that evaluates individuals at the time of emergency service admission. The physician that examines the cardiac injury patient at the time of admission should be experienced of recognising these injuries and intervening in urgent cases [5]. The general surgeon at

the emergency unit should also be able to deal with severe hemorrhage or cardiac tamponade in chest trauma patients due to the mortality risk of penetrating cardiac injuries [6].

This is crucial for the survival of such subjects the mortality rate in hospitals has been reported up to 69% in previous publications [7]. Thus most of the injured individuals cannot make it to the emergency unit due to hemorrhage, coronary artery injury, and cardiac tamponade, resulting in cardiogenic, hypovolemic and obstructive shock [8].

Although health care technologies are advancing day by day penetrating cardiac injuries still pose a remarkable challenge not only for the emergency unit staff but also for the cardiothoracic surgery teams due to the high mortality rates [5,9]. During the hospital admission and initial examination the emergency unit physicians should consider the possibility of hypovolemic shock due to exsanguination and cardiac tamponade and imminently consult a general or cardiac surgeon [9].

Although the cardiac injuries have life threatening potential in most of the situations the cardiac surgeon is usually not the first physician that evaluates individuals at the time of emergency service admis-

sion. This may delay early intervention and lead to the deterioration of patients' health status, thus losing the window of opportunity in a majority of the subjects.

Our institution has 24 hour working cardiac surgeons in a shifting schedule enabling to deal with cardiac trauma cases. We believe that conducting the initial evaluation and early intervention by a cardiac surgeon may have an impact on decreased mortality. In this article we have reflected our expertise on 22 cardiac injury patients and tried to contribute to existing literature.

MATERIAL AND METHODS

This study has been conducted with 22 patients who have been admitted to Ankara Training and Research Hospital between September 2016 to September 2020 with cardiac trauma history. The subjects who were operated after applying to emergency service have been enrolled in this retrospective analysis. Individuals that have died due to cardiac arrest at admission have been excluded from the study. The subjects with penetrating cardiac injury who have undergone sternotomy or thoracotomy has been included in the analysis.

The initial diagnosis, imaging records, patient folders and electronic files of the enrolled patients have been investigated by the study team in a retrospective manner. The stable and unstable subjects have been detected and individuals that have undergone surgery have been categorized in a different segment. All the analyzed cases consisted of patients whose initial intervention had been conducted by a cardiac surgeon.

The hemodynamic signs, echocardiography and cardiac angiographies have been recorded and patients without any imaging due to shock, hemodynamically unstable or resuscitated subjects were noted. The rate of sternotomy and thoracotomy and the rate of mortality and morbidity have been calculated.

The study has been approved by the ethical committee of our institution at 27/0472021 (Protocole Number: E-58230125-929).

Patient data were evaluated via SPSS 22 (IBM Corp, Armonk, NY, USA) program. Descriptive analyses were conducted using means and standard deviations of normally distributed variables. Frequencies and percentages were given for categorical and nominal variables. Survival rates were calculated at the end of second year of operation. A p-value of less than 0.05 was considered as statistically significant.

RESULTS

The patients were between the ages of 21 to 66 and 91% of them consisted of males. The systolic blood

pressure measurement at admission revealed that 59% (n=13) of them were >90mmHg and 41% (n=9) of them were <90mmHg. At the time of admission 4 patients has been presented with shock and 2 patients had been administered resuscitation due to cardiac arrest. The duration of operation was 130.18±85.37 (42–178) minutes and average intensive care unit stay was 3.16±4.32 (2–14) days (Table 1).

We have enrolled 22 patients (n=2 female, n=20 male) in this retrospective analysis. The injuries of the patients were as follows: right ventricle (n=10), left ventricle (n=7) and both of the ventricles (multiple cardiac injury) (n=2), right atrium (n=1) and pulmonary artery (n=1). We have conducted sternotomy to 19 patients and thoracotomy to 3 patients and coronary artery bypass graft surgery to 1 patient (aortic coronary bypass to left anterior descending artery via vena saphenous). The most frequently used techniques were primary repair, felt or plectet. No valve injury has been detected. The rate of mortality of the study population was 32% (n=7) (Table 2).

The gun shot wound cases were 27% (n=6) and of these cases 3 of them were alive while the remaining 3 died. The stab wound cases were 73% (n=16) with a higher survival rate of 75% (n=4/16). Thoracotomy has been conducted less than sternotomy as the rate was 13.6% (n=3) versus 86.4% (n=19). The overall rate of mortality has been found as 32% (n=7).

Table 1. Demographic and clinical characteristics of the patients.

AGE	
Range	21–66
Mean ±SD	44.5 ±11,78
SEX, n (%)	
Male	20 (91)
Female	2 (9)
HEMODYNAMIC STATUS	
Systolic bloodpressure	
>90 mmHg	13 (59)
<90 mmHg	9 (41)
Shock	4 (18)
Cardiac arrest- resuscitation	2 (9)
Mean ±SD	
Blood transfusion (unit)	7.5 ±3.22 (3–15)
Duration of operation (minute)	130.18 ±85.37 (42–178)
Intensive care unit (day)	3.16 ±4.32 (2–14)
Duration of hospital stay (day)	8.12 ±2.24 (5–13)
MORTALITY, n (%)	
	7 (32)

Table 2. Data on cardiac injury patients.

Age	Sex	Injured region (cardiac)	Surgical approach	Treatment	Injury Type	Result	Descriptions
26	Male	Right ventricle injury	Sternotomy	Primary repair – without pump	Gunshot wound	Death	Exsanguination and shock
39	Male	Left ventricle injury	Sternotomy	Primary repair – without pump	Stab wound	Alive	Mattress suture repair with 3.0 Prolene
48	Male	Left ventricle anterior side	Sternotomy	On-pump-ventricular repair	Stab wound	Alive	Mattress suture repair with 3.0 Prolene
47	Male	Left ventricle lateral side	Left thoracotomy	Primary repair – without pump	Stab wound	Alive	Suture repair with Teflon pledgets
33	Male	Right ventricle injury	Right thoracotomy	Primary repair – without pump	Stab wound	Death	Cardiogenic shock
43	Male	Right ventricle anterior side	Sternotomy	Primary repair – without pump	Gunshot wound	Alive	Both thorax, mediastinal and abdominal injury, laparotomy performed
41	Male	Right ventricle anterior side	Sternotomy	Primary repair – without pump	Stab wound	Alive	Cardiogenic shock
58	Male	Right ventricle anterior side	Sternotomy	Primary repair – without pump	Stab wound	Alive	Primary repair
66	Female	Right ventricle anterior side	Sternotomy	Primary repair – without pump	Stab wound	Alive	Primary repair with 3.0 Prolene
28	Male	Right- Left ventricle injury	Sternotomy	On-pump-biventricular repair	Stab wound	Death	Cardiac tamponade or shock and present as a medical emergency
24	Male	Left ventricle injury	Sternotomy	Primary repair – without pump	Gunshot wound	Death	Hemodynamic lability or shock status
46	Male	Right ventricle injury	Sternotomy	Primary repair – without pump	Gunshot wound	Alive	Two separately injuries in right ventricle, abdomen injury
31	Male	Left ventricle posterior injury	Sternotomy	On-pump-biventricular repair	Stab wound	Alive	Taken to the operating room with medical and mechanical resuscitation
21	Male	Left mammary artery injury	Sternotomy	Primary repair – without pump	Stab wound	Alive	Lung and LIMA injury
31	Male	Left chest injury	Left thoracotomy	Primary repair – without pump	Gunshot wound	Death	Left ventricle and lung injury
22	Male	Right- Left ventricle injury	Sternotomy	Primary repair – without pump	Stab wound	Death	With LAD injury –CABG bypass
34	Male	Right atrium	Sternotomy	Primary repair – without pump	Stab wound	Alive	Primary repair
27	Male	Pulmonary artery injury	Sternotomy	Primary repair – without pump	Stab wound	Death	Arrest cardiac
24	Male	Right ventricle injury	Sternotomy	Primary repair – without pump	Stab wound	Alive	Primary repair
26	Female	Right ventricle-Abdomen	Sternotomy –laparotomy	Primary repair – without pump	Stab wound	Alive	With laparotomy
39	Male	Left ventricle injury	Sternotomy	Primary repair – without pump	Stab wound	Alive	Primary repair
46	Male	Right ventricle injury	Sternotomy	Primary repair – without pump	Gunshot wound	Alive	Primary repair

CABG – Coronary artery bypass grafting,
 LIMA – Left internal mammary artery,
 LAD – Left anterior descending artery

DISCUSSION

Most of the individuals die at the crime scene due to bleeding complication of penetrating injury or gunshot wounds. Thorax wounds are also fatal due to cardiac, pulmonary or main artery injuries. Patients who have succeeded to admit to hospital have lower mortality rate as expected. The urgent transportation to hospital, patient management at the emergency service and the initial examination by an experienced physician is crucial for the survival of the patient. In this study we have conducted sternotomy to 19 patients and thoracotomy to 3 patients and coronary artery bypass graft surgery to 1 patient (aortic coronary bypass to left anterior descending artery via vena saphenous). The most frequently used techniques were primary repair, felt or pledget. No valve injury has been detected. The rate of mortality of the study population was 32% (n=7). Our findings also correlated with the previously published data.

Manduz et al. have reported in one of their studies that the extra cardiac injuries accompany 35% of cardiac injuries [10]. Kang et al. have reported the following involvement rates: right ventricle 43%, left ventricle 34%, right atrium 18%, left atrium 5%. Involvement of multiple chambers is 18–35% [11]. In this study (n=22) the injuries of the patients were as follows: right ventricle (n=10), left ventricle (n=7) and both of the ventricles (multiple cardiac injury) (n=2), right atrium (n=1) and pulmonary artery (n=1).

Although penetrating cardiac injuries consist of 10% of all thoracic traumas they are the most common cause of mortality [12, 13] and the patient population usually younger males (under 40 years of age). In our study 20 of 22 cases were males. Mortality in penetrating cardiac injuries is also closely related to adjacent organ injuries. The artery injuries are also not a common denominator of cardiac trauma and only reported as 5% in previous research. Arterial injuries are generally detected in the distal branches of the coronary thus enabling the surgeon to ligate the coronary artery without the need for additional processing. In an article by Atayi et al (2017) 94.58% (86.48% stab wounds and 8.1% gunshot wounds) of patients were operated because of penetrating injury [14].

As expected, penetrating cardiac injuries caused by gunshot wounds have higher mortality rates than stab wounds [12]. The features of stab wounds are generally in the form of a single lesion and the wound can be limited by tamponade. The survival rate of stab wounds is approximately 70%-80% and this ratio is quite lower 30%-40% in gunshot

wounds [6]. The mortality rate observed with stab wounds was 43.75%. The overall mortality rate was 55% in a study conducted by Kaljusto et al. and was 27.3% in a study conducted by Aksoyek et al. [13, 14] which was 32% in our study.

Cardiac tamponade can be observed in approximately 80% patients in penetrating injuries [6, 16]. In penetrating and blunt cardiac injuries, the diagnosis of hemopericardium with echocardiography is crucial [11, 18]. Generally, median sternotomy and left anterolateral thoracotomy were the preferred surgical incisions in patients with suspected cardiac injury.

Although there is no consensus, there are numerous publications about different incision approaches as published data. Up to date many studies have been published indicating that significant survival rates have been achieved in emergent antero-lateral thoracotomy for cardiac injuries admitted to emergency room. On the other hand, some authors have reported that thoracotomy for penetrating cardiac injuries should only be performed by experienced and well-equipped teams to achieve favorable results [15].

In suspicion of posterior cardiac injury or/and esophageal injury, thoracotomy can be chosen as the primary surgical option. The initial plans for the approach cannot yield proper exposure to the injury site and an additional sternotomy or a thoracotomy can be needed sometimes. Mitchell et al. have reported 20% sternotomy in thoracotomy patients and a 3% thoracotomy in sternotomy patients in their study [16]. Besir et al have reported that 11% of the thoracotomy patients needed additional sternotomy and 14% of the sternotomy patients needed additional thoracotomy [15].

Additional incisions are not desirable due to additional pain burden and cosmetic issues so it is important to avoid extra incisions. Preoperative imaging should be leveraged as the main strategy driving surgical approach as long as the patient is hemodynamically stable enough. In some cases; however, it is inevitable to perform additional incisions no matter how hard imaging modalities have been instituted to make a decision.

Survival rates in penetrating cardiac injuries can vary between 3% and 84% in published studies [7, 17]. Tyburski et al. have reported the following variables as mortality factors: hemodynamic instability, mechanism of injury (firearm injuries are the most fatal injuries), presence of cardiac tamponade at admission, presence of great vessel injury and presence of multiple injuries [17]. The best prognosis is reported for the right ventricle injuries. In published studies, authors have generally compared thoracoto-

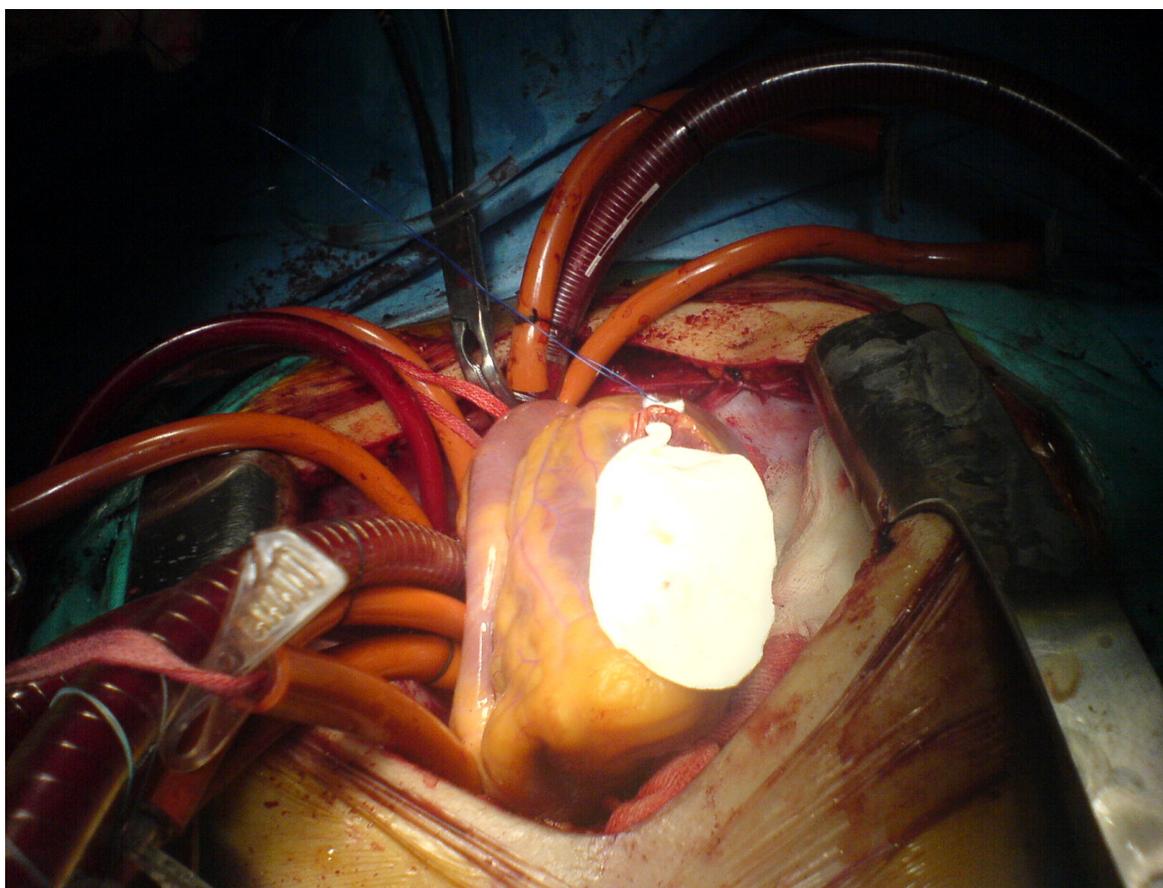


Fig. 1. Repair of left ventricular injury following sternotomy with Teflon pledget

mies performed in the emergency room (ER) and the thoracotomies performed in the operation room for prognosis [18].

The most important life-saving factors are convenient and fast transport to the emergency room, early diagnosis, hemodynamic status of the patient, presence of cardiac tamponade, and elapsed time between admission and surgery. Thoracotomy and sternotomy are two different approaches in suspected penetrating cardiac injuries [19].

Up to the experience in our clinic one can admit that the decision of thoracotomy or sternotomy should be taken by the surgeon according to radiological evidence and vital signs. In most of the situations the cardiac surgeon is usually not the first physician that evaluates patients at the time of emergency service admission. This may delay early intervention and lead to the deterioration of patients' health status, thus losing the window of opportunity in a majority of the subjects. Sternotomy enables a better operative area for mediastinum, thorax or cardiopulmonary bypass (Fig. 1). On the other hand thoracotomy may be advantageous on isolated right,

left or posterior injuries. As we have mentioned previously, the experience and resources of the institution plays an important role in the decision of surgical approach; for example sternotomy may be chosen in a majority of the cases where cardiopulmonary bypass is conducted routinely. However it is possible to save the patients' life with thoracotomy in centers with limited sources.

LIMITATIONS OF THE STUDY

The main limitation of our study could be attributed to the enrolled study population of 22 cases. On the other hand the main strength may be elaborated as the physician conducting initial intervention was a cardiac surgeon.

CONCLUSIONS

According to the results of this study one can say that conducting initial intervention to cardiac trauma patients by a cardiac surgeon reduced the rate of mortality and morbidity. Future research with a greater sample size are required to enlighten this issue.

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PERFECTIONISM AND BURNOUT IN HEALTH CARE PROFESSIONALS

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Abstract

Aim: To discover the relationship between adaptive and maladaptive perfectionism and professional burnout in laboratory diagnosticians in the Pomorskie [Pomeranian] Voivodship, Poland.

Material and methods: The Oldenburg Burnout Inventory (OLBI) and the Adaptive and Maladaptive Perfectionism Questionnaire (PAD) were used in the descriptive cross-sectional study.

Results: Previous research suggests that the phenomenon of occupational burnout among the professional group of laboratory diagnosticians seems to have a specific nature, different from burnout in other medical professionals. It is believed that extremely high job demands, insufficient personal resources, as well as certain personality characteristics (which can alter the perceptions and responses to job demands as well as the perception and use of resources), are essential to the development of professional burnout.

Conclusions: In the age of the SARS-CoV-2 coronavirus pandemic, strict compliance with safety procedures when performing tests for virus infection through laboratory diagnostics is of especially great importance to the entire epidemiological situation.

Key words

burnout, perfectionism, laboratory scientists, disengagement

INTRODUCTION

Laboratory diagnosticians form a unique professional group, formally recognized in only a few European countries. The nature of the work suggests that the successful performance of a medical analyst's duties requires precision and meticulousness. It might thus favor people who are more willing than others to submit to existing standards and rules, especially in the age of the SARS-CoV-2 pandemic. Laboratory diagnosticians are currently working under enormous pressure, putting their health and even lives at risk. Such a burden may be conducive to the development of occupational burnout and leaving the profession among the already small group of laboratory diagnosticians in Poland. Our research suggests possible diagnosticians' coping mechanisms. Thus, the recognition of such mechanisms can be beneficial from the public interest perspective.

It is believed that extremely high job demands combined with insufficient personal resources, as well as certain personality characteristics which can

alter the perceptions and responses to job demands and the perception and use of resources, are essential to the development of professional burnout [1].

The definitions of individual symptoms of professional burnout have evolved, and now take into consideration two factors:

1. "exhaustion", which, aside from a decrease in energy, also denotes loss of physical strength as well as depletion of cognitive resources, and
2. "work disengagement", defined as distancing oneself from work and developing a negative attitude toward things and tasks related to it [1].

Perfectionism may be a factor in the occurrence of professional burnout [2]. Two dimensions of perfectionism can be distinguished: perfectionistic strivings and perfectionistic concerns [3]. Perfectionistic strivings are referred to as adaptive perfectionism, which is characterized by focusing on one's own high personal standards and striving for perfection, and is generally associated with achieving positive outcomes [3].

Perfectionistic concerns are referred to as maladaptive perfectionism, which is characterized by doubting the quality of one's own performance, concerns over mistakes, negative reactions to imperfections, and a perceived social pressure to be perfect [4]. Generally, perfectionism is associated with professional burnout and perfectionism increases engagement [5]. Both dimensions of perfectionism are associated with problem-focused coping [4].

Relatively small in numbers in comparison to other categories of medical professionals, and not necessarily with a similar personality profile, the profession of a laboratory diagnostician has not been sufficiently studied with regard to the relationship between perfectionism and professional burnout. Studies of nurses have demonstrated that maladaptive perfectionism is a predictor of both higher exhaustion and lower work engagement, whereas adaptive perfectionism is "protective, allowing to maintain work engagement and counteract exhaustion" [2]. However, a 2018 study of diagnosticians suggests an opposite relationship between burnout and perfectionism. The results of that study show that the "healthier" (more "adaptive") the perfectionism the diagnosticians displayed, the higher level of burnout they presented. In this profession, lower risk of burnout is displayed by those who show lack of confidence in the quality of their actions and negative reactions to their own imperfections, which are associated with the imposed social obligation to be perfect. The individuals pursuing their internal high standards experience burnout faster [6].

Apart from the two studies mentioned above, we are not aware of any other studies on the relationship between perfectionism and burnout among medical professionals. On the other hand, the phenomenon of occupational burnout among medical workers has been examined, among others, in the employees of Polish tissue and organ banks, many of whom had been involved in the procurement and processing of tissues from deceased donors [7]. The study used the Polish version of the Oldenburg Burnout Inventory (OLBI), and the psychosocial working conditions questionnaire (PWC), a Polish instrument for monitoring psychosocial stress at work. Work related support has been identified as the most important factor among burnout correlates which could influence the efficacy of the transplant network in Poland [7].

Medical staff experience a heavy workload and suffer from a considerable level of stress, which can result in the deterioration of mental health and burnout [8-10]. The British Medical Association reports that 40% of physicians and medical students reported currently suffering from a broad range of psycho-

logical and emotional conditions such as depression, anxiety, burnout and stress. What is more, 90% of the respondents stated that their current working or studying environment had contributed to their condition to a significant or partial extent [11]. Currently there are no similar studies in the professional group of laboratory diagnosticians.

THE AIM

Our study aimed to discover the relationship between adaptive and maladaptive perfectionism and professional burnout in the laboratory diagnosticians in the Pomorskie [Pomeranian] Voivodship, Poland.

MATERIAL AND METHODS

The study was planned and conducted as a descriptive cross-sectional study. The scope of the study related to adaptive and maladaptive perfectionism and professional burnout. The participants of the study were laboratory diagnosticians, who took part in a recurring laboratory diagnosticians' convention, financed by the National Chamber of Laboratory Diagnosticians and organized in the Pomorskie Voivodship. 33 laboratory diagnosticians from the Pomorskie Voivodship were participated for the survey. Participation in the study was voluntary and any-

Table 1. Characteristics of the studied population.

Variables	Categories	Number	Percentage [%]
Gender	male	2	6
	female	31	94
Work Experience	no more than 5 years	5	15
	6-10	7	21
	11-15	2	6
	16-20	7	21
	21-25	4	12
	26-30	6	18
	31 years or more	2	6
Marital status	in a relationship	23	70
	single	10	30
Education	university education	19	58
	university education with a specialization	9	27
	a doctorate	1	3
	a doctorate with a specialization	4	12
Employer	private institution	12	36
	public institution	21	64

mous. Participants did not receive remuneration. Each participant signed an informed consent form to participate in the study and could resign from it at any time. The exclusion criterion was the lack of consent to the study. It is worth noting that the professional group of laboratory diagnosticians in Poland is quite small and scattered throughout various centers throughout the country.

Descriptive statistics were computed and analyzed. In order to determine the relationship between professional burnout and the two dimensions of perfectionism (adaptive perfectionism and maladaptive perfectionism), Pearson's correlation coefficients were calculated and statistical significance ($p < 0.05$; $p < 0.001$) analysis were performed. Tests for distribution normality (Kolmogorov-Smirnov and Shapiro-Wilk Test) and nonparametric tests to confirm the results were also carried out. IBM SPSS Statistics 25 software (IBM SPSS Inc., Chicago, IL, USA) was used for data analysis.

All persons who participated in the study completed paper questionnaires:

1. Perfectionism was evaluated using Polish version of Adaptive and Maladaptive Perfectionism Questionnaire (PAD) [12]. The questionnaire is comprised of 35 statements concerning personal characteristics and behaviors, with responses recorded on a 7-point Likert-type scale (from "strongly disagree" to "strongly agree"). The instrument has good psychometric properties and has been shown to measure two dimensions of the trait of perfectionism, namely adaptive and maladaptive perfectionism. Cronbach's alpha internal consistency coefficient for the scale of maladaptive perfectionism is 0.947 and for the scale of adaptive perfectionism is 0.846 [12].

2. Professional burnout was evaluated using the Polish version of Oldenburg Burnout Inventory (OLBI) by Demerouti et al. and Baka, Basińska [13, 14]. The inventory consists of 16 statements concerning the respondent's attitude to their job and their feelings about it. The questionnaire measures two aspects of professional burnout: disengagement and exhaustion. The respondent rates each statement using a 4-point Likert-type scale. Some of the items are reverse scored. Higher scores indicate higher levels of professional burnout. The OLBI questionnaire also has good psychometric properties, confirmed in many studies. Cronbach's internal consistency coefficient for the scale of exhaustion is 0.73, and for the scale of disengagement is 0.69 [10, 14].

The study was approved by the Independent Bioethics Committee for Scientific Research at the Medical University of Gdańsk [decision No. NKBBN/487/2016-2017].

RESULTS

The average age of the sample group was 42.60 ± 9.86 years. Other features of the studied population are shown in table 1. Women constituted the vast majority of the sample, which reflects the composition of the professional group of laboratory diagnosticians in Poland, as well as in the Pomeranian Voivodeship.

Correlation analysis indicates that maladaptive perfectionism correlates negatively with professional burnout (specifically, with the exhaustion component), whereas adaptive perfectionism does not correlate with professional burnout (in either of its components, i.e. exhaustion and disengagement). Those results are shown in table 2.

Table 2. Perfectionism and professional burnout.

Variables	Respondents (N=33)		Correlations		
	M	SD	Adaptive perfectionism	Maladaptive perfectionism	Disengagement
Adaptive perfectionism	66.36	8.06	-		
Maladaptive perfectionism	67.67	15.14	0.080	-	
Disengagement	22.91	3.84	-0.088	-0.241	-
Exhaustion	23.85	4.88	-0.071	-0.563	0.350

1 $p < 0.05$; 2 $p < 0.001$

M – mean

SD – standard deviation

DISCUSSION

This study has demonstrated that one of the aspects of professional burnout, i.e. exhaustion, is negatively correlated with maladaptive perfectionism.

These results suggest that the opposite of a typical relationship between perfectionism and burnout applies to the profession of the laboratory diagnostician. In our study, people characterized by higher maladaptive perfectionism burn themselves out less.

The reasons for this are puzzling. Could the results be related to predispositions of the respondents, or is it more about the manner in which one becomes qualified for this profession? As mentioned in the introduction, the work of a laboratory diagnostician requires particular competence, i.e. the ability to strictly observe procedures. This limits the opportunities for innovative actions. Perhaps people with a higher fear of making mistakes and with a negative response to them, who doubt the quality of their actions, constantly correct their work and feel more socially pressured to be perfect, cope with such demands better [4]. Such people feel the external pressure to be perfect more than the internal one. Thus, they might expect their job to impose strict standards, procedures and rules more than others would. Therefore, highly formalized job demands suit their rigorous internal self-image criteria and their willingness to be critically evaluated by others in their work environment [5]. Therefore, people with higher levels of maladaptive perfectionism ultimately burn themselves out more slowly in the profession of a diagnostician.

At present, it is thought that the key factors for developing professional burnout syndrome are: an overly demanding job, insufficient personal resources, and personality characteristics that may modify perception and reactions towards job demands as well as perceiving and using personal resources [1]. The original understanding of professional burnout has changed since the concept was developed. A bifactor model is commonly used now, with the two factors being “exhaustion”, which means not only lower energy but also limited cognitive resources, and “disengagement from work” i.e. having a negative approach towards things and tasks connected with work. It is worth noting that the component of “reduced sense of personal accomplishment” appears independently at later stages of professional burnout and this may be a consequence of the phenomenon, rather than an axial element of it.

According to the assumptions of the authors of the PAD questionnaire, perfectionism can influence a person’s functioning either constructively or destructively, depending upon whether the adaptive or maladaptive components have been internalized [15].

The adaptive components indicated by the authors are high standards or the need for organization and order, whereas the maladaptive components are discomfort and distress associated with the discrepancy between the high standards required in all aspects of life and the quality of performance. Characteristics of maladaptive perfectionism also include difficulties in interpersonal relationships, high levels of anxiety, and fear of making any mistakes.

Unlike people driven by external pressure to be perfect, others, who are more oriented towards self-development whilst also having a greater need for feeling satisfied with their activity, burn themselves out in this profession faster [4]. Long-term striving for job accomplishments, which could help to develop positive self-esteem in other professions, may consume too much of their available resources. Furthermore, the job demands may involve the abandonment of creativity, which eventually proves to be overly frustrating and leads to exhaustion [1].

The aim of our study was to find the relationship between adaptive and maladaptive perfectionism and professional burnout among laboratory diagnosticians. The concept of the two aspects of perfectionism has been adopted for the purpose of this study, i.e., adaptive (healthy) and maladaptive (unhealthy) [12]. Moreover, a bifactor model of professional burnout has been considered comprising exhaustion and disengagement from work [1]. We have discovered a negative relationship between maladaptive perfectionism and one of aspects of professional burnout – exhaustion. A low level of maladaptive perfectionism is a significant correlate of exhaustion from work among these health care specialists, which confirms the results of our previous research [6].

Diagnosticians presenting “maladaptive” perfectionism are less likely to develop professional burnout, which raises questions about the psychological characteristics of people choosing this type of clinical work. We can interpret this result as indicating that adapting to the demands of a specific profession might be easier for individuals more likely to accept being or even expect to be subjected to external pressure to be perfect and impeccable. It can be assumed that people choosing the profession of a diagnostician very much need, for psychological reasons, the structure provided by formal rules, procedures, etc.

It can also be assumed that the professional group of laboratory diagnosticians is very specific, even within the broader group of medical professionals, and what makes adapting to the to the job difficult in other professions, actually helps here.

These findings lead us to question the appropriateness of a rigid interpretation of perfectionism as “adaptive” and “maladaptive” [3, 4].

The results obtained in our study can also be used to gain a more general understanding of the specifics of this particular profession, and to identify other medical professions similar to laboratory diagnostics. This could be an interesting research question for further studies. It is likely that other jobs which also consist of repetitive and highly formalized procedures and algorithms may demonstrate similar dynamics of burnout and perfectionism. As the development of technology is likely to lead to the elimination or significant reduction in employment in such specializations due to their replacement by robotics and machine learning, it is particularly important to pay attention to people choosing this type of work.

The study has certain limitations and one should therefore be cautious about drawing more general conclusions. Among the most important limitations is the small size of the sample. However, gathering a large number of laboratory diagnosticians in one place to complete the required questionnaires is not possible in Poland. There is also a need to replicate the study in a broader context, e.g. by repeating the survey in the populations of laboratory diagnosticians in other

countries. The research would also benefit from using in-depth interviews to elaborate on the subject matter. The authors of the study are open to cooperation with other researchers interested in deepening and verifying the results obtained thus far.

CONCLUSIONS

The phenomenon of occupational burnout among laboratory diagnosticians seems to have unique characteristics, different from burnout in other medical professionals.

Our results indicate that the relationship between burnout and perfectionism among laboratory diagnosticians should be examined in a more systematic and deeper way, perhaps in comparison with other categories of medical professionals. It would also be advisable to develop appropriate intervention methods to minimize the risk of occupational burnout among laboratory diagnosticians. It is highly probable that the significant stressor of the SARS-CoV-2 pandemic will exceptionally burden diagnosticians in connection with their professional role, commitments and responsibilities. Our research explains the diagnosticians' coping mechanisms. Therefore, the recognition of such mechanisms can be beneficial from a social perspective – for the prevention of burnout in this group.

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LIFEGUARDS' KNOWLEDGE RETENTION FOLLOWING AIRWAY MANAGEMENT, VENTILATION AND OXYGEN ADMINISTRATION TRAINING

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Abstract

Aim: To assess the retention of lifeguards' knowledge after Qualified First Aid Course and its recertification in 3 essential categories: airway management, ventilation and oxygen administration.

Material and methods: The study was performed from August 2020 to November 2020. The online survey addressed to lifeguards from 16 provinces of Poland was used as the evaluation method. Analysis of knowledge retention depending on the time that has passed since Qualified First Aid Course or its recertification was carried out on basis of 312 collected questionnaires.

Results: Participants obtained the mean score of 7.9 ± 2.5 out of 15 points. Statistically significant difference was found between mean scores achieved by respondents who attended in the full course ($n = 171$) and those ($n = 141$) who have taken part in at least 1 recertification (respectively 7.6 ± 2.53 vs. 8.3 ± 2.7 points; $p = 0.018$). Although data analysis did not show a statistically significant downward trend depending on the time that has passed since Qualified First Aid Course, mean scores obtained by the study group in specific periods of time that has passed since recertification differ significantly ($p = 0.026$). The study identified 6 areas of knowledge least assimilated by lifeguards respectively: 2 in airway management, 3 in ventilation and 1 in oxygen administration category.

Conclusions: Significant downtrend over time after Qualified First Aid Course recertification and detected areas of insufficient knowledge relating to key issues of life support indicates that the lifeguards' training should be reanalyzed and redesigned carefully.

Key words

first aid,
airway management,
near drowning,
educational measurement,
lifeguard

INTRODUCTION

There are an estimated 320,000 annual drowning deaths worldwide, which makes drowning the 3rd leading cause of unintentional injury deaths and the 2nd leading cause of unintentional pediatric deaths [1, 2]. Evidently the risk of death due to accidental drowning is higher in Poland than in any other European Union country [3]. Only in 2019, there were 471 drowning accidents in Poland, which resulted in 456 unnecessary deaths [4]. These data confirm the need for possessing effective saving system for drowning victims, based on competent rescuers [5, 6]. Keeping in mind that untrained bystanders' assistance in cardiopulmonary resuscitation in a drowning event seems insufficient [7, 8], it seems important to provide certificated lifeguards with appropriate and efficient training. The lack of knowledge may lead to stress and frustration among rescuers and that in turn may result in mistakes which otherwise should be easy to avoid [9, 10].

In Poland every active lifeguard must complete a 66-hour Qualified First Aid Course (QFAC). In accordance with the law the program provides 25 hours

of theoretical and 41 hours of practical training [11]. Upon completing QFAC every lifeguard should also be skilled in the airway management such as the use of oropharyngeal tube (OPA), laryngeal tube (LT-D), laryngeal mask airway (LMA) and manual suction devices, ventilation by bag-valve mask with reservoir (BVM) and oxygen administration by non-rebreather mask (NRB) [11].

In order to treat severe tissue hypoxia caused by intrusion of water to the lungs of a drowned victim it is crucial to initiate effective ventilation as soon as possible [12]. The necessity of this action should be taken under consideration when teaching and testing the knowledge of a lifeguard. According to scientific research based on the assessment of lifeguards' knowledge of rescue airway devices and ventilation much more training seems necessary [2, 13-15]. Research among prehospital healthcare providers having qualifications similar to those of a lifeguard show that managing the airway is the most difficult skill to master [16, 17]. Therefore, lifeguards' training should concentrate more on that problem in order to increase the chance of survival. Although lifeguards

rarely encounter the victims of respiratory or cardiopulmonary arrest, they have to be ready when those worst-case scenarios happen, so the competent training is essential to the job of a rescuer [18].

The above remarks show the necessity of the educational work every lifeguard has to undertake in order to improve his/her competences and to be useful as a main drowning victims rescuer. Even though the knowledge about airway management, ventilation and oxygen administration is widely believed to be one of the most important aspects of life support techniques performed on drowned victims, little research has been done on the subject. The European Resuscitation Council (ERC) Guidelines for Resuscitation 2021 state that the abilities necessary for successful cardiopulmonary resuscitation (CPR) in basic life support (BLS) fade away within 3 – 12 months of completing the training [19]. Due to the fact that the effectiveness of rescue comes from specialized knowledge which depends on the quality of the rescuers' education, every trained individual whose chance of participating in a resuscitation is higher than average should be put under re-evaluation every 6 – 12 months [19]. Despite those recommendations the QFAC needs to be re-certificated every 3 years in order to maintain the title of a lifeguard [11]. These discrepancies and the small number of scientific reports on the lifeguard's knowledge and skills retention prompted us to take interest in this subject.

THE AIM

The aim of the study was to assess the retention of lifeguards' knowledge in 3 essential categories: airway management, ventilation and oxygen administration. The 2 main hypotheses formulated in this study state that:

- the lifeguards' knowledge shrinks over time after the QFAC,
- the lifeguards' knowledge shrinks over time after the QFAC recertifications (reQFAC).

Secondary aim was to identify the least assimilated areas of knowledge.

MATERIAL AND METHODS

The study was performed from August 2020 to November 2020. The online questionnaire was anonymous and voluntary, used as the evaluation method addressed to active lifeguards. Analysis of knowledge retention was carried out in 4 groups (<12 months, 1-2 years, 2-3 years, > 3 years) depending on the time passed since QFAC and 3 groups (<12 months, 1-2 years, 2-3 years) depending on the time that has elapsed since reQFAC. Group > 3 years since

QFAC included lifeguards with extended eligibility due to training difficulties during the SARS-CoV-2 pandemic.

The first part of the questionnaire consists of 2 sociodemographic questions and 4 questions devised to gather information about respondents' certification with subsequent recertification and training process. The second part of the questionnaire consists of 15 multiple choice practical exam questions with one correct answer: 5 questions from each of 3 essential categories: airway management, ventilation and oxygen administration. The maximum number of points that a participant could obtain was 15. No negative points were considered in the calculation.

Statistical analysis of the data was executed by the PQStat, version 1.8.0.438. Quantitative variables are presented using basic descriptive statistics: the arithmetic mean (\bar{x}), standard deviation (SD), median (Me) and/or percentages (%). The participants' scores were compared to the Kruskal-Wallis test (when $k > 2$) and the post hoc Dunn test with Bonferroni correction and the trend was estimated with the Jonckheere-Terpstra test. In the case of dichotomous scales ($k = 2$) the results were analyzed with the Mann-Whitney U test. Test probability at $p < 0.05$ was considered as significant and test probability at $p < 0.01$ was considered as highly significant.

RESULTS

Lifeguards that participated in the study were working in all 16 provinces of Poland. 60 questionnaires have been excluded from the study due to incomplete data and 312 questionnaires have been taken under consideration. The mean age of the study group was 25.7 ± 9 years. Participants obtained the mean score of 7.9 ± 2.5 points.

Participants were divided into 4 groups, according to the time that have passed since their QFAC certification. The number of participants in each group was as follows: < 12 months – $n = 55$, 1-2 years – $n = 81$, 2-3 years – $n = 63$ and > 3 years – $n = 113$. The participants who took part in a recertification process have been asked an additional question to specify the period of time in which the last recertification occurred. In these groups the total number of participants with at least 1 recertification was 141 lifeguards and the exact numbers were as follows: < 12 months – $n = 45$, 1-2 years – $n = 64$, 2-3 years – $n = 32$ (including lifeguards with extended periods of validity due to the COVID-19 pandemic).

The analysis of the data depending on the participation in the recertification showed a statistically significant difference between scores achieved by

respondents who attended in the QFAC ($n = 171$) and those ($n = 141$) who have taken part in QFAC and at least 1 reQFAC (respectively 7.6 ± 2.53 vs. 8.3 ± 2.7 points; $p = 0.018$). Analysis of the mean score depending on time that has passed since the last QFAC certification showed a significant difference ($p = 0.014$) but it relates only to the difference in the mean number of points obtained in the group <12 months in comparison to the group 1-2 years after the QFAC. The comparison in all groups did not show a statistically significant downward trend depending on the time that has passed since QFAC (Table 1).

The mean scores obtained by the study group in specific periods of time that has passed since reQFAC differ significantly ($p = 0.026$). Data analysis also showed a significant downtrend over time (Table 2).

In accordance with the secondary aim the identification of the least assimilated areas of knowledge were made (Table 3.). The proportion of less than 50% correct answers were used to establish areas

with low level of knowledge in the study group.

Analysis of the questions concerning airway management shows low percentage of correct answers concerning determination of the right size of laryngeal tube (32% with $n = 101$) and the need of assessment of foreign material presence in the mouth of a non-breathing drowning victim before proceeding to further steps (23% with $n = 72$).

The frequency of correct answers to 5 questions regarding oxygen therapy was in the range of 49-62%. According to the adopted criteria, 1 question related to oxygen supplementation in an unconscious victim after a head injury did not reach the required threshold level of 50% (49% with $n = 152$).

In the ventilation category, participants did not reach the required threshold level of correct answers in 3 out of 5 questions: when to actively ventilate victims with respiratory distress after drowning episode (32% with $n = 99$), correct frequency of asynchronous ventilation in adults (32% with $n = 101$) and pediatric victims (18% with $n = 56$).

Table 1. Analysis of knowledge retention after Qualified First Aid Course, depending on time.

Time passed since last certification (n = 171)	x (SD)	Me	IQR
< 12 months	8.46 (2.27)	8	7 - 10
1 - 2 years	6.97 (2.13)	7	5 - 8
2 - 3 years	7.83 (2.01)	8	6 - 9.25
> 3 years	7.25 (3.47)	7.5	4.75 - 10
p value	0.387		

x – mean,
SD – standard deviation,
Me – median,
IQR – interquartile range

Table 2. Analysis of knowledge retention after recertification of Qualified First Aid Course, depending on time.

Time passed since last certification (n = 141)	x (SD)	Me	IQR
< 12 months	9.11 (2.49)	9	7 - 11
1 - 2 years	7.92 (2.73)	8	6 - 10
2 - 3 years	7.76 (2.63)	8	6 - 10
p value	0.026		

x – mean,
SD – standard deviation
Me – median
IQR – interquartile range

Table 3. The frequency of correct answers to individual questions within the study group.

The content of the questions:	Percentage of correct answers	Number of correct answers (n = 312)
Assessment of airway before further actions	23%	72
Determining the right size of laryngeal tube	32%	101
Determining the right size of oropharyngeal tube	57%	177
Securing the laryngeal mask airway	67%	208
Activities undertaken in the absence of tolerance oropharyngeal tube by the victim	86%	269
Frequency of asynchronous ventilation in resuscitation of a child victim	18%	56
Decision making while ventilating victims with respiratory distress after drowning episode	32%	99
Frequency of asynchronous ventilation in resuscitation of an adult victim	32%	101
Potential complications of squeezing the bag-valve mask too rapidly	72%	224
Cardiopulmonary resuscitation algorithm modifications in victims after drowning episode	89%	278
Passive oxygen therapy in unconscious head trauma victims (using non-rebreather facemask)	49%	152
Methods of achieving desired oxygen concentration in the inspiratory mixture	53%	166
Desired oxygen concentration in the inspiratory mixture during cardiopulmonary resuscitation	57%	179
Purpose of the reservoir in bag-valve mask ventilation	62%	192
Desired oxygen flow during cardiopulmonary resuscitation	62%	193

DISCUSSION

The risk of death due to accidental drowning is not an uncommon accident [1-3]. Therefore, Polish lifeguards undergo the training in the form of QFAC. This course highlights their necessity to provide crucial help, since they are the first on the scene of accident, before Emergency Medical Service arrives. Many sources point out that the lifeguards may be obliged to perform airway and breathing assessment and to treat any abnormalities in the respiratory impairments [5, 7, 8, 15, 20]. Additionally, research shows that the lifeguards are the best source of primary help [7, 8]. These requirements can be only met when the rescuer has a specific set of skills based on extensive knowledge of the life support techniques. It is reasonable to assume that the efficiency of a lifeguard depends on the quality of the QFAC. Unfortunately, the program is carried out in the same way for all first responders such as: lifeguards, firefighters, soldiers, policemen [21]. The course syllabus does not highlight the important aspects of working with the drowning victims, which questions the effectiveness of the education. Additionally, reQFAC is not equivalent to a full 66-hour course. According to the

Polish law, a lifeguard must pass an exam which may be preceded by a short training only (1- or 2-days program once every 3 years).

The present study shows an important difference between the scores of respondents who attended the QFAC and those who also have taken part in reQFAC (respectively 7.6 ± 2.53 vs. 8.3 ± 2.7 points). However, despite the higher scores achieved by the group that completed the course and at least 1 recertification, data analysis showed a significant down-trend over time after reQFAC ($p = 0.026$). Such a trend was not found after the full 66-hour course. Knowledge retention regarding key rescue activities such as airway management, ventilation and oxygen administration after reQFAC may be insufficient. It is reasonable to consider the cause of those effects resulting from ineffective recertification and its rarity of occurrence (once every 3 years) [11]. The results of the study show that it would be suitable to increase the frequency of examinations and to introduce additional refreshing courses. A study by Barcal-Furelos et al. who assessed the efficiency of rescue equipment in lifeguard resuscitation efforts for drownings suggests that rescuers need more training in CPR.

Especially considering the importance of effective ventilation for drowning victims [13]. In addition to the amount of time spent on CPR and critically ill patient management training, short and cyclic refresher courses are also worth paying attention to. The research by Fernandez-Mendez et al. concludes that the lifeguards' rescue approach comprises a set of various skills and knowledge whose competency might decrease over time. Hence, lifeguards' training should take this aspect into consideration and the periodic re-training should be obligatory to maintain the skills quality [14]. This approach is consistent with the ERC Guidelines 2021 which state that the abilities necessary for successful CPR fade away within 3-12 months of completing the BLS training [19]. Therefore, the entire lifeguards' training process should probably be reanalyzed carefully and afterwards the knowledge and skills recall system should be redesigned appropriately.

According to the secondary aim, the study identified the areas of knowledge least assimilated by lifeguards. By setting a threshold level of 50%, 6 areas of knowledge with the greatest deficiency were detected (Table 3) - respectively: 2 questions in airway management, 3 in ventilation and 1 in oxygen administration category.

It is very disturbing that the participants of the study did not consider airway patency verification to be the first step in dealing with an unconscious victim after drowning. Failure to open the airway prior to ventilation may cause a tragic deterioration of the victim's health, such as hypoxia due to incompetent airway clearance or aspiration pneumonia after fluid/foreign body aspiration [22]. To ensure the proper clearance of the airway using manual suction devices, visual confirmation of any fluids and/or foreign matter is mandatory, with particular attention to the contents of the gastrointestinal tract. Perhaps some adjustments in education on this subject should be worth considering.

The lifeguards who took part in the survey do not have the expected knowledge about the usage of LTTD. The lack of this knowledge can cause inappropriate airway clearance and insufficient ventilation which can be dangerous to the victim [23]. This may result from unclear legal regulations relating to the use of blind insertion airway devices (BIADs) by rescuers certificated after QFAC [21]. The usage of BIADs is common in Polish lifeguarding, due to its advantages over BVM or mouth-to-mouth ventilations [24, 25].

Questions regarding the ventilation indicate that the study participants are not aware of the proper principles of ventilating while performing the ventilation

of near-drowned victims and also drowned victims suffering from cardiopulmonary arrest. This knowledge category turned out to be the least assimilated, judging by the percentage of correct answers, which translates to mere results in work field operations. The decision to initiate active ventilation as early as possible is crucial for the victim's life [12]. Despite the fact that only 32% of the interviewed lifeguards knew how to properly ventilate an unconscious, respiratory distressed victim with preserved circulation.

Furthermore, the frequency of asynchronous ventilation for both the adults and the children seems to have a great influence on the outcome of treatment [26, 27]. Results additionally indicate that the knowledge about pediatric victims is less understood. Half as much lifeguards knew the proper answer to the same question, but asked about pediatric victim. This knowledge should be reacquired because for the children drowning it is one of prime death causes from unintentional injury [2].

The last area detected as insufficient indicates that the lifeguards from the study group are not competent in passive oxygen therapy administrated to unconscious victims with head trauma. Lifeguards being a group of rescuers that often deals with casualties experiencing injuries [19, 28] should apply usage of NRB due to immense demands of oxygen in traumatic victims [29, 30].

Considering such a low rate of correct answers to questions concerning the key issues for lifeguards, it is worth considering the necessity to adjust QFAC programs to the needs of individual rescue services. Along with a properly selected system of repeated, frequent training, it could potentially have a positive impact on the quality of the lifeguards' knowledge and skills.

LIMITATIONS OF THE STUDY

Due to the COVID-19 outbreak, the practical skills of the participants could not be assessed. Future research should include evaluation of full training models. Also, the number of participants was not satisfactory and may not be fully representative of the entire professional group.

CONCLUSIONS

Although the lifeguards' knowledge of airway management, ventilation and oxygen administration has not declined over time since QFAC, data analysis showed a significant downtrend over time after reQFAC. In addition, the detected areas of insufficient knowledge relating to key issues of life support indicates that the lifeguards' training process should be reanalyzed and redesigned carefully.

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CONFLICT OF INTEREST

Filip Jaskiewicz is the medical consultant for Octopus VR, Lodz, Poland, in the project "Development work in the field of VR ACT application enabling the implementation of medical simulations in ALS/PALS training scenarios" which is co-financed by the European Union under the European Regional Development Fund, Action I.2. investments of enterprises in research and innovation. Jakub R. Bieliński has no potential conflict of interest.

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SELF-ASSESSMENT OF KNOWLEDGE OF EMERGENCY MEDICAL SERVICES SYSTEM EMPLOYEES ON NEW PSYCHOACTIVE SUBSTANCES – CURRENT STATUS AND DEVELOPMENT PROSPECTS

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Abstract

Aim: To examine the level of knowledge on new psychoactive substances (NPS) among health care professionals (HCPs) working within the Emergency Medical Services (EMS) system in Poland, and to assess how they would like to improve it.

Material and methods: The study involved 602 HCPs working within the EMS system and was carried out using a survey questionnaire. Both online and paper-copy surveys were utilized. The collected data were statistically analyzed using the STATISTICA 12.5PL computer program (StatSoft, Inc., USA).

Results: Most responders perceived themselves as having a “sufficient” (49%) or a “weak” level (40.5%) of knowledge of NPS, while only 10.5% as “good”. The Internet was a main source of information on NPS. In the 4-year period covered by the study, only less than 22% of HCPs took part in any training courses on NPS. Most participants expressed a need to learn more about “pharmacological treatment”, “legal provisions” and “qualification for hospital treatment”.

Conclusions: An inadequacy in essential knowledge of NPS by HCPs working within the EMS system highlights the need for education on these novel molecules.

Key words

healthcare professionals,
new psychoactive substances,
drug education,
Emergency Medical Services

INTRODUCTION

Over the last two decades there has been an increase in the availability and use of new psychoactive substances (NPS), introduced into the drug scene in order to circumvent legal restrictions against existing substances of abuse. The emergence of the NPS market has become a policy challenge and a major international concern. A growing interplay between these new substances and traditional illicit drug market is being observed, and the synthetic drug market continues to evolve rapidly [1]. The United Nations Office for Drugs and Crime (UNODC) has defined NPS as “substances of abuse”, either in a pure form or a preparation, that are not controlled by the 1961 Single Convention on Narcotic Drugs or the 1971 Convention on Psychotropic Substances, but which may pose a public health threat’ [2]. According to the latest UNODC report, the total number of monitored NPS in years 2009-2019 was 949 [3]. At the end of 2019, the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) was monitoring around 790 NPS, 53 of which were reported for the first time in Europe in 2019 [4].

NPS often appear under colloquial names, such as “designer drugs”, “party pills”, “smarts”, “legal highs”, “herbal highs” or “research chemicals”. In Poland, NPS were originally referred to as “boosters” or “legal highs”, and this is how they function within the society. This unfortunate name is primarily misleading as it suggests stimulating and euphoric effects of these compounds, which is a great generalization of a wide range of various substances classified as NPS. In fact, NPS represent a complex and diverse group of substances divided into the following main categories: synthetic agonists of cannabinoid receptors (synthetic cannabinoids), stimulants (dominated by synthetic derivatives of cathinone), hallucinogens, dissociatives, opioids, sedative/hypnotics and others [5, 6]. They are sold as single compounds or a mixture of compounds. Users may unintentionally consume NPS mixtures with unclaimed ingredients. Adulterants and bulking agents were found to be commonly combined with NPS, and they presence may produce synergistic, additive, supra-additive effects, and hence potentiate the desired but also toxic effects. Similarly, involuntary contamination or presence of by-products from incomplete chemical

reactions during the illicit manufacture of NPS may lead to inadvertent intoxication [6-9].

There is limited systematic collection of data on the acute toxicity associated with NPS. Although the use of NPS mostly produces minor or moderate poisonings, serious complications also occur and could eventually lead to death [10]. Currently, very little is known on the knowledge and confidence of health care professionals (HCPs) in managing acute toxicity of NPS [11]. The abuse and toxic effects of NPS have led to numerous interventions of ambulance teams of emergency ambulance service, which require a precise and current knowledge from the medical staff. Taking into account the amazing dynamics of the so-called "drug scene", accurate preparation of Emergency Medical Services (EMS) system seems to be a difficult task.

A few studies have addressed the inadequacy in essential knowledge and skills required by HCPs on NPS and highlighted the need for education on these novel molecules [6, 11-14]. In light of the fact that Poland ranked first as the country with the highest 12-month rates of NPS use by country globally, more effective education on these compounds should be implemented [12].

THE AIM

The present study was aimed to explore knowledge on NPS among HCPs (medical doctors, nurses and paramedics) working within the Emergency Medical Services system in Poland. The study also aimed to assess how they would like to improve their knowledge of NPS.

MATERIAL AND METHODS

The research is based on a diagnostic survey, which was carried out using a survey questionnaire. Both online and paper-copy surveys were utilized. The project received a positive opinion of the Bioethics Committee at the Medical University of Łódź (RNN/308/18/KE). The study was conducted between August 16 and December 31, 2018. Paper questionnaires were disseminated to HCPs working at hospital emergency departments of Maria Konopnicka Memorial Hospital in Łódź, Mikołaj Kopernik Memorial Hospital in Łódź, Jan Paweł II Memorial Provincial Hospital in Bełchatów, Provincial Emergency Medical Service Station in Łódź, Accident and Emergency Unit of the Independent Public Healthcare Centre in Turek, and the Admission Room of the Independent Public Healthcare Centre in Koło. In total, 147 paper questionnaires (including 18 incomplete) and 473 online surveys were collected.

The questionnaire used in the study included the following questions:

1. When was the first time you encountered the term of "legal highs"? – to determine if the notion had existed in a specific professional group before it appeared in the mainstream media.
2. Do you know the term "substitute substances"? – to verify whether the respondents are aware of implementing new terminology related to a legislative work.
3. Have you participated in a training(s) on new psychoactive substances ("legal highs") during the last four years? – to evaluate if the respondents were exposed to any trainings on NPS, and if they were, what form it was and what entity it was organized by.
4. What is the main source of knowledge about NPS used by the respondents?
5. How do they themselves assess their knowledge about NPS?
6. What are the most important issues for them to be explored in the future?

The collected data were statistically analyzed using the STATISTICA 12.5PL computer program (StatSoft, Inc., USA). The normality of quantitative variables (age, work experience) was evaluated using Kolmogorow-Smirnow and Shapiro-Wilk tests. As the empirical distributions of quantitative variables significantly deviated from the theoretical normal distribution, the statistical significance of differences between the groups was assessed using a non-parametric Kruskal-Wallis test. In cases where the significance test was positive ($p < 0.05$) and the null hypothesis about the lack of differences in the mean values in the groups was rejected, post-hoc tests (Dunn's multiple comparison tests) were performed.

RESULTS

KNOWLEDGE OF TERMS "LEGAL HIGHS" AND "SUBSTITUTE SUBSTANCES"

The study involved 602 HCPs working within the Emergency Medical Services (EMS) system, aged 20 to 62 years old (mean = 35.3), including 240 women (39.9%). Detailed data of the study group are presented in table 1. The largest group of respondents were employees of both EMS team and Emergency Departments/Admission Rooms.

Majority of the respondents ($n = 374$; 62%) declared to have known the term "legal highs" before 2014, i.e. before it became a commonly used notion for NPS in the mass media in Poland. This observation indicates that the medical community was very

Table 1. Characteristics of the respondents based on their workplace.

Variable	Workplace						p-value
	EMS team (n = 164)		EMS team and ED/ Admission Room (n = 365)		ED/ Admission Room (n = 73)		
	n	[%]	n	[%]	n	[%]	
Gender							
Women	47	28.7	147	40.3	46	63.0	0.000
Men	117	71.3	218	59.7	27	37.0	
Age M IQR	32 [28; 37]		31 [26; 40]		28 [25; 36]		0.052
Seniority IQR	6 [3; 12]		6 [3; 12]		3 [1; 10]		0.001
Position							
Medical specialist	3	1.8	30	8.2	5	6.8	0.000
Specialist registrar	2	1.2	30	8.2	10	13.7	
Paramedic	147	89.6	247	67.7	37	50.7	
Nurse/system nurse	12	7.3	58	15.9	21	28.8	
Population in the place of an employment							
up to 10,000	11	6.7	17	4.7	2	2.7	0.303
10 – 20,000	20	12.2	39	10.7	4	5.5	
20 – 100,000	47	28.7	115	31.5	18	24.7	
100 – 250,000	25	15.2	46	12.6	12	16.4	
250 – 500,000	15	9.1	44	12.1	6	8.2	
over 500,000	46	28.0	104	28.5	31	42.5	

EMS team – Emergency Medical Services team,
ED – Emergency Department.

Table 2. First contact with the term “legal highs” and knowledge of the term “substitute substances” depending on the size of the city where the respondent works.

First contact with the term “legal highs”	Population of the city (in thousands) where the respondent works												p-value
	below 10 (n = 30)		10 – 20 (n = 63)		20 – 100 (n = 180)		100 – 250 (n = 83)		250 – 500 (n = 65)		over 500 (n = 181)		
	n	[%]	n	[%]	n	[%]	n	[%]	n	[%]	n	[%]	
before 2014	17	56.7	34	54.0	104	57.8	44	53.0	41	63.1	134	74.0	p=0.000
2014	4	13.3	11	17.5	36	20.0	24	28.9	13	20.0	31	17.1	
2015	3	10.0	12	19.0	29	16.1	14	16.9	10	15.4	14	7.7	
2016	3	10.0	4	6.3	8	4.4	0		1	1.5	2	1.1	
2017	3	10.0	2	3.2	3	1.7	1	1.2	0		0		
Familiar with the term “substitute substances”	20	66.7	45	71.4	122	67.8	62	74.7	42	64.6	122	67.4	p=0.795

quickly exposed to this phenomenon or the term was coined originally as a form of professional slang within it. Along with the size of the city where the respondents worked, the percentage of EMS system employees who encountered the term “legal highs” before 2014 increased. At least half of the subjects encountered this notion before 2014, and in cities of more than 500,000 inhabitants even 74%. This proves a greater intensity of the NPS phenomenon itself in large Polish cities before 2014, and at the same time its popularity in Poland (Table 2).

More than 67% of the respondents admitted to know the term “substitute substances”, which was introduced into the nomenclature through the amendment to the Anti-Drug Abuse Act and the Act on the State Sanitary Inspection on October 8, 2010 [15]. The term was not widely used in the media, and familiarity with it reflects at least a cursory knowledge of the current legislation and regulations in the field. Additionally, the knowledge seems to be independent of the size of the city where the HCPs work, the experience they have or their function within the system (data not shown).

KNOWLEDGE SELF-ASSESSMENT

When asked about their knowledge of NPS most responders perceived themselves as having a “sufficient” ($n = 295$; 49%) or a ‘weak’ level ($n = 244$; 40.5%). Only 10.5% regarded themselves as having ‘good’ knowledge of NPS. Only among the HCPs working in cities with a population of 20,000–100,000 inhabitants the percentage of HCPs who assessed their knowledge as ‘weak’ was greater than the percentage of those respondents who considered their knowledge as ‘sufficient’. This could reflect

previous observations demonstrating a lower percentage of participation in scientific conferences in this population than in others (Table 2).

SOURCES OF KNOWLEDGE OF NPS AMONG HCPS WORKING WITHIN EMS SYSTEM

As indicated in Figure 1, most of the respondents pointed to the Internet as a main source of knowledge of NPS, followed by articles in scientific or professional journals. Only a small group stated specialist trainings as the main source of their knowledge of NPS. Television does not provide qualified expertise to the medical community. The term “other” was most often extended by the subjects to: all of the above-mentioned ones except for television, exchange of work experience, contact with HCPs from toxicology departments, own observations of patients, conversations with patients and persons abusing psychoactive substances (Fig. 1).

Along with the size of the city, the importance of scientific/professional literature increased, while that of websites decreased. This observation likely reflects wider availability of the professional journals in larger urban centers and a greater frequency of formal or informal academic discussions among EMS system personnel. HCPs working in cities with a population of 10,000–20,000 inhabitants declared that the main source of their knowledge were articles from scientific journals (46%), and less frequently the Internet (39.7%). Only this subgroup claimed that the Internet allowed them to easily find different sources of evidence-based data (Table 3).

HCPs working in the EMS system with a shorter internship of service acquired knowledge from scientific/professional literature more often than other

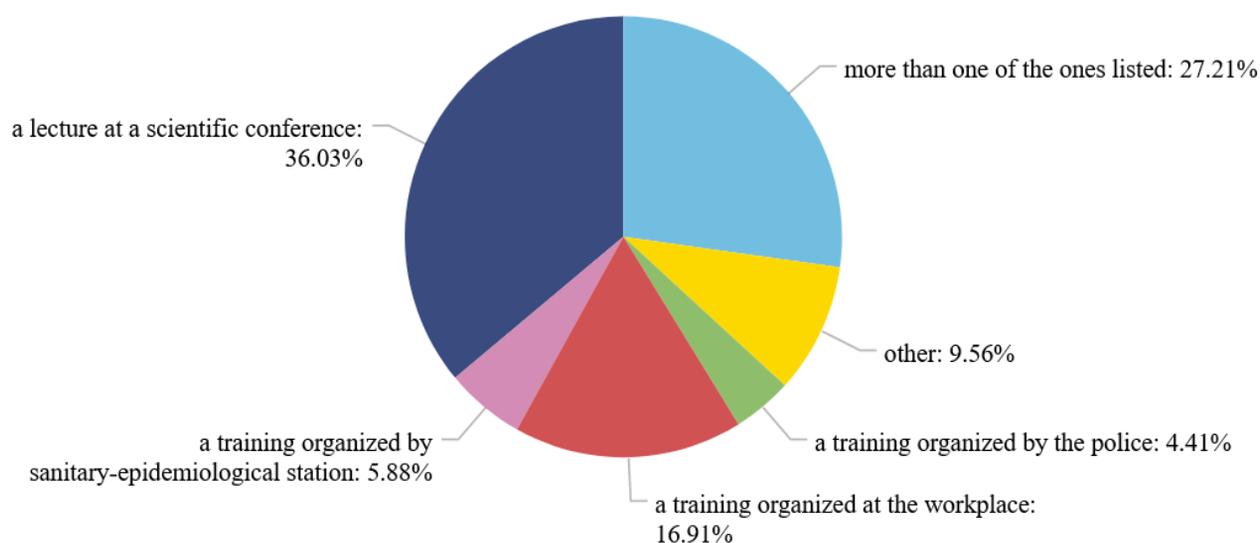


Fig. 1. Trainings on NPS which the respondents participated in.

Table 3. Sources of knowledge about new psychoactive substances (NPS) depending on the size of the city where the respondent works.

Sources of NPS knowledge	Population of the city (in thousands) where the respondent works												p-value
	below 10 (n = 30)		10 – 20 (n = 63)		20 – 100 (n = 180)		100 – 250 (n = 83)		250 – 500 (n = 65)		over 500 (n = 181)		
	n	[%]	n	[%]	n	[%]	n	[%]	n	[%]	n	[%]	
Specialist trainings	3	10.0	5	7.9	2	1.1	4	4.8	2	3.1	10	5.5	0.083
Scientific/professional articles	5	16.7	29	46.0	55	30.6	30	36.1	28	43.1	71	39.2	0.033
Internet	18	60.0	25	39.7	114	63.3	43	51.8	33	50.8	83	45.9	0.005
Television	2	6.7	2	3.2	4	2.2	1	1.2	0		5	2.8	0.434
Patients	1	3.3	1	1.6	5	2.8	5	6.0	2	3.1	10	5.5	0.574

Table 4. Sources of knowledge about new psychoactive substances (NPS) depending on the length of service in the EMS system.

Sources of knowledge about NPS	Years of service in the EMS system						p value
	below 3 (n = 148)		3-10 (n = 268)		over 10 (n = 186)		
	n	[%]	n	[%]	n	[%]	
Specialist trainings	4	2.7	14	5.2	8	4.3	0.480
Scientific/professional articles	65	43.9	99	36.9	54	29.0	0.018
Internet	73	49.3	143	53.4	100	53.8	0.671
Television	3	2.0	1	0.4	10	5.4	0.002
Patients	2	1.4	10	3.7	12	6.5	0.058

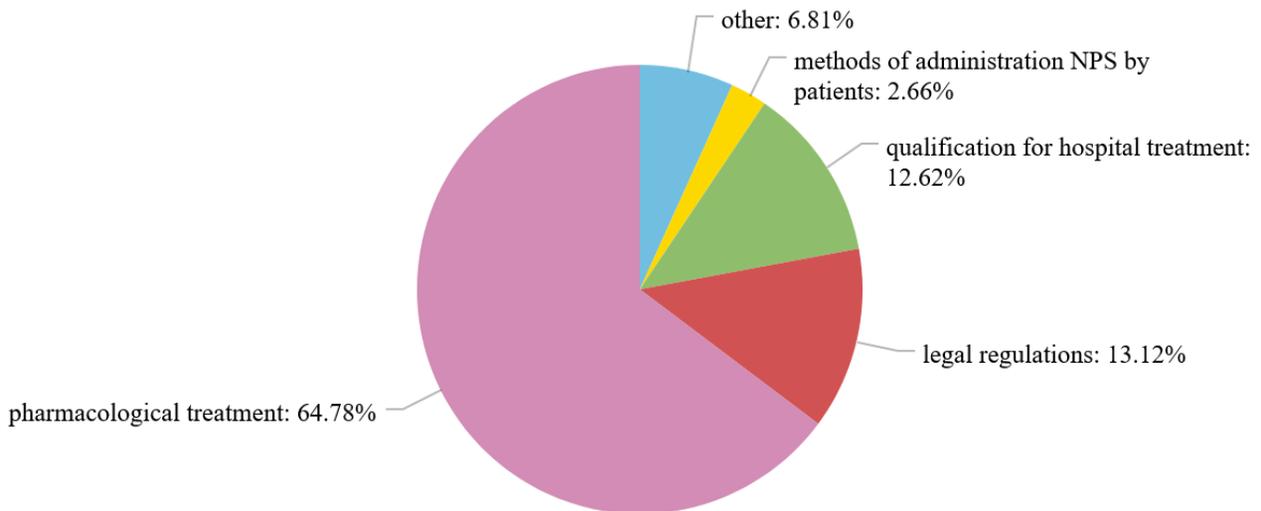


Fig. 2. Respondents' interest in the topics of trainings on NPS.

employees. Television, in turn, was indicated as a source of knowledge in the highest percentage by HCPs with more than 10 years of service (5.4%), which may suggest a weakening power of this medium among younger people (Table 4).

EDUCATIONAL TRAININGS

In the 4-year period covered by the study, only less than 22% of the respondents took part in any training courses on NPS. The majority of subjects who participated in this type of trainings pointed out lectures

at scientific conferences. Another large group participated in trainings organized at the workplace by the Police and Sanitary-Epidemiological Station. Although programs of these trainings were not always directed to the medical community, they were also attended by HCPs. Over 25% of HCPs who underwent a training declared participation in more than one of the proposed types of training (Fig. 2). Furthermore, answers to “other” included: a training for volunteers at a Woodstock Festival, a training organized by the Medical Chamber as part of the “Medical Rescue After Hours” campaign, a training organized by the State Fire Service, a lecture at meetings in a clinic or classes as a part of doctoral studies.

When HCPs were asked about their desired area for improvement, “pharmacological treatment” was most frequently ranked first, followed by “legal provisions” and “qualification for hospital treatment” (Fig. 2).

DISCUSSION

In the present study the level of knowledge on NPS among HCPs (physicians, nurses and paramedics) working within the Emergency Medical Services (EMS) system in Poland was examined. The responders were familiar with the terms “legal highs” and “substitute substances”, the popular and official, respectively, nomenclature related to NPS. Individuals working only in EMS teams were more often accustomed with the notion of “substitute substances” than those working only in in-patient centers. This observation likely reflects the specificity of formal and legal responsibility for the patient at every level of the EMS system. Operations within ambulance teams are directed by a leader of a specific team. Thus, the responsibility of the leader forces him to be acquainted with all legal acts, guidelines and recommendations regarding rescue operations. The new phenomenon, namely the emergence of “substitute substances” and patients under their influence, required quick situational awareness and monitoring current changes for EMS teams. On the other hand, in the context of tasks performed by an Admission Room/Emergency Department, patients suspected to be acutely intoxicated with NPS are diagnosed there in order to determine whether they require hospitalization or only an outpatient treatment. Additionally, if a patient’s condition is serious enough, the diagnostics and treatment become tasks of an appropriate hospital ward.

More than half of the respondents declared the level of knowledge about NPS to be at least sufficient to fulfill their professional obligations. How-

ever, it must not be forgotten that the knowledge which is sufficient today may soon require updating, especially in the face of the constantly changing drugs market. Therefore, the group of respondents, uncertain of the information they have, may actually be larger than the survey suggests. Few previous studies have addressed the inadequacy in essential knowledge and skills required by HCPs on NPS, and highlighted the need for education on these novel molecules. Campbell et al. documented that more than half of HCPs did not have “adequate knowledge” on drug interactions involving NPS [13]. Wood et al. stated that greater confidence was reported by both physicians and nurses on managing acute toxicity due to classical recreational drugs compared to NPS [11].

The information on NPS comes from a variety of different sources, including websites, media (e.g., TV), reports on user discussion forums, poisons information centers, case reports/series, scientific literature, training courses and conferences. Results of the current study demonstrate that websites were a main source of information on NPS, followed by articles in scientific or professional journals. Only a small group of the respondents pointed to special trainings as the main source of their knowledge. Recently Ramos et al. examined baseline knowledge on NPS among HCPs in the United Kingdom. They found that most of the received information come from websites, colleagues and media, followed by emails, scientific literature and conferences/seminars/workshops. Only a small group of the responders (12.7%) declared participation in online courses [6].

When HCPs were asked about their desired area for improvement, they expressed their need to learn more about NPS products, clinical warnings associated with them, pharmacological treatment of intoxicated patients, and legal status of these drugs [6].

It should be emphasized that with an exception of opioids and benzodiazepines, management of acute toxicity is not dependent on knowing the NPS, but should be on the basis of these clinical signs/symptoms [8, 11].

Although legal regulations are not in the center of attention of HCPs, their knowledge becomes essential as the society becomes more demanding. In the context of patients being under the influence of psychoactive substances, several issues still remain unclear: a scope of their autonomy and a vague recognition of a situation, their health condition and consequences of their decisions, deciding whether and to what extent direct coercion and compulsion

to treat may be applied or to what extent such a patient is responsible for violation of physical inviolability or personal rights of health service workers. These are very important issues, the knowledge of which will undoubtedly facilitate attending to this type of patients. “Eligibility for hospital treatment” is partly related to legal issues due to the specificity of psychiatric hospital management and compulsory treatment and hospitalization.

It should be emphasized that a deficit in general knowledge on NPS may lead to inappropriate medical diagnoses and potentially the provision of inappropriate medical advice or interventions. Hence, the topics for future educational sessions should be tailored according to the type of HCPs work in the EMS system.

CONCLUSIONS

Most EMS employees surveyed by in the current study declared only “basic” to “intermediate” NPS knowledge and expressed a need for training and updates as insufficient NPS-related information is currently received. This observation demonstrates that continual education about NPS is fundamental for the provision of improved harm reduction interventions, better referral pathways, effective dissemination of information and sharing of best practice to help NPS users achieve full recovery and enhance their care throughout the treatment. This is especially important, as NPS of varying types continue to emerge even in the era of COVID pandemic, and drug scenarios are ever-changing [16, 17].

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

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EPIDEMIOLOGY OF OUT-OF-HOSPITAL SUDDEN CARDIAC ARREST HAPPENING IN BRZOW COUNTY – PILOT STUDY

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Abstract

Aim: Analysis of out-of-hospital sudden cardiac arrest cases in Brzozow county.

Material and methods: Analysis of 105 out-of-hospital sudden cardiac arrest cases in Brzozow county. Data was extracted between September 2016 to end of February 2018 from dispatch order cards and emergency medical services cards. Statistical analysis was conducted using STATISTICA 12 software. Statistical significance was set to $p < 0,05$ level.

Results: There were 66 men (62,9%) and 39 (37,1%) women in the analysed group. Average age was 70,5 (SD=15,8). In 88,6% cases sudden cardiac arrest happened at home and for the rest 11,4% cases it was a public place. Families called emergency services in 20% (n=21) cases, in 16,2% (n=17) cases people suffering from sudden cardiac arrest and in 63,8% (n=67) cases it was a person classified as "other". Sudden cardiac arrest most frequently happened between 6:00-11:59 among 39,1% (n=41) of all patients. Incidence rate in the specified region was 106,06/100 000/year. ROSC occurred only in 15,3% (n=16 cases).

Conclusions: Out-of-hospital cardiac arrests in the specified region indicate low occurrence of return of spontaneous circulation. The reason behind this might be associated with a small number of cardiopulmonary resuscitation trials. Results indicate that further analysis of this phenomenon is required.

Key words

epidemiology,
out-of-hospital cardiac arrest,
emergency medicine service

INTRODUCTION

Occurrence of out-of-hospital cardiac arrest (OHCA) is a major medical problem and a challenge in the area of public health that leads to significant number of deaths in Europe and United States [1, 2]. Incidence of sudden cardiac arrest is high and amounts to 350 000-420 000 cases per year in the United States and from 275 000 up to 700 000 cases per year in Europe [1, 3, 4]. Understanding epidemiology of out-of-hospital sudden cardiac arrest in smaller regions can be useful in comparison with other areas and general results. As a result, a country in Podkarpackie voivodeship has been chosen in order to better exemplify NZK scale in this area. Podkarpackie voivodeship is located in the south-eastern Poland and is inhabited by 2,129,000 million people [5]. Population density differs from 19 per km² in Bieszczadzki county to 1,591 per km² in Rzeszow city and the average for the whole voivodeship is 119 per km². Population density in Brzozow county is 122 per km², that is nearly equal to the average for the whole voivodeship, therefore it was chosen for the pilot study.

THE AIM

The aim of this study is to analyse epidemiology of out-of-hospital sudden cardiac arrest cases in Brzozow county.

MATERIAL AND METHODS

The study took place in Brzozow county, which is inhabited by 66 000 people, between 1st September 2016 and 28th February 2018. 105 cases of out-of-hospital cardiac arrest were used as a sample which happened during the above specified timeframe. Data was extracted from medical documents (dispatch order cards and emergency medical services cards).

RESULTS

During an 18-month-long study in Brzozow county, there were 105 cases of out-of-hospital cardiac arrest (OHCA). Sudden cardiac arrest (SCA) occurred among 66 (62,9%) men and 39 (37,1%) women. All patients were adults and aged between 20-98. Sample average age was 70,5, standard deviation was 15,8 and median was equal 73,0. SCA most frequently happened at home (n=93; 88,6%), in other circumstances it was a public place (n=12; 11,4%). As specified in medical documents, calling emergency services by "other" happened in 63,8% (n=67), by family in 20,0% (n=21) and by the person suffering from SCA in 16,2% (n=17) cases. Incidence of OHCA appeared to be highest on Saturdays (n=19; 18,1%) and lowest on Mondays (n=12; 11,4%) (Fig. 1)

Cardiac arrest was most frequent in the mornings between 6:00-11:59 (n=41; 39,1%) and in the after-

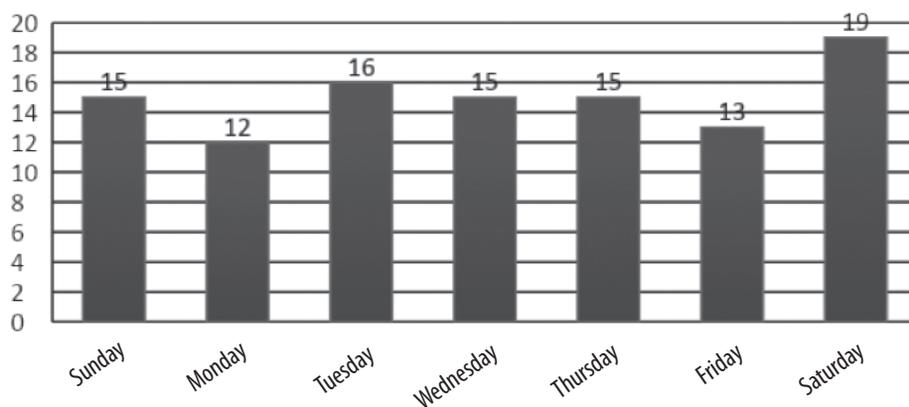


Fig. 1. Number of OHCA cases on particular day.

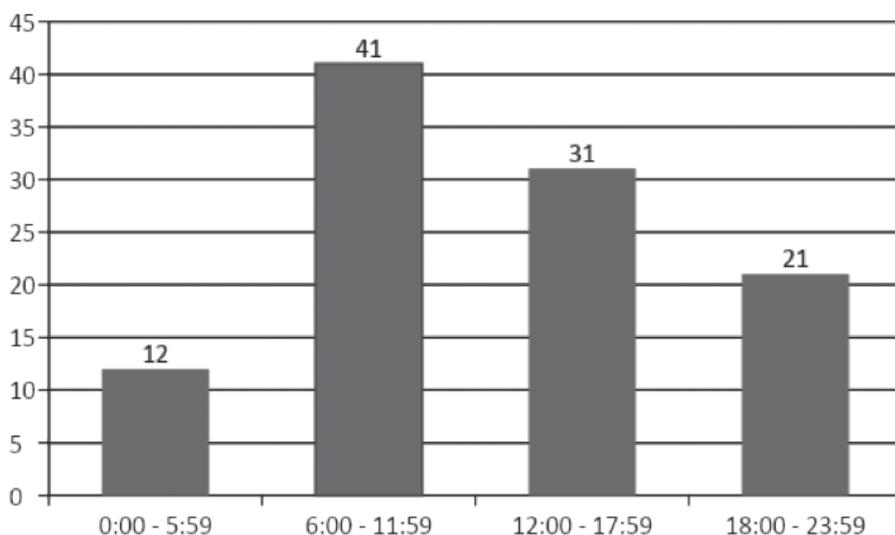


Fig. 2. Number of OHCA at particular hours.

noons 12:00-17:59 ($n=31$; 29,5%), what resulted to 68,6% of all OHCA cases in the sample. The least occurrence of cardiac arrest was in the evenings 11,4% ($n=12$) (Fig. 2). Epidemiological analysis indicated that the incidence of out-of-hospital cardiac arrest in Brzozow county was on level 106,06/100 000/year. Applying cardiopulmonary resuscitation by witnesses before emergency services arrived happened only in 29 (27,6%) cases. Return of spontaneous circulation occurred in 15,3% ($n=16$) patients.

DISCUSSION

Brzozow emergency centre offers medical rescue services in Podkarpackie voivodeship, in Brzozow county to be accurate which is inhabited by 66 000 people. Emergency services teams operate in the total area of 540,39 km². The study was aimed to present the epidemiology and scale of out-of-hospital cardiac arrest (OHCA) in the specified region. The occurrence frequency of sudden cardiac arrest (SCA) in the operating area of Brzozow emergency services was 106/100 thousands inhabitants per

year. In other regions of Poland this indicator varies. Szczerbinski et al. [6] using Opole as a sample presented a higher indicator which was equal to 156/100 thousands. Similar results were received by Gach et al. [7] 170/100 thousands inhabitants in Bielsko-Biala area. Significantly lower values were extracted by the analysis of WPR documents in Katowice [8], where incidence rate was 59,37/100 thousands inhabitants. Overall incidence rate of out-of-hospital cardiac arrest in Poland was based on 2 studies: EuReCa ONE [9] and EuReCa TWO [10], however they were carried out on the small sample size compared to the population of the whole country [11]. Nadolny et al. [12] took into account 16 regions of Poland in their study. The number of out-of-hospital cardiac arrest with cardiopulmonary resuscitation trials was 70/100 thousands inhabitants and placed in the range from 58,9 to 84,5 cases per 100 000 inhabitants. OHCA in Europe differs from 36 to 128 cases per 100 thousands depending on the country [6, 13]. The result received in our study fits in the range described for Europe.

In the analysed sample sudden out-of-hospital cardiac arrest occurred most frequently among men and amounted to 62,9% (n=66) of all cases. Almost identical number, 63 % for male with OHCA was presented by Szczerbinski et al. [6] and 62,7% by Nadolny et al. [8]. Similar results were received in the United States [14, 15], Sweden [16], Austria [17] and Japan [18].

Age median for the sample was 73. In the analysis of Gach et al. [7] who researched Bielsko-Biala population, the age median was 71. Goodwin et al. [19] presented in their study that women are on average 8 years older than men at a time of OHCA and this result is statistically significant difference in age. In Brzozow county, OHCA happened most frequently between 6:00-11:59 (39,1% in total) and least frequently at night between 0:00-5:59 (11,4% in total). Daytime variability in out-of-hospital cardiac arrest was also noticed in other publications [6, 20].

Saturday was the most common day for cardiac arrest (n=19; 18,1%), what was also consistent with the study of Szczerbinski et al [6] and Brooks et al. [21]. However, Ong et al. [20] claimed Monday was the day with the highest incidence of cardiac arrest (Monday is the second day in terms of numbers of SCA according to Szczerbinski et al. [6]), whereas our study indicated that Monday is the day when there were least cases of SCA in the whole week.

Out-of-hospital cardiac arrest most frequently happened at the patient's home (88,6% cases). Result was consistent with the study of Nadolny et al., however their number was lower (71,1%).

Due to disproportionate months distribution in the study period seasonal analysis of OHCA does not allow for reasonable conclusions. However, during the autumn-winter period the number is significantly higher (73,3% cases of OHCA) than in other periods. Impact of seasonality on out-of-hospital cardiac arrest is shown by foreign studies from the United States [21, 22] where most incidents happened in December.

ROSC occurred in 15,2% cases which is significantly lower than other studies, which presented the return of spontaneous circulation rate between 25,8% to 33,4% [8, 9, 23]. It might result from a small number of cardiopulmonary resuscitation trials before emergency services arrived – only 27,6% cases among which in 83,8% cases SCA happened in the presence of witnesses.

CONCLUSIONS

1. Number of out-of-hospital cardiac arrests per 100 thousands inhabitants amounted to 106 in Brzozow county. This result is not the highest compared to other regions.
2. Men more frequently suffer from out-of-hospital cardiac arrests compared to women.
3. Daytime, day of the week and month have an impact on the frequency of OHCA.
4. Incidence of cases that return of spontaneous circulation was successful is significantly higher than in other areas.
5. More attention should be drawn to reasons of low application of cardiopulmonary resuscitation by the witnesses.

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CONFLICT OF INTEREST

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INFLUENCE OF EMERGENCY MEDICAL STUDENTS TRAINING ON PREPAREDNESS TO PERFORM PAEDIATRIC LIFE SUPPORT

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Abstract

Aim: Assessment of the increase in knowledge in specific categories among students of the last-year emergency medical students after 45-hour training in advanced paediatric life support. Comparison of the impact of participation in the project and the ILS course on the increase of knowledge in the field of advanced life support in children.

Material and methods: 138 third-year emergency medical students of the University of Rzeszów were studied. A proprietary questionnaire on paediatric life support was conducted before and after completing a 45-hour training on emergency medical services in children (pretest/posttest).

Results: The mean percentage of subjects' correct answers in the post-test was slightly over 60 which was statistically significantly higher compared to the pre-test, $t(276)=6.54$; $p<0.001$. The highest percentage of correct answers concerned paediatric basic life support and AED ($M=77.78$; $SD=12.47$), while the lowest – cardiac arrest in children in special situations ($M=60.54$; $SD=21.06$). No statistically significant relationship was found between the percentage of correct answers in the pre-test/post-test and the respondents' age, gender and participation in a competence development project ($p>0.05$).

Conclusions: The knowledge of paediatric life support among the third year emergency medical students is good. The students of subsequent years and individuals reading the literature and participating in the competence development project are better prepared to perform life support procedures in newborns and infants. From year to year, students gain less knowledge from medical literature and have the least knowledge on cardiac arrest in children in special circumstances.

Key words

paramedic students,
advanced life support,
child,
medical education

INTRODUCTION

ASSESSMENT OF LIFE SUPPORT SKILLS AFTER TRAINING

Resuscitation procedures in children are rarely performed by emergency medical teams (EMS). They are more common in pre-hospital management than in the emergency department. Therefore, knowledge and skills in this field should be constantly improved [1]. A review of the literature by Au et al. indicates that most of the studies assessing skill improvement after advanced life support training were conducted in North America and concerned trainees or novice learners. The content of certified courses i.e.: Advanced Cardiac Life Support (ACLS), then Neonatal Resuscitation Program (NRP), Advanced Life Support (ALS) and Advanced Trauma Life Support (ATLS) was the most widely studied. The most commonly used primary endpoint was skill retention 6 months after training. Simulation-based interventions and refresher courses with the content of certified advanced life support courses have

been found to have the greatest impact on skill retention [2].

FACTORS INFLUENCING THE INCREASE IN PREPAREDNESS TO PERFORM PAEDIATRIC LIFE SUPPORT

The level of skills in performing emergency medical services, which are rarely used in paramedic's work, decreases with time [3,4]. Therefore, it is important that future paramedics are well prepared to conduct life support in children already during the studies. The high fidelity simulation through advanced training scenarios improves competences in the management of emergencies in children [5-7]. Also, online training sessions on an online platform with simulated clinical scenarios are assessed by students as a useful tool for the initial assessment, diagnosis and treatment of the patient [8]. Janczewska et al. study conducted among the students of medicine proved that the level of knowledge in the field of emergency medical services tested using the "pretest-posttest" method increases after having classes in emergency medicine [9, 10].

INFLUENCE OF MENTORING AND SOURCES OF ACQUIRING KNOWLEDGE ON STUDENT LEARNING OUTCOMES

The role of an academic teacher during practical classes in emergency medical services with students is to provide current knowledge, teach practical skills in the field of cardiopulmonary resuscitation (CPR) in children and shape social attitudes to provide help [6]. The academic teacher should instill in the student a willingness to acquire knowledge and further training also after graduation. Clinical learning environment (CLE) is of great importance during education of medical students. It has an impact on the students' learning outcomes. CLE depends primarily on proper supervision and mentoring, the role of the teacher in professional training, an atmosphere conducive to learning in the ward, the quality of care provided in the ward, and the leadership style of the ward manager [11, 12]. A useful tool used to assess CLE in academic education is the Instrument Clinical Learning Environment, Supervision and Nurse Teacher Scale (CLES + T) [11, 13]. Emergency Medicine is only first-cycle studies, graduates obtain BSc degree. This field of study does not provide for continuation of vocational training at second-cycle studies. Further professional development is carried out on certified advanced life support courses [14, 15]. Such training can use CLES+T, which is an effective tool for monitoring postgraduate education in the form of clinical training. This instrument helps to maintain CLE at an acceptable level, affects the satisfaction with postgraduate education, and thus encourages involvement in various postgraduate courses in the future [11].

Emergency medical students should not obtain knowledge and skills solely and exclusively from attending subjects included in the curriculum or from non-reviewed websites. Preparing a student for the profession should be supplemented with reading peer-reviewed articles and books related to paramedics and emergency medicine.

EDUCATION SYSTEM OF EMERGENCY MEDICAL STUDENTS IN THE FIELD OF PAEDIATRIC LIFE SUPPORT

In Poland, until 2021, the third-year emergency medical students are educated on the basis of the current educational standard [16]. It provides for a 45-hour training in paediatric life support, for which the student obtains 3 points according to the European Credit Transfer System (ECTS) [17]. Since 2022, the last year emergency medical students will be subject to a new educational standard for this major [14]. Since 2017 to 2019, a part of the last-year emergency medical students of the University of Rzeszów participated in the project "Program for the development

of competences of students of the Medical Faculty of the University of Rzeszów". Within the framework of this project, the third-year emergency medical students participated in workshops on innovation in emergency medicine and ILS course.

Therefore, there is a need to check the increase in knowledge and preparedness of the last-year emergency medical students to perform advanced paediatric life support before and after the 45-hour training. It is also important to investigate the impact of participation in the project, increasing students' competences, including completing the Immediate Life Support (ILS) course on their knowledge in paediatric emergencies.

THE AIM

Assessment of the increase in knowledge in specific categories among students of the last-year emergency medical students after 45-hour training in advanced paediatric life support. Comparison of the impact of participation in the project and the ILS course on the increase of knowledge in the field of advanced life support in children. Determining the sources of obtaining knowledge by students about emergencies in children.

MATERIAL AND METHODS

Assessment of the effects of training in advanced paediatric life support was carried out in 2017-2019. The study covered 138 last-year students of Emergency Medical Services at the University of Rzeszów (UR).

The study was conducted using a proprietary questionnaire containing questions about life support in children. The questions were based on the 2015 European Resuscitation Council (ERC) Guidelines and current knowledge. The quantitative research method was used – the so-called "Pretest-posttest". The first measurement (pre-test) was carried out before starting the classes in the subject of Emergency Medical Services at the Department of Emergency Medical Services, UR. The final measurement (post-test) was carried out after 45-hour training. The training covered the subject of opening the airways in children, basic and advanced life support in children, and special situations. Detailed information about the training is provided in Supplementary materials 1. The training was conducted using simulation classes with phantom exercises for advanced life support in children. The pre-test and post-test questions were identical.

STATISTICAL ANALYSIS

The collected research material was statistically developed using the IBM SPSS Statistics (v. 25) sta-

tistical package. The analysis with the t-student test for independent samples or its non-parametric counterpart (the Mann-Whitney U test – in the case of small groups) allowed to check whether there were statistically significant differences between the two independent groups. Using the analysis of variance test, it was checked whether there was a statistically significant interaction of a group of people (pre-test / post-test) with the year of study (2017-2019), i.e. affecting the analyzed categories and the total percentage of correct answers. The analysis of Spearman's correlation allowed to investigate the presence of a statistically significant relationship between the analyzed variables. The statistical analysis of the results used the mean, standard deviation, median, minimum and maximum. A P value of <0.05 was considered statistically significant.

RESULTS

138 last-year students of Emergency Medical Services, including 63 women and 75 men, participated in the study. Slightly less than 50% of the respondents (64 students) participated in the project of developing the competences of UR students and the ILS course. Most of the students are non-working (120 people), and they acquire knowledge about life support mainly from study programme. Table 1 shows the sociodemographic data as well as the sources of knowledge about emergencies in children.

When analyzing the answers given in the pre-test and post-test to the questions asked, the occurrence of statistically significant differences between the studied groups was observed. In the post-test, when asked about the parameter that can be calculated using the formula: $[\text{child's age (in years)} + 4] \times 2$ more people indicated the answer which is body weight. Likewise, more people in the post-test gave the correct answer regarding: the most common rhythm accompanying cardiac arrest in children, the energy to start defibrillation in a child during CPR, the recommended ratio of chest compressions to breaths in children, the oxygen concentration used in the life support of a newborn, fluid administration in a three-year-old child in hypovolemic shock, intramuscular doses of adrenaline administered to a seven-year-old in anaphylactic shock, first-line drug in children with paroxysmal supraventricular tachycardia, management of a child with subglottic laryngeal oedema, and choking in a 7-month-old child.

In every tests, the examined students could score a maximum of 21 points. Table 2 presents descriptive statistics concerning the obtained percentage of correct answers. The average percentage of answers given

by students in the post-test turned out to be statistically significantly higher compared to those in the pre-test, $t(276)=6.54$; $p<0.001$. The average percentage of correct answers was slightly over 60, so it can be concluded that the level of knowledge of the respondents in the field of emergencies in children is good.

No statistically significant relationship was found between the percentage of correct answers from the pre-test and post-test to the age of the respondents, sex, and participation in the competence development project and the ILS course ($p>0.05$). The percentage of correct answers given in the surveyed groups of people, broken down by gender, and participation in the competence development project and the ILS course are presented in Table 3.

In terms of the source of the acquired knowledge, two statistically significant differences were observed in the pre-test group. They include study programme ($U = 762$; $p = 0.04$) and literature ($U = 1771$; $p = 0.009$). Students using this type of knowledge sources obtained a statistically significantly higher percentage of correct answers compared to those who did not use them (Table 4). The level of knowledge in the studied group of students was similar, i.e. it did not differ in a statistically significant way depending on the source used. For each of the sources, the average percentage of correct answers given was approximately 60.

The fact of using one or multiple sources of knowledge was also analysed. No statistically significant differences were found between the respondents using one or more sources in terms of the percentage of correct answers. This applies to both the pre-test and post-test groups ($p>0.05$).

The impact of training on the preparedness of students to provide emergency medical services was analysed by dividing the questions in the survey into 4 categories. The answers provided by the respondents were assigned the following score: a) basic life support and AED in children (max 6 points), b) advanced life support in children (max 5 points), cardiac arrest in children – special situations (max 6 points), CPR in a newborn and infant (max 4 points). Subsequent analysis of the percentage of correct answers revealed the highest score for questions on basic life support and AED in children, while the lowest for cardiac arrest in children in special situations (Table 5).

Statistically significant differences were observed in the category of advanced life support in children ($t(274) = 4.98$; $p < 0.00$), cardiac arrest in children – special situations ($t(269)=4.43$; $p<0.001$) and CPR in a neonatal and infant ($t(262) = 4.25$; $p < 0.001$). People from the post-test group obtained a statistically

Table 1. Sociodemographic data and sources of knowledge about life support in children among the surveyed students.

Variable		N		[%]	
		Pre-test	Post-test	Pre-test	Post-test
Sex	Woman	63	66	45.7	47.8
	Men	75	72	54.3	52.2
Participation in the competence development project of UR students and the ILS course	Yes	64	58	46.4	42
	No	75	80	54.3	5.8
Working in another profession	Yes	18	12	13.0	8.6
	No	120	126	87.0	91.3
Source of knowledge about emergencies in children *	Medical journals	23	36	16.7	26.1
	Literature	71	81	51.4	58.7
	Study programme	120	121	87	87.7
	Internet	46	32	33.3	23.2

* Multiple choice question

Table 2. Descriptive statistics concerning the percentage of correct answers given by students in both tests.

Variable	M		Me		SD		Min		Max	
	Pre-test	Post-test								
The percentage of correct answers	59.66	69.19	59.52	71.42	12.98	11.12	23.81	38.1	90.48	90.48

Table 3. Percentage of correct answers in the surveyed groups of students, broken down by sex and participation in the ILS course.

Variable		M		Me		SD		Min		Max		
		Pre-test	Post-test									
The percentage of correct answers	Sex	Women	59,86	66,69	61,9	71,42	12,38	11,36	33,33	38,1	85,71	90,48
		Men	59,49	69,64	57,14	71,43	13,54	10,97	23,81	38,1	90,48	90,48
	Participation in the competence development project of UR students and the ILS course	No	58,25	69,21	57,14	71,43	13,76	10,71	23,81	52,38	85,71	90,48
		Yes	61,23	69,21	61,9	71,43	12,05	11,49	33,33	38,1	90,48	90,48

Table 4. Percentage of correct answers given in the group of pre-test and post-test students, broken down by their source of knowledge about life support in children.

Variable			M		Me		SD		Min		Max	
			Pre-test	Post-test								
The percentage of correct answers	Medical journals	No	59.59	68.86	57.14	71.43	13.3	11.48	23.81	38.1	90.48	90.48
		Yes	60.04	70.1	61.9	71.43	11.55	10.16	38.1	52.38	76.19	90.48
	Literature	No	56.72	67.84	57.14	66.67	13.31	12.15	23.81	38.1	90.48	90.48
		Yes	62.44	70.14	61.9	71.43	12.11	10.32	33.33	38.1	85.71	90.48
	Study programme	No	52.43	67.79	52.38	66.67	12.24	11.97	33.33	47.62	76.19	85.71
		Yes	60.48	69.38	61.9	71.43	12.94	11.05	23.81	38.1	90.48	90.48
	Internet	No	61.08	68.91	61.9	71.43	12.74	11.12	23.81	38.1	85.71	90.48
		Yes	56.83	70.09	57.14	71.43	13.14	11.3	33.33	52.38	90.48	90.48

Table 5. Percentage of correct answers given in the group of pre-test and post-test students, broken down by their source of knowledge about life support in children.

Variable	M		Me		SD		Min		Max		
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	
The percentage of correct answers	Basic life support and AED in children	74.76	77.78	66.67	83.33	14.13	12.47	33.33	50	100	100
		62.9	75.36	60	80	22.09	19.38	20	20	100	100
	Advanced life support in children	49.51	60.54	50	66.67	19.94	21.06	16.67	16.67	100	100
		53.29	64.26	50	75	20.34	21.5	25	25	100	100
	Cardiac arrest in children – special situations	52.43	67.79	52.38	66.67	12.24	11.97	33.33	47.62	76.19	85.71
		60.48	69.38	61.9	71.43	12.94	11.05	23.81	38.1	90.48	90.48
	CPR in a neonatal and infant	61.08	68.91	61.9	71.43	12.74	11.12	23.81	38.1	85.71	90.48
		56.83	70.09	57.14	71.43	13.14	11.3	33.33	52.38	90.48	90.48

Table 6. Source of knowledge on life support in children in the pre-test / post-test group by the class of the third year students.

Source of knowledge on life support in children	The class of students	N	[%]	N	[%]	Statistical test result	
						Pre-test	Post-test
Journals	2017	15	27.8	17	31.5	$\chi^2(2) = 7.89; p = 0.02$	$\chi^2(2) = 1.35; p = 0.51$
	2018	3	10	7	23.3		
	2019	5	9.3	12	22.2		
Literature	2017	19	35.2	25	46.3	$\chi^2(2) = 20.85; p < 0.001$	$\chi^2(2) = 9.05; p = 0.01$
	2018	26	86.7	24	80		
	2019	26	48.1	32	59.3		
Study programme	2017	44	81.5	51	94.4	$\chi^2(2) = 3.29; p = 0.14$	$\chi^2(2) = 8.08; p = 0.02$
	2018	29	96.7	28	93.3		
	2019	47	87	42	77.8		
Internet	2017	21	38.9	11	20.4	$\chi^2(3) = 7.4; p = 0.06$	$\chi^2(3) = 7.4; p = 0.06$
	2018	6	20	5	16.7		
	2019	19	35.2	16	29.6		

significantly higher percentage of correct answers in the scope of 3 above-mentioned categories as compared to the people from the pre-test group. In terms of basic life support and AEDs in children, no statistically significant differences were found ($t(274) = 1.88; p = 0.06$) (Table 5).

The study also analyzed 4 categories according to the class (2017-2019) of third-year students. The two-factor analysis of variance did not show any statistically significant effect of the interaction of the group of people (pre-test / post-test * class), i.e. concerning 4 categories, as well as the total percentage of correct answers obtained. This means that third-year students from one class of the pre-test group do not differ in a statistically significant way from third-year students from the pre-test group from other classes. The same

applies to the post-test group, e.g. the 2017 class of third-year students from the post-test group do not differ from the post-test students from the other classes (the same applies to the other two classes).

The analysis of the correlation of the category with the class of study showed the presence of one statistically significant relationship in the pre-test group, i.e. with the percentage of correct answers regarding CPR in neonatal and infant ($r = 0.24; p = 0.005$). The later the class of third-year students from the pre-test group, the higher the percentage of correct answers in this category. The class did not show a statistically significant relationship with the other categories, as well as with the total percentage of correct answers ($p > 0.05$). The average percentage of correct answers was similar for individual classes.

The study additionally investigated the sources of knowledge about life support in children in particular years. The statistically significant relationships that were observed indicate that in the pre-test group: knowledge from journals was most often acquired by the students from class of 2017, while knowledge from literature was most often acquired by the students from class of 2018. The same applies to people from the post-test group; in the group of people from the post-test group, the smallest percentage of people acquiring knowledge from the study programme were students from the class of 2019 (Table 6).

It was also analyzed whether participation in the competence development program of UR students had a statistically significant impact on individual categories. In the pre-test group, one such difference was observed in terms of the percentage of correct answers on the CPR of the newborn and the infant. Students from this group participating in the program for the development of competences of UR students obtained a statistically significantly higher percentage of correct answers compared to those who did not participate in it ($t(126) = 3.15; p = 0.002$).

The last analysis conducted concerned the impact of students' use of various sources of knowledge on the individual 4 categories. One statistically significant difference was observed. Students from the pre-test group using the literature, compared to those who did not read it, obtained a statistically significantly higher percentage of correct answers regarding the CPR of the newborn and infant. No other statistically significant differences were observed. The number of sources of knowledge used by the surveyed students did not affect the 4 individual categories.

DISCUSSION

Paramedics often have concerns about emergency ambulance run to an event involving a child. The most severe cases involve cardiac arrest in young patients. Preparation for life support procedures in children should begin at the stage of students training in the field of emergency medical services. This most often takes place in several subjects where issues in the field of paediatrics are discussed. Later, in the course of professional work, such skills are trained on compulsory specialist courses.

The level of knowledge of the third year emergency medical students in the field of life support in children is good. The average percentage of correct answers in the post-test is higher compared to the pre-test. Similar studies among the students of medicine were carried out by Janczewska et al. None of the students studied showed a low level of knowledge

in the post-test, which was the case during the pre-test. The most numerous group in the post-test were students who presented a high level of knowledge (52.2%). According to the researchers, despite the fact that the training had a satisfactory effect, the students' knowledge of first aid and emergency medical services was unsatisfactory. Janczewska et al. claim that compulsory education in this field should be introduced at least at the secondary school level. This is also confirmed by Wójcik et al. in their study among students of universities in Łódź [18]. Education during studies conducted during theoretical and practical classes with the use of simulators [19] significantly influences the increase of students' knowledge. The use of the pretest-posttest study method allows for drawing valuable conclusions as to the effectiveness and efficiency of education at the Department of Emergency Medicine. [9] Some studies indicate that remote-controlled simulation in Paediatric Advanced Life Support (PALS) classes is more effective than on-site teacher simulation [20].

Students of the final year of emergency medical services are best prepared for basic life support and AED in children. The poorest knowledge was found in cardiac arrest in children in special situations.

The increase in knowledge after the training was observed in the category of advanced life support in children, cardiac arrest in children – special situations and CPR of the newborn and infant.

The participation of the third-year students in the competence development program for UR students and the ILS course did not affect the percentage of correct answers in the entire study.

Attending an additional Paediatric Basic Life Support (PBLIS) or PALS short course is a useful tool to help prepare students to perform CPR in children. Bhanji et al. propose a 4-hour paediatric CPR course based on the goals and teaching methods of the PALS course. The authors created a case-based course tailored to the appropriate level for medical students. Students passed the pre-course and post-course equivalent multiple-choice examinations using selected PALS course questions. To minimize “guess-work,” subjects were punished for incorrect answers. Students' test scores increased significantly compared to the test before and after (12.65 / 22 vs. 17.70 / 22; $p < 0.001$). Additionally, students were tested for the perceived educational value of a paediatric CPR course. All medical students want to study properly designed paediatric resuscitation courses and believe that it should be compulsory in their training [21].

Quraishi et al. assessed the basic level of self-confidence of medical students in the management of

cardiac arrest in children. Subjects participated in an established one-day PBLs course and a first aid course at one of the UK's medical schools. Participants were asked to complete a questionnaire before and immediately after the course. After the training, the students' result statistically increased ($p < 0.05$). The confidence interval for the mean for paediatric resuscitation increased from 2.2 / 10 (2.2 out of 10) to 7.5 / 10. Before training, the confidence interval for the mean was 2.6 / 10. The results clearly show a very low preparation of medical students in the field of resuscitation of children at all stages of their training. The authors support the inclusion of the PBLs component in medical school curricula so that future doctors are properly prepared to provide reliable PBLs [3].

The study of the third-year emergency medical students indicates that their preparedness to perform life-saving procedures in children in 2017-2019 was comparable. They acquiring knowledge about child resuscitation from different sources has no effect on the percentage of correct answers. Students gain information mainly from study programme and literature. In the pre-test group, medical journals were used the most by students of the class of 2017, while literature by the class of 2018. In the post-test group, the largest number of students gained knowledge from study programme, as was the case for the class of 2019. Such a situation may indicate a lack of self-education and preparation at home.

Before training, more students used the Internet to gain information. However, after the training, the participation in obtaining information from the Internet decreased in favor of reading of medical journals.

The knowledge of neonatal and infant CPR among the third-year emergency medical students increases year by year in the pre-test group. Additionally, in this category of people who participated in the student competency development program and the ILS course, the percentage of correct answers increased. The use of literature by students also contributes to increasing knowledge in this category.

Chang et al. indicate that a good outcome in neonatal CPR can also be achieved through simulation

training and Neonatal Resuscitation Program (NRP). Classes with the subjects were held in the form of lectures and simulation sessions on a dummy. The increase in knowledge results after training was 63% ($p < 0.00001$). Prior participation in CPR training, age, occupation, and test results before training had no significant effect on the results of the knowledge test after training. The average assessment of the subjects' comfort improved from 4 to 5 ($p < 0.00001$) [22].

LIMITATIONS OF THE STUDY

The study did not analyze the percentage of correct answers for the entire study group (pre-test plus post-test) due to the fact that they were two separate groups. People from the pre-test group did not have any codes that would make them recognizable in the post-test group.

CONCLUSIONS

The level of knowledge of the third-year emergency medical students in the field of performing life support in children is good. The average percentage of correct answers in post-test is higher compared to the pre-test.

In the process of educating students of emergency medical services, the scope of content related to cardiac arrest in children in special situations should be increased.

The increase in knowledge after the training was observed in the category of advanced life support in children, CPR of a newborn and infant, and cardiac arrest in children – special situations, however, in this category the result was the lowest.

The preparation of the last year emergency medical students to conduct resuscitation procedures in newborns and infants increases every year, more often in people reading the literature and participating in the program of developing competences of UR students.

Finding out about CPR from a variety of sources has no effect on the percentage of correct answers. From year to year, students gain less knowledge from medical literature and journals.

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CONFLICT OF INTEREST

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MANAGEMENT OF THE EMERGENCY DEPARTMENT PATIENT WITH TOXIC ALCOHOL POISONING

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Abstract

The aim of the study is to present the process of diagnosis and treatment of the patients poisoned with toxic alcohols. Furthermore, the suicide risk assessment was presented. The role of supportive cure and the importance of the treatment with alcohol dehydrogenase blockade with fomepizole or ethanol hemodialysis for severe intoxicated patients were presented. The differences in the treatment of poisoning with particular toxic alcohols were presented. Moreover, the important psychological factors in the management of this group of patients were also discussed. The paper was illustrated with typical case studies of patients suffering from methanol and ethylene glycol intoxication. Conclusions: 1. The recognition of toxic alcohol poisoning remains a challenge for the clinician, because nonspecific symptoms are similar in many other conditions. 2. Proper management of the poisoned patients requires thorough analysis of many aspects: circumstances of the event, laboratory findings, response to the treatment, and the patient's psychological problems.

Key words

emergency department,
poisoning,
toxic alcohols

INTRODUCTION

Toxic alcohols are group of substance that are not meant to be drunk [1, 2]. The consumption of these alcohols may have accidental or non-accidental character: suicidal, homicidal, or usage due to lack of ethanol and strong desire to drink alcohol. The toxic alcohols lead to severe poisoning after ingestion of the amount which in the case of ethanol is not so deleterious.

THE AIM

The aim of the study is to present the principles of pathophysiology of toxic alcohol poisoning, and the process of its diagnosis and treatment. Furthermore, the suicide risk assessment was presented.

REVIEW AND DISCUSSIONS

The main toxic effects exert the metabolites of methanol and glycol (Fig. 1.) and the first step for ethanol, methanol and glycol is the same enzyme: alcohol dehydrogenase which has the greatest affinity to ethanol [1, 3]. The availability of toxic alcohols increases in Covid-19 pandemic because they can be applied as sanitizers, therefore, discussing the main issues regarding this topic seems to be important [4].

HOW TO RECOGNIZE AND TREAT TOXIC ALCOHOL POISONING

In case of intoxication with isopropyl alcohol or methanol the symptoms of toxic poisoning can occur just after substance ingestion. They are presented

as biphasic symptoms. Initial symptoms are nausea, vomiting, abdominal pain and mild CNS depression. Then next, after latent period of 12 to 24 hours which is needed to convert methanol into formic acid, are occurred dyspnoea, altered mental status, different degrees of visual loss: blurred vision, motion vision without clear shape, rarely total blindness. The diagnosis is difficult and the symptoms are common to many other diseases [5-9].

A clue suggesting the diagnosis of poisoning is the availability of information about a patient's drinking of various alcoholic beverages, although cases of inhalation and percutaneous poisoning are also described in literature, but they occur much less frequently. For this reason, it is worth knowing the products that may contain these compounds of toxic alcohol. Ethylene glycol and methanol are used in industry as a substrate for chemical syntheses (methyl group donor – CH₃), as a solvent for paints and varnishes, as an additive to gasoline, in pharmaceuticals, dyes industry, plastics, synthetic fibers, used as fuel or fuel component and in the production of explosives. While in the household, these substances are present in window cleaners, anti-freeze fluids and coolants. Individuals with alcohol addiction often drink these fluids as a substitute for ethanol. Ethylene glycol is sweet, which sometimes may be important when the history from the patient is being taken. Patients often believe they drank wine because the drink was sweet and report it sponta-

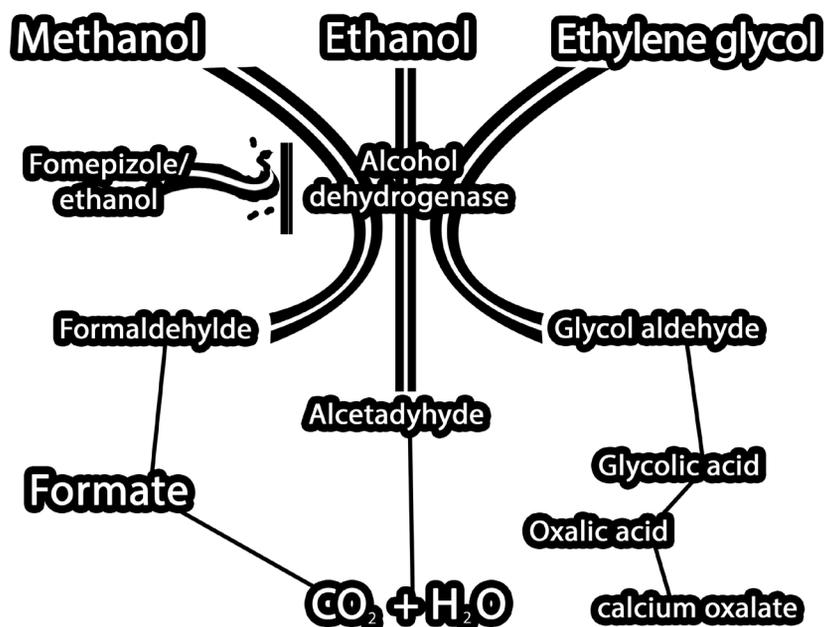


Fig. 1. The main toxic effects exert the metabolites of methanol and glycol.

neously to the doctor. Early clinical effects of ethanol and non-consumer alcohols are similar: nausea, vomiting, blurred vision, headache, loss of coordination, abdominal pain, decreased level of consciousness. These effects occur during the first hour after alcohol ingestion. However, alcohol dehydrogenase converts methanol and ethylene glycol respectively into formic acid and glycolic acid which among others cause optic neuritis. Formic acid inhibits cytochromic oxidase, which causes these symptoms. The acids deteriorate the patient's conditions and the expected sobering up does not occur. The isopropyl alcohol is metabolized into acetone which is not a substrate for alcohol dehydrogenase [1-5].

WHEN DO WE KNOW THAT SOMEONE HAS CONSUMED SUCH ALCOHOL?

When we have a certain interview, but it is rare.

INTERVIEW WITH THE PATIENT'S RELATIVES

Usually, the toxic alcohol poisoned patient is brought to the Emergency Department in a serious condition. Getting an interview from him is either difficult or impossible. For unconscious patients, it is important to take an interview with family or friends. It requires an active attitude of the physician in order to contact someone from the patient's environment. We can ask the Emergency Medical Services if they have the details of the person who was at the place of incident or call to the Emergency Notification Center for the phone number from which the call was made. Before starting the interview, we should notify relatives that the questions we ask are standard and that

we ask the family of each patient who is in a serious condition. The questions are aimed at looking for the cause of the disease, which will allow a faster diagnosis and more effective treatment. Providing this information is important as it may be difficult for the family to admit that a patient has a problem with alcohol abuse or dependence. Using the statement that asking about psychoactive substances is a routine procedure decrease the feeling of stigma and causes more openness in communication with medical staff.

Important questions in an interview with the family of a patient with toxic alcohols poisoning are:

- The circumstances of the event – the course of poisoning from the moment the patient was found,
- Patient's medical history,
- Allergies,
- Medications taken,
- Information on how often the patient consumes alcohol,
- Information whether the patient is drinking alcohol of unknown origin or non-consumable alcohol,

Blood methanol concentration – above 20 mg/dL
 Permissible – up to 20 mg/dL
 Toxic – over 50 mg/dL
 Fatal – over 150 mg/dL
 Blood glycol concentration – above 20 mg/dL
 Permissible – up to 20 mg/dL
 Toxic – over 50 mg/dL
 Fatal – over 150 mg/dL

Fig. 2. Levels indicating intoxication with toxic metabolites.

- Information whether the patient has an access to toxic substances,
- Information when the relatives last saw the patient in a good condition.

WHEN DO WE SUSPECT SUCH POISONING?

We suspect toxic alcohol poisoning if there are disturbances of consciousness, CNS disorders, deep coma in a subject who admits to consumption of “some alcohol”, in an individual with alcohol abuse or addiction, especially when there is an altered mental state and for a person abusing psychostimulants. The next group in which we suspected poisoning is any patient in a coma with metabolic acidosis.

After or during measurement of vital parameters the first diagnostic test at the Emergency Department is the analysis of critical parameters.

Usually, the poisoning with toxic alcohols is associated with metabolic acidosis. It is important to remember that just after drinking toxic alcohol the metabolic acidosis may be absent because the alcohol was not converted into acid yet.

Other poisonings associated with metabolic acidosis may be caused poisoning by salicylates, metformin or result from the excessive production of lactate in poisoning with carbon monoxide or cyanide.

Next conditions with metabolic acidosis that should be considered in the differentiation of intoxication are metabolic acidosis in patients with alcoholism, acidosis in diabetes, acidosis in shock, after cardiac arrest and seizures.

Clinical clues to recognize toxic alcohol poisoning are: tachypnoea, visual changes, not sobering as expected occurrence of seizure.

HOW DO WE CONFIRM TOXIC ALCOHOL POISONING?

The plasma concentration for methanol of glycol should be assessed. In the box 1 the cut-off points for methanol and glycol concentrations are presented (Fig. 2).

ADDITIONAL BLOOD TESTS

In addition, for the purposes of systematic assessment of the patient's condition and the progress of therapy, we need to monitor acid-base balance (blood gases analysis), blood glucose levels, potassium and sodium levels, creatinine and urea, as well as amylase and lipase (sometimes pancreatitis is associated with poisoning).

HIGH OSMOLALITY AND OSMOLAR GAP, ANION GAP

Osmolality is caused by the presence of substances like potassium and sodium, glucose, etha-

nol, urea which are osmotically active molecules. The normal blood osmolality is between 285 and 295 mOsm. It is important to remember that the osmolality could be measured and calculated. The measured osmolality contains all blood “osmoles” whereas the calculated osmolality is assessed on the basis of the sodium, ethanol, glucose and urea concentrations. The difference between them is called osmolality gap and if the gap is more than 10 mOsm the presence of additional osmotically active molecules is suspected, e.g. methanol.

The anion gap is the difference between positive and negative ions and is usually up to 15 mEq/l [10]. However, to utilize the serum anion gap the local laboratory limits should be known.

Just after toxic alcohol consumption the blood osmolality is high whereas due to alcohol dehydrogenase action with acidosis progression the osmolality decreases, and osmolar gap also decreases. However, the anion gap increases due to the increasing level of negative anions because of the presence of acids. The formula for osmolar and anion gap analyses were presented in the box 2.

LOW ETHANOL AS A NEGATIVE PREDICTOR FOR METHANOL INTOXICATION

Some authors consider a negligible ethanol level in patients with decreased level of consciousness to indicate no methanol ingestion because methanol intake is usually simultaneous with ethanol consumption [5]. However, at Toxicology Department the intoxication with methanol alone are often observed.

ELECTROCARDIOGRAM

The QT prolongation may be found in patients intoxicated with ethylene alcohol. The prolongation may be caused by hypocalcemia. The decreased calcium level is a consequence of metabolism of ethylene glycol to oxalic acid and its combining with calcium.

TREATMENT

The main goal of the treatment is the removal of methanol and/or glycol and their metabolites as well as blocking the formation with ethanol the toxic metabolites and combating the resulting acidosis. The goal is to achieve pH correction to at least 7.2.

The treatment consists of the simultaneous actions:

- Supporting vital functions,
- Symptomatic treatment,
- Specific treatment,
- The use of methods accelerating the elimination of poison and its metabolites.

It is essential to maintain basic life functions depending on the clinical situation:

- Prevention of hypoxia -> respiration monitoring, pulse oximetry -> oxygen therapy, endotracheal intubation, respiratory therapy,
- Cardiovascular monitoring (ECG, arterial pressure, pulse) -> filling the vascular bed -> infusions of 5% dextrose and multiple electrolyte injection, administration of osmotically active fluids -> use of vasopressor amines,
- Diuresis monitoring -> fluid balance, catheterization -> filling the vascular bed -> infusion of 5% dextrose and multiple electrolyte injection, administration of osmotically active fluids -> hemodialysis.

Such proceedings should be started immediately in the Emergency Department.

The treatment should be also focused on symptomatic management, i.e.: balancing electrolyte disturbances, administration of benzodiazepines in convulsions, treatment of cerebral edema and above all, to correct acidosis.

Rapid acidosis correction is possible by using sodium bicarbonate infusion. The Astrup formula is used to calculate the dose of sodium bicarbonate needed to compensate for acidosis. The amount of solution 8.4% NaHCO₃ (mmol) may be calculated by multiple base deficiency BE (mmol) x body weight in kg x 1/3 (or 0.3). In common use there is an 8.4% sodium bicarbonate solution containing 1mEq of sodium bicarbonate per ml. Often half the calculated dose is sufficient, but usually not in alcohol poisoning. In the ED when the history is relevant for toxic alcohol consumption, one can initially administer 100 – 150 mEq of sodium bicarbonate. It could be done before blood gases analysis especial when it is not easy available. The next doses depend on the blood pH, which is measured every 1-2 hours. Administration of bicarbonate is stopped when the blood pH exceeds 7.25. The preparation can be administered either by in

a direct intravenous injection undiluted (for vital reasons, e.g. during cardiac arrest) or in intravenous drip infusion only through a catheter inserted into the vein, in a form diluted with 5% dextrose solution in the ratio 1:1, at the rate of 60 drops / min (3 ml / min). It is important to remember not to attempt to completely correct the alkaline deficit within 24 hours of therapy, as metabolic alkalosis and its associated side effects may occur. If possible, a central line should be inserted for the administration of ethanol solutions and for the infusion of vasopressor amines. Such proceedings should be started immediately in the ED.

SPECIFIC TREATMENT

The specific treatment is due to administration of antidotes, i.e. ethanol and Fomepizole as competitive inhibitors of alcohol dehydrogenase. Ethanol administration can be started in the ED. Moreover, folic acid could be give to enhance the conversion of formate into water and carbon dioxide. Hemodialysis is the most powerful method to eliminate toxic alcohols and their toxic metabolites from blood.

ETHANOL

Ethanol should be administered orally in the form of a 40% solution as soon as possible in conscious patients. Initial dose for adults is 1 ml of 95% ethanol / kg of body weight or 2.5 ml of 40% ethanol / kg b.w., maintenance dose of 0.1–0.2 ml of 95% ethanol / kg of body weight /h. For unconscious patients, ethanol may be administered via a gastric tube at doses same as administered to conscious persons. It can also be given as an intravenous infusion of a 10% solution in 5% dextrose. Initial dose of 10 ml / kg of body weight as an intravenous infusion over period of 30 minutes, then the maintenance dose of 1.5 ml / kg body weight infused with a flow to maintain blood ethanol concentration at 1.0 – 1.5 g / L.

During hemodialysis, the ethanol supply should be increased so that the ethanol level in the blood is also 1.0 – L (1‰).

$$\text{Serum Anion Gap} = (\text{Na} + \text{K}) - (\text{Cl} + \text{HCO}_3)$$

$$\text{Osmolar Gap} = \text{Measured osmolality} - \text{Calculated osmolality}$$

$$\text{Calculated Osmolality} = 2 * [\text{Na}] + \text{Glucose}(\text{mg/dL})/18 + \text{BUN}(\text{mg/dL})/2.8 + \text{EtOH}(\text{mg/dL})/4.6$$

Fig. 3. The formula for osmolar and anion gap analyses.

Na – sodium, K- potassium, Cl – chloride, HCO₃ – bicarbonate, BUN – blood urea nitrogen, EtOH – ethanol

FOMEPIZOLE (4-METHYLPYRAZOLE 4-MP)

The initial loading dose is 15 mg / kg of body weight. Maintenance dose of 10 mg / kg of body weight four times every 12 hours, then 15 mg / kg every 12 hours until the ethylene glycol levels are at least below 15 mg / dL and the patient becomes asymptomatic with normal pH. Each dose of the drug should be diluted in 250 ml of 5% dextrose or 0.9% NaCl solution. Doses should be infused intravenously slowly over 30 minutes. Fomepizole is dialysable and during hemodialysis it should be administered every 4 hours at a dose of 10 mg / kg of body weight.

FOLIC ACID

Replenishment of cofactors of enzyme which metabolizes formate into water and carbon dioxide. Folic (or folic) acid may also be given to enhance the endogenous metabolism of formate which is caused by an enzyme 10-tetrahydrofolate synthetase. Folic acid (Calcium folinate, Calciumfolinat-Ebewe, Leucovorin

Ca Teva) 1-2 mg / kg of body weight administered intravenously. The first dose should be given before dialysis and the second dose after dialysis. 50 mg of folic acid should be administered orally or via a gastric gavage every 4-6 hours for 24 hours after intoxication to enhance elimination of formic acid.

HEMODIALYSIS

Hemodialysis is the method of choice. This treatment usually takes place in a Toxicology Department or other facility capable of such procedure.

The absolute indication for the use of hemodialysis are:

- Blood methanol concentration above 50 mg / dL,
- Blood glycol levels above 50 mg / dL,
- Metabolic acidosis with bicarbonate levels below 12 mmol / L,
- Difficulties to compensate for metabolic acidosis,
- Damage to the optic nerves.

Hemodialysis in intoxicated patients could be performed because the intoxication: usually the first

Table 1. A case study of a patient with methanol poisoning.

Male 47 y.o.	Patient brought by the Emergency Medicine Services was admitted to the Emergency Department. The day before he drank illegally bought alcohol. At 11:00 PM patient returned home under the influence of alcohol, in the morning he told his family that he had lost his eyesight, his condition worsened. Then at 3:30 PM he was admitted to the ED, deeply unconscious after 30 minutes of bradycardia and cardiac arrest in the PEA mechanism.
History at admission	
Examination on admission	Methanol level was 234.3 mg/dL, ethyl alcohol was absent. After intubation and connection to a ventilator, pH 6.978 BE=- 20mmol/L pCO ₂ 45.7 mmHg PO ₂ 336 mmHg NA 134 mEq/L, K 3.6 mEq/L creatinine 0.8 mg/dL; Hb 15.2 g/dL; MCV 90.3fl; L 5.16 G/L; glycaemia 205 mg/dL, ALT 31 IU/L CK 1271IU/L
Treatment	Respiratorotherapy, NaHCO ₃ , ethanol via a gastric tube, haemodialysis Pressure amines due to shock
Outcome	On the 4 th day multi organ failure occurred, then cardiac arrest and death

Table 2. A case study of a patient with ethylene glycol poisoning.

Male, 63 y.o.	The patient addicted to alcohol lost consciousness at home, the ambulance was called, the patient was intubated and connected to a ventilator. CT of the head, neurological and cardiological consultation and blood gases analysis were performed, metabolic acidosis was determined.
History at admission	
Examination on admission	Ethylene glycol – 98.3mg/dL pH=6.983 BE=-26.5 mmol/L pCO ₂ =14.6mmHg pO ₂ = 157.6 mmHg L-22.16 G/L Hb 14.1 g/dL K 3.9 mEq/L Na 138 mEq/L Glucose 162mg/dL; creatinine 1.6 mg/dL, ALT-16 IU/L CRP-78.21 ng/dL
Treatment	Long (9h) "toxicological" hemodialysis treatment, achieving a decrease in glycol <20 mg/dL, ethanol through a tube intragastrically, natrium bicarbonicum, catecholamines due to hypotension during dialysis.
Complications during the treatment of poisoning	Abstinence syndrome treated with benzodiazepines, pneumonia, urinary tract infection, anuria – multiple "renal" hemodialysis, rehabilitation, hospitalization for 34 days, he was in bed for a long time.
Outcome	Discharged home

dialysis which is called toxicological dialysis and it often lasts up to 12 hours. Later, the next dialyses are performed due to renal failure, the patients need dialysis similar to the patients with renal failure of other reasons lasting about 3 hours and these dialyses are called renal dialyses.

ISOPROPYL ALCOHOL INTOXICATION

Isopropyl alcohol is a toxic alcohol, however it is not metabolized by alcohol dehydrogenase therefore a treatment with this alcohol has some differences. Moreover, nowadays it is the most frequently used alcohol for sanitizers reasons.

The lethal dose of the isopropyl alcohol is 160-240 ml. Orally ingested isopropyl alcohol is absorbed completely within 2 hours. It is metabolized into acetone which is excreted by kidneys. The acetone is not a substrate for alcohol dehydrogenase, therefore inhibitors of alcohol dehydrogenase are not used to treat the isopropyl alcohol intoxication. Isopropyl alcohol is a central nervous system depressant which causes hypotension and decrease of respiratory rate. It also causes gastritis, hypoglycemia, myocardial depression. Ingestion of isopropyl alcohol leads to ketosis without an elevated anion gap/acidosis (Fig. 3).

SUICIDE RISK ASSESSMENT

Alcohol use disorder is associated with higher suicide risk. Patients with substance use disorder are 6 times more often reported in lifetime suicide attempt than those without alcohol use disorder in history [13]. Alcohol intoxication may be accidental, but it may also be the result of an attempted suicide. This is an issue that needs to be carefully investigated and clarified after detoxification. The question of suicidal thoughts and suicidal intentions is an important element of the patient's assessment. One should not be concerned that such questions may inspire suicidal thoughts or intentions.

ALCOHOL ABUSE ASSESSMENT

If a patient is able to cooperate, he should be screened for a history of alcohol abuse. Several screening tools are recommended for use in Emergency Department: Single Alcohol Screening Questionnaire (SASQ), the Alcohol Use Disorders Identification Test (AUDIT), the Cutting down, Annoyance by criticism, Guilty feeling, Eye openers Questionnaire (CAGE) and the Paddington Alcohol Test (PAT) [14,15]. These assessments take a possibility of individual underreporting of alcohol intake. Feedback from screening results is a basis for brief intervention

which helps to highlight the danger and educate patient on acceptable limits of alcohol intake.

A representative case study of a patient with methanol poisoning is presented in Table 1.

A representative case study of a patient with ethylene glycol poisoning is presented in Table 2.

CONCLUSIONS

The presented case studies are similar to those introduced in the literature [10, 11] and stress the importance of the following conclusions:

1. An unconscious patient requires blood gases analysis, the presence of metabolic acidosis needs testing of the level of toxic alcohols and ethanol.

2. Immediately after drinking methanol, there may be no acidosis, but in practice, no one goes to the hospital so early as the reason for call for help is usually malaise that occurs only after some time, which allows the development of acidosis.

3. A clinical interview with family and friends is often incomplete and false as both patients and their relatives tend to use the denial mechanism. They minimize their usage of alcohol because they are afraid of being judged negatively or interfering with their personal lives. It is important to emphasize the routine nature of the questions about alcohol and the importance of obtaining answers to them as a condition for providing adequate assistance to the patient.

4. Drinking toxic alcohol most often is accidental.

5. A patient poisoned with alcohol, whose condition worsens, requires testing for toxic alcohols and intracranial trauma.

6. In the practice of the Toxicology Department the factor that delayed the admission to the ward was neurological and cardiological diagnostics.

7. Patients who, according to their family, have stopped drinking alcohol and are sober, in fact can drink alcohol in smaller amounts in hiding.

8. The first dialysis in the Toxicology Department is called toxicological dialysis and is usually carried out until the presence of the toxin has completely disappeared or the concentration is below the threshold values. Repeated dialysis sessions are often required because the follow-up of dialysis is usually acute renal failure. Hypotension in toxicological cases of alcohol poisoning, i.e. where the only salvation is hemodialysis, is not a contraindication to dialysis, high doses of catecholamines are used.

9. There are complications during hospitalization in patients poisoned with toxic alcohols: shock, respiratory failure, renal failure, urinary tract infections.

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THYROID STORM AS A LIFE-THREATENING CONDITION IN THE PRACTICE OF EMERGENCY MEDICAL SERVICE TEAMS

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Abstract

Thyroid storm is a medical emergency. It comprises disorders of several organs and body systems, including disturbances of consciousness (also coma), heart failure, symptoms of shock, and high body temperature. The diagnosis of thyroid storm is challenging because it is based primarily on medical history and physical examination. Additional laboratory tests only perform an auxiliary function, and the initiation of therapy should not be delayed until the determination of thyroid hormones in the blood. Moreover, clinical symptoms often do not correlate with thyroid hormones concentration in the blood. Diarrhea, vomiting, and fever may lead to the diagnosis of thyroid storm. These are not typical symptoms of uncomplicated hyperthyroidism. The remaining symptoms of thyroid storm are symptoms of decompensation of individual organs and systems. When diagnosing thyroid storm, one uses the Burch and Wartofsky criteria. Accurate and quick diagnosis and implementation of initial treatment is the aim of pre-hospital management. These are fluid therapy, oxygen therapy, and antipyretic drugs. For this reason, it is essential not to delay the patient's transport to the nearest hospital emergency department. One may also consider calling a specialist ambulance with a doctor who can give the right medication on the spot. Rapid treatment initiation can improve the status of most patients within 12-24 hours. Treatment delay worsens, and intensive treatment improves the prognosis in patients with thyroid storm. The mortality rate of thyroid storm has decreased and is now 20-30%.

Key words

thyroid diseases,
medical emergency service,
thyroid storm

INTRODUCTION

Thyroid storm (TS) is a medical emergency. It is a consequence of a sudden breakdown in the balance of the system, which develops based on undiagnosed or insufficiently treated hyperthyroidism. It is associated with disorders of several organs and body systems, including disturbances of consciousness (also coma), heart failure, shock symptoms, and high body temperature [1].

Thyroid storm is the most dangerous complication that can develop during hyperthyroidism. TS management is challenging because its diagnosis is based primarily on medical history and physical examination. Additional laboratory tests only perform an auxiliary function, and the initiation of therapy should not be delayed until the determination of thyroid hormones in the blood. Moreover, clinical symptoms often do not correlate with thyroid hormones concentration in the blood. Diarrhea, vomiting, and fever may lead to the TS diagnosis. However, these are not typical symptoms of uncomplicated hyperthyroidism. The remaining TS symptoms are symptoms of decompensation of individual organs and systems. Nervous system symptoms are usually quantitative or qualitative disturbances of consciousness such as somnolence, agitation, delirium, or coma. Cardiovascular decompensation may manifest as exacerbation

of heart failure with edema, dyspnea, and hepatomegaly. Cardiac arrhythmias are almost always observed, including sinus tachycardia or atrial fibrillation. In the laboratory tests, the TS occurrence may be indicated by increased transaminases, alkaline phosphatase, hyperbilirubinemia, hyperglycemia, and leukocytosis with a left shift in the smear hypercalcemia, increased activity of lactate dehydrogenase, and creatine phosphokinase [1].

THE AIM

The study aimed to draw attention to the TS problem as the immediate threat to the patient's life. However, due to the lack of characteristic deviations in additional tests, its diagnosis is based primarily on thorough medical history and physical examination.

REVIEW AND DISCUSSION

Based on epidemiological data, the TS incidence is estimated at 0.2 per 100,000 per year, and the TS affects 0.22% of patients with hyperthyroidism [2]. TS accounts for 1-2% of hospitalizations for hyperthyroidism in the US [3]. In recent years, the incidence of TS has been decreasing due to improved treatment effectiveness and proper preparation for goiter surgery. Most TS cases are observed in patients with Graves' disease – untreated or improperly treated [2].

Thyroid storm is extremely rare in patients with thyrotoxicosis caused by other causes, such as subacute thyroiditis, nodular goiter, acinar moles, TSH-secreting pituitary tumor, or thyroid cancer [4-8]. Thyroid storm most often is triggered by certain factors, such as viral or bacterial infections, hypoglycemia, diabetic ketoacidosis, trauma, severe burns, surgery (mainly thyroid surgery in the period of hyperthyroidism), discontinuation of antithyroid drugs, an overdose of thyroid hormones, pulmonary embolism, pregnancy, and stress. Thyroid storm may also occur with drugs whose side effects may be hyperthyroidism, such as amiodarone, sorafenib, or ipilimumab. Thyroid storm is more common in women (F:M ratio = 3:1) [9-11].

The thyroid gland is the largest odd endocrine gland, located in the anterior-lower part of the neck. It is made of two side lobes connected by an isthmus. There may also be a third pyramidal lobe. The boundaries of the thyroid gland extend upwards to the half of the laryngeal thyroid cartilage, laterally to the cervical vascular nerve bundle, backward to the pre-vertebral fascia, and downwards to the fifth laryngeal cartilage. The isthmus connects the side lobes. The weight of the thyroid gland ranges from 30 to 60 g. It may increase in size during pregnancy or the menstrual cycle. The thyroid gland produces triiodothyronine (T3), thyroxine (T4), and calcitonin. These hormones influence the metabolism and the body's calcium-phosphorus balance [12].

Thyroid hormones affect most organs and systems of the body. By influencing the bones, e.g., they stimulate the growth of bone tissue. In the cardiovascular system, they increase the effect of catecholamines, increase systolic blood pressure, stroke volume, contractility of the heart muscle, and accelerate the heart rate. They regulate the entire metabolism by stimulating (intensify) thermogenesis. They also intensify the metabolism of amino acids, lipids, carbohydrates, boost energy production in the kidneys, muscles, and liver, and amplify the transport of glucose and amino acids to cells (substrates for metabolic transformations). They stimulate the growth and development of other tissues as well as intensify cell proliferation. They increase oxygen consumption by stimulating Na⁺/K⁺-ATPase in all tissues except the brain, spleen, and testes. They regulate the work of the sweat glands, intensify the endothelial production of nitric oxide, and influence the regulation of the hypothalamic-pituitary-thyroid axis. In addition, they influence neurological and somatic development in utero and the first years after birth, stimulating the growth of nervous tissue and myelination in the central nervous system [12].

Medical history and physical examination allow identifying a significant proportion of hyperthyroidism cases and determining its severity initially. However, the clinical picture of hyperthyroidism is similar regardless of its cause. It depends on the patient's age and the response of individual organs to the increased concentration of hormones, not on the absolute concentration of hormones in the blood [12].

When collecting the medical history, special attention should be paid to the history of radiotherapy to the head and neck area, tests performed with the use of a contrast agent, iodine supply, taking medications affecting the thyroid function (e.g., amiodarone, lithium, iodine preparations, interferon) and existing diseases in the family (hyperthyroidism and hypothyroidism, thyroid cancer, autoimmune diseases such as diabetes, rheumatoid arthritis, vitiligo, psoriasis, anemia or severe myasthenia gravis) [12].

While taking the medical history, one can assess the patient's mental state preliminarily. For example, patients with hyperthyroidism often report fear, anxiety, increased irritability, and emotional lability. They also report problems with concentration and insomnia. Older adults may be apathetic and prone to depression. They can also report increased appetite, weight loss, constant heat feeling, and excessive sweating [12].

On history taking, in virtually every system, one can notice abnormalities resulting from the existing hyperthyroidism. Cardiac arrhythmias are the most common circulatory symptom in hyperthyroidism. There is also a worsening or increased frequency of angina symptoms. Symptoms of heart failure may also be worsened. Shortness of breath and edema are one of the components of the thyroid-cardiac syndrome [12]. The main ailment of the respiratory system is dyspnea, associated with an increased demand for oxygen and an increase in blood flow through the lungs. Also, dysphagia may appear as a result of the pressure of a large goiter on the esophagus. Another symptom of the gastrointestinal tract may be diarrhea, which is a sign of accelerated digestive passage. Considering the musculoskeletal system, hand tremor and muscle weakness are typical symptoms [12].

The symptoms of an overactive thyroid also apply to the reproductive system. In an overactive thyroid, periods are usually regular but scanty. In severe thyrotoxicosis, rare or absent menstruation (amenorrhea) may occur. In addition, both sexes may experience decreased libido in hyperthyroidism and hypothyroidism, and in men – erectile dysfunction [12].

After the medical history, we move on to the next stage, i.e., the physical examination. First, we pay attention to the general physique – hyperthyroidism is

usually accompanied by weight loss. However, this does not mean that all people with hyperthyroidism will be thin – it depends on the starting body weight. In addition, in some men with thyrotoxicosis, gynecomastia in one or both mammary glands can be observed. This is due to the increased production of the sex hormone-binding protein (SHBG), which binds testosterone to a greater degree than estrogen [12].

When examining the skin and subcutaneous tissue, it is possible to notice increased heat and moisture, hyperpigmentation (in severe hypertension), increased sweating, increased dermatographism, softness, and brittleness in the nails, as well as onycholysis. In hyperthyroidism caused by Graves' disease, there may be pruritus, urticaria, and pre-shin edema. In the event of TS, fever is a permanent systemic symptom. Jaundice may also occur [12].

Ocular symptoms are the characteristic symptoms of hyperthyroidism, which most often occur in autoimmune thyroid diseases. Still, they can also occur in patients with hyperthyroidism of other origins and even in healthy people. In nearly 98% of patients with Graves' disease, the following symptoms occur: Jellink's symptom (hyperpigmentation of the eyelid skin), Dalrymple's symptom (retraction of the upper eyelid, causing the excessive opening of the eyelid gap and an expression of fear), Graefe's symptom (delayed movement of the upper eyelid in the eyeball and visualization of the sclera limestone over the cornea during the downward movement of the eyeball), Kocher symptom (delay in the movement of the eyeball in relation to the raised upper eyelid and exposure of the sclera part above the cornea during the upward movement of the eyeball), Moebius symptom (impairment convergent movement of the eyeballs), Stellwag symptom (infrequent blinking), and slight exophthalmos not related to visual impairment [12].

During palpation of the thyroid gland, it is possible to find an enlarged gland (goiter), possibly increased cohesiveness, and vascular murmur (it is caused by Graves' disease, accompanied by an increase in blood flow through the thyroid gland) [12].

When assessing the cardiovascular system, we can find tachycardia or other heart rhythm disturbances (most often extrasystoles and atrial fibrillation), loud tones and systolic murmur at the apex and the base of the heart (caused by hyperkinetic circulation), and an increase in the amplitude of arterial pressure (increase in systolic blood pressure and a decrease in blood pressure). Focusing on the respiratory system, we can find tachypnea, signs of congestion in the pulmonary circulation, or inspiratory wheezing – in the case of tracheal stenosis due to severe goiter.

In thyrotoxicosis, psychomotor agitation and intensification of tendon reflexes draw attention. Hyperthyroidism leads to weakness and reduction of the mass of skeletal muscles, especially large proximal muscles, i.e., pelvic and shoulder muscles, rarely the face, larynx, pharynx, or respiratory muscles [12].

CRITERIA FOR THE DIAGNOSIS OF THYROID STORM

The TS diagnosis is made based on the clinical image and the medical history that leads to the diagnosis. It is important to stress that there is no correlation between clinical symptoms and blood levels of thyroid hormones. Hypermetabolism and stimulation of the adrenergic system are characteristic of TS. Patients present high fever reaching 39-41 degrees Celsius, profuse sweating, vomiting, and diarrhea that may lead to dehydration. Tachycardia over 140/min is very common and results from the action of thyroid hormones on the conductive system. Other cardiac arrhythmias, often atrial fibrillation or supraventricular tachycardia, may also occur. In addition, some symptoms should be considered typical for TS, such as significant mental agitation, emotional lability, anxiety, delirium, insomnia, redness of the skin, nausea, weight loss, jaundice, tremors, muscle weakness, disorientation, consciousness disturbances, convulsions, hypotension, and coma [13, 14].

When diagnosing TS, we use the TS risk assessment scale according to the Burch and Wartofsky criteria (Table 1).

PRE-HOSPITAL MANAGEMENT

The aim of pre-hospital management is accurate and quick diagnosis and implementation of initial treatment. The operation of a paramedic in the primary EMS team in the case of TS is limited, as the Act on the State Emergency Medical Services of September 8, 2006, strictly defines the medications that can be used by a paramedic alone [16]. In the case of TS, these are fluid therapy, oxygen therapy, and antipyretic drugs. For this reason, it is essential not to delay the patient's transport to the nearest hospital emergency department. One may also consider calling a specialist EMS team with an EMS doctor who can give the right medication on the spot.

Scheme of pre-hospital management [13, 17-19]:

1. Protection of basic vital functions according to the ABCDE scheme
2. Correcting fluid and electrolyte deficiency by administering 1000 mL of 0.9% NaCl in the first hour of treatment
3. Administration of oxygen in the maximum available concentration and flow

4. Physical (cold compresses) and pharmacological cooling of the patient
5. Inhibition of thyroid hormones production and secretion by administering methimazole 20 mg every 6 hours orally, intravenously, or rectally or 150 mg propylthiouracil every 6 hours (medications that a paramedic can administer after consultation with a doctor or medical coordinator)
6. Looking for causes that may lead to TS
7. Transport to the hospital to the intensive care unit

CONCLUSIONS

Thyroid storm is the most dangerous complication that directly threatens the patient's life and may develop in the course of hyperthyroidism. Thyroid storm is associated with disturbances in most organs and body systems. The diagnosis of TS is difficult because it is based primarily on medical history and physical examination. Laboratory tests only fulfill the auxiliary function. Infections are the most common triggering factor for this clinical condition. In addition, the occurrence of an acute condition (e.g., heart attack, stroke) or exacerbation of a chronic disease may lead to it. Thyroid storm is most often preceded by prodromal symptoms, including insomnia, fever, nausea, vomiting, and increased tremor. In a full-blown TS, cardiovascular symptoms dominate, i.e., a significant increase in heart rate, possibly heart rhythm disturbances (e.g., atrial fibrillation), exacerbation of heart failure symptoms, or the occurrence of de novo acute heart failure. Fever (> 38-40°C) and psychiatric disorders (ranging from over-agitation to coma) are common. Management is directed at preventing decompensation of hyperthyroidism, which may lead to TS. One assesses the TS probability on the Burch and Wartofsky criteria. Here, these criteria assess the body temperature, symptoms from the nervous, digestive, and cardiovascular systems, and the possible presence of predisposing factors. Gathering ≥ 45 points indicates that TS is very probable. Treatment of TS should be carried out in the intensive care unit. The standard of care is administering antithyroid drugs, beta-blockers, hydrocortisone, antibiotics (if there is even a slight suspicion of infection), anticonvulsants, sedatives, and oxygen. Moreover, the management aims to correct fluid and electrolyte disturbances and lower body temperature. Antithrombotic prophylaxis should be used. However, the most important thing is identifying the cause that led to such a condition and treating this disease intensively [12].

According to the literature, the TS mortality rate ranges from 8% to 25% [2, 13]. The most common

Table 1. Burch and Wartofsky criteria.

Parameter	Points
Body temperature (°C)	
38.0 – 38.5	5
38.6- 39.0	10
39.1 – 39.5	15
39.6 – 40.0	20
40.1 – 40.6	25
> 40.6	30
Nervous system symptoms	
None	0
Mild (agitation)	10
Moderate (delirium, psychosis, severe sleepiness)	20
Severe (convulsions, coma)	30
Digestive system symptoms	
None	0
Mild (diarrhea, nausea, vomiting, stomachache)	10
Severe (jaundice)	20
Tachycardia	
90-109/min	5
110-119/min	10
120-129/min	15
130-139/min	20
>140/min	25
Heart failure	
None	0
Mild (swelling of the lower legs)	5
Moderate (crackles at the base of the lungs)	10
Severe (pulmonary edema)	15
Atrial fibrillation	
None	0
Present	10
Predisposing factor	
None	0
Present	10

Scoring Interpretation:

- < 25 points – thyroid storm is unlikely
- 25-44 points – threatening thyroid storm
- ≥ 45 points – thyroid storm very likely

causes of death in this group of patients were a multi-organ failure (24%), circulatory failure (21%), respiratory failure (8%), arrhythmia (8%), disseminated intravascular coagulation (DIC; 5%), and sepsis (3%) [2].

Accurate diagnosis and quick multi-specialist treatment determine the effectiveness of the therapy.

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SKIN DISEASES CAUSED BY THE SARS-COV-2 VIRUS AND THEIR INCREASE DURING THE USE OF PERSONAL PROTECTIVE EQUIPMENT

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Abstract

The aim of the study was to present skin diseases that occur during the Sars-CoV-2 pandemic, especially among healthcare workers. Literature data on skin symptoms associated with COVID-19, frequently reported, e.g. by healthcare workers in the last months of the pandemic. Properly built, healthy, undamaged skin is our protection. It is extremely important for our health during the COVID-19 pandemic, and especially for people working in the health service. There is an increasing number of reports of irritating dermatitis among healthcare workers due to the increased need to wear personal protective equipment and more frequent hand washing than before the pandemic. Overzealous use of disinfectants and frequent hand washing can lead to disturbances in the functioning of the skin barrier, which in turn can lead to diseases such as hand eczema. This systematic review focuses on all skin problems related to COVID-19, including primary and secondary COVID-related cutaneous presentations. Skin diseases caused by Sars-CoV-2 virus should be monitored.

Key words

skin diseases,
skin,
medical personnel,
SARS-CoV-2

INTRODUCTION

Skin is the largest organ of the human body, therefore its proper structure and proper health condition are extremely important for our health in the time of the COVID-19 pandemic. The condition of the skin is extremely important for health of people and in particular for people working in the health service. Healthcare is currently facing an ever increasing burden from the new coronavirus (COVID-19) pandemic. It becomes mandatory to wear protective masks and disposable gloves, and this applies not only to medical personnel, but to the entire population. Frequent and long-term use of antiseptics and personal protection can lead to skin damage, especially among healthcare professionals. Dirk et al. pay special attention to the fact that poor skin condition contributed even to reduction of the workforce and a decrease in labor productivity. History is full of examples of cutaneous lesions which reduce the effective workforce and even such, which change the course of history [1]. Roughly half of the United States Forces in the Mekong Delta were immobilized by skin conditions at some stages of Vietnam conflict, with inflammatory tinea, immersion foot and intertrigo, amongst the most prevalent health problems. Skin disease is a large proportion

of occupational injury and lost days at work, among health care workers who report a high incidence of occupational skin disease [2]. Therefore, in the era of the coronavirus pandemic, condition of skin is extremely important for the health of people, in particular people working in the health service. On this account, skin diseases caused by Sars-CoV-2 virus and use protective clothing, as well as disinfectants should be monitored on an ongoing basis. The incidence of skin conditions related to protective equipment is high. Duration of employment, atopy, low humidity, frequency of hand washing and glove use are important risk factors for hand dermatitis amongst medical personnel [3].

THE AIM

The aim of this study was to present skin diseases that appeared during the Covid-19 pandemic and the increased need for personal protective equipment and hand disinfection among healthcare workers.

MATERIAL AND METHODS

Literature data on skin symptoms associated with COVID-19, frequently reported by healthcare professionals in the last several months of the pandemic, have been retrospectively analysed.

REVIEW AND DISCUSSION

Due to the increased need to wear personal protective equipment and more frequent hand washing, than before the pandemic, there is an increasing number of reports of irritating dermatitis among healthcare workers, especially those working with patients infected with COVID-19. In China, where the pandemic started, as many as 97% of workers in infectious diseases hospitals reported skin problems such as eczema associated with protection against infection [4]. Despite recognition of this problem's scope, there is a lack of published literature on effective measures to reduce the incidence of occupational skin injury among physicians and nurses [5]. Latex-free gloves are now standard in many clinics and hospitals, and effort to reduce exposure to low-level irritants have potential to decrease occupational skin disease [6]. Hand eczema (HE) is a recurrent and chronic condition with heterogeneous etiology. Exposure to detergents and soaps, frequent hand washing more than 20 times a day, and the use of gloves are well known risk factors for developing disease or exacerbation. The need to use these measures during the COVID-19 pandemic can increase the incidence of eczema, which can become an occupational disease and reduce work productivity, as well as eliminate medical personnel [7]. Ferguson [8] reports that 146 health workers in Great Britain (in Manchester and London) have been diagnosed with irritating contact dermatitis and have reported oppressive facial inflammation caused by wearing face masks and goggles. Research by The British Society for Cutaneous Allergy starting from May to July 2020, conducted on 337 health care workers (mainly nurses and primary care assistants, working with patients infected with SARS-CoV-2) indicates that the most common dermatosis is skin contact eczema, which occurred in 59% of examined, as well as destruction of the protective layer of the skin and degreasing of the skin. This is most likely related to the increased frequency of hand washing with soap and the use of disinfectants, as shown in previous research on contact dermatitis. A history of atopic eczema was reported in 40.6% of workers, compared with prevalence estimates for the UK population of 8.3%. In addition, acne vulgaris and rosacea have been reported in healthcare workers wearing protective masks, whereas worsening of symptoms has been reported in those with a past history of acne. This may be due to the fact that the masks worn provide a moist and warm environment, which stops, among others bacteria and sebum, worsening or causing disease symptoms [9]. Healthcare is currently facing an ever increasing burden from the new coronavirus (COVID-19) pandemic.

Coronaviruses belong to a large group of viruses that can infect humans and animals, and can lead to diseases of the respiratory tract, intestines, liver and nervous system, including mental disorders. Coronaviruses known so far can infect the upper respiratory tract with a rather mild course. A new type of SARS-CoV-2 coronavirus has been described in the Chinese city of Wuhan, from where it has been spread throughout the world. COVID-19 can cause pneumonia and acute respiratory distress syndrome, which are the leading causes of death among infected people. It spreads by droplets causing fever, fatigue, dry cough, shortness of breath, headaches, muscle and joint pain. Small percentage manifests itself with gastrointestinal complaints, and skin manifestations are even less common. The percentage of patients with skin lesions ranges from 1% to 20% of all SARS-CoV-2 patients, so skin diseases account for a high percentage of symptoms caused by SARS-CoV-2 [10]. High percentage of asymptomatic carriers, combined with the significant infectivity of the new coronavirus, has caused a change in social behavior to prevent its spread. Preventive measures currently recommended by the World Health Organization (WHO) include social distancing, avoiding touching your face, covering your mouth and nose when coughing or sneezing, and frequently washing your hands with soap or alcohol-based disinfectants. It is becoming more and more popular to wear protective masks and disposable gloves, and this applies not only to medical personnel, but to the entire population. Frequent and long-term use of such aggressive antiseptics and personal protection measures can lead to skin damage, especially among healthcare professionals. Lan et al. reported a high incidence of skin complications related to the use of protective measures among healthcare professionals treating patients infected with COVID-19. In case of skin diseases, further use of protective measures may be difficult, and attempts to avoid abrasions may reduce the protective effectiveness of the face mask. [6]. Proper hand hygiene is one of the basic preventive measures to stop the spread of SARS CoV-2 virus, severely attacking the human respiratory system. Nevertheless, overzealous use of disinfectants and frequent washing of hands can lead to disturbances in the functioning of the skin barrier, which in turn can lead to diseases such as hand eczema. The most common symptoms are itching, burning and dryness, additionally, reddening, peeling and blistering may develop. It is said that there is an increased risk of contact dermatitis among healthcare workers directly related to the care of COVID-19 patients, whereas the Singh and Pawar studies report a diagnosis of hand dermatosis in

case of 16 non-healthcare patients in India. Ten of them were diagnosed with contact dermatitis, 5 patients had allergic eczema and 1 patient had mixed symptoms. It should be emphasized that all patients admitted to excessive use of alcohol-based disinfectants, which could be irritating. Too frequent hygiene and disinfection of hands lead to a gradual loss of surface lipids, causing the detergent to penetrate deeper into the skin layers [7]. Similar conclusions are shown by Giacalone et al. from Italy, where during the lockdown period in Italy (March 9 to May 4, 2020) contact eczema was found among 24 patients due to excessive hygiene and hand skin disinfection, which may adversely affect the prevention of transmission virus from human to human. Damaged or broken skin barrier can create an entry route for the coronavirus that causes SARS-CoV-2 [11]. The latest research shows that COVID-19 infection has a huge impact on the exacerbation of primary and secondary skin lesions and the occurrence of dermatological diseases associated with decreased immunity, e.g. herpes simplex. There are several reports on dermatological symptoms related to the first symptoms of COVID-19 infection: vasomotor rashes, urticaria and maculopapular eruptions. There are also dermatoses closely related to the treatment of coronavirus infection, especially generalized pustular rash caused by hydroxychloroquine [12]. Furthermore, some acute conditions tend to become chronic (psoriasis, chronic contact dermatitis). There are patients who, due to the pandemic, have poor control of their chronic dermatological diseases, and these in turn worsen or exacerbate. There are also many dermatoses arising from certain circumstances (e.g. stress, irregular visits, treatment interruptions, delayed therapies) where patients may require a change in medicine dosage or dosing frequency, or even discontinue dosing. It can be concluded that the COVID-19 pandemic negatively affects patients with pre-existing dermatological diseases, especially those receiving immunosuppressive therapies [13]. Basically, the coronavirus pandemic has badly affected skin of Polish people. This is mainly due to the fear of coming to appointments and meeting other people in the waiting room. If patients consult a doctor, it is only in the case of a troublesome disease or very rapid exacerbations of chronic skin diseases. Research conducted in the United States showed that during the Sars-CoV-2 coronavirus pandemic, more than half of dermatologists closed their offices or restricted practices only to patients needing emergency care or cosmetics, and in most of them, elective surgery was postponed [14]. Stress caused by the pandemic and frequent wearing of masks also have a negative impact on skin condi-

tion. Lin et al. conducted a survey at Wuhan hospitals to find out what the impact of protective clothing on skin condition is. Since the outbreak of coronavirus disease (COVID-19), healthcare professionals caring for patients infected with COVID-19 have to use personal protective equipment (PPE), leaving them exposed to adverse skin reactions associated with PPE. However, little is known about the frequency and characteristics of these adverse skin reactions and the risk factors associated with them. In Wuhan and surrounding regions, a cross-sectional survey was carried out on February 6-11, 2020, which included five Wuhan University Hospitals and five Regional Hospitals in and around Wuhan. The survey respondents included doctors and nurses caring for COVID-19 patients. Lin et al. inform about skin diseases associated with the use of prophylactic measures in health care, by workers treating patients infected with coronavirus. According to the authors, wearing protective clothing had a negative effect on the health of skin, causing ulceration and abrasion of the skin layers. The skin lesions involved the nose, forehead, cheeks, hands and breastbone. Facial dermatitis has been reported among health care professionals. This was associated with the length of time wearing a face shield (protective goggles and face masks). Most of the skin injuries to the face were related to wearing goggles, and less was the skin damage that was related to wearing face masks [15]. Frequent hand washing causes aquagenic wrinkling of palms of hands (AWP) which is an uncommon reaction leading to transient, oedematous, whitish papules and plaques. They are formed on palms after short exposure to water. This skin condition has been reported under many different names: transient reactive papulotranslucent acrokeratoderma, syringeal acrokeratoderma, aquagenic keratoderma and aquagenic palmoplantar keratoderma [16]. It is important to further characterize the dermatological symptoms of COVID-19 and determine if the cutaneous manifestations of COVID-19 can help detect the disease early. Until now, the skin manifestations of COVID-19 have been atypical and mostly non-specific. The most frequently reported symptoms preceding or accompanying coronavirus infections include erythematous rashes, urticaria, blisters similar to chickenpox and accompanying itching. Tatu et al. were among the first to describe the case of a family with maculopapular rashes associated with COVID-19 infection. The interview revealed that the rash started in a 34-year-old patient, 17 days after the first symptoms of COVID-19. It was located at the elbow fossa. From there, over the next 24 hours, it spread to the trunk, then to the limbs and face. In a further medical interview, it turned out

that seven other family members had similar symptoms (her husband and two children, the patient's sister, sister-in-law, mother-in-law and grandmother), of which the sister, mother-in-law, sister-in-law, grandmother and daughter had a positive results of immunological tests for SARS-CoV-2. The patient's one-year-old daughter had a fever and chills two days before her mother, and the nonspecific maculopapular erythematous rash appeared 16 days later. The patient's six-year-old son had a mild cough parallel to the patient's symptoms, and the erythema of urticaria appeared 17 days later, at about the same time as in the mother's case. The patient's sister, aged 46, had mild symptoms of infection with a two-day shift from the previously described patients, and 17 days later, she developed an erythema, of about 10 cm in diameter, on the elbow, which did not spread to other parts of the body and disappeared within a few days. It has not been fully established whether SARS-CoV-2 may in fact cause erythematous skin eruptions, but the observations of researchers regarding this family seem to be strong evidence for such a relationship [17]. Similar findings have been described by scientists in other publications. Galvan Casas et al. [18], trying to classify various skin symptoms possibly related to SARS-CoV-2 infection, published a report where out of 375 skin lesions, as many as 47% (176 patients) presented similar maculopapular rashes as those observed in the study conducted by Tatu et al. Increasingly, there are reports of various skin lesions in certain subgroups of patients with positive SARS-CoV-2 test result, accompanying respiratory symptoms. The most common of them, vesicular, urticarial and maculopapular eruptions are described on an ongoing basis and the data is extended and updated. According to the data collected by Novak et al. maculo-papular rash appears together with symptoms of COVID-19 (often in more severe cases with a mortality rate of up to 2%), lasts 7-9 days and occurs in over 50% cases described so far; vesicular eruptions with moderate itching preceding or concurrent with COVID-19 symptoms occur in approximately 15% of the reported cases and last from 10-12 days. Urticaria occurs at the same time as other COVID-19 symptoms, it lasts 6-8 days, and in more severe cases is accompanied by itching. Necrosis and other forms of vasculitis tend to occur in more severe cases, with relatively high mortality, and the onset of lesions coincided with symptoms of COVID-19. In general, the skin lesions associated with SARS-CoV-2 infection may result from direct infection with the coronavirus, transfer of the virus itself from elsewhere, or as a result of a general immune system reaction to the presence of the virus. In the case of putative

infection, skin lesions can serve as important early indicators of disease or an indicator for asymptomatic virus carriers [10]. Erythematous rashes as the main symptom of COVID-19 was a proliferative rash reported in a 20-year-old, previously healthy male from the USA. Extensive maculopapular and non-itching lesions on the trunk and extremities consistent with viral eruptions. The patient showed both positive test results for SARS-CoV-2 polymerase chain reaction (PCR) and bilateral multifocal pneumonia [19, 20]. There was an estimated result of cutaneous involvement, at the level of 0.2%, during the COVID-19 pandemic in China where only two patients of 1,099 with confirmed SARS-CoV-2 infection presented with "skin rash" without further characteristics [21]. Whereas, in Italy the range of reported skin manifestations reached 20.4%, considering that 18 of 88 patients with COVID-19 had it. They suffered from erythematous rash (14 patients), widespread urticarial lesions (three patients), and chickenpox-like vesicles (one patient). These lesions were asymptomatic or slightly pruritic and affected mainly the trunk and appeared at the onset of the infection or within the course of hospitalization. They were usually healing in few days [22]. There were urticaria-like rashes, urticarial eruption on the face and extremities in the case of a 27-year-old French woman which preceded any other symptoms of disease that developed within the time of the following 48 hours and were confirmed by positive SARS-CoV-2 test [23]. In the case of a 64-year-old woman from France suffering from diabetes, an erythematous rash on both elbow pits, extending further to the trunk and armpit folds has developed. The rash resembled Symmetrical drug-related intertriginous and flexural exanthema (SDRIFE) associated with taking paracetamol, however the rash disappeared 5 days after its appearance, regardless if the drug application was continued. The patient tested positive for SARS-CoV-2 in the PCR test and had changes of chest, characteristic for COVID-19 shown in computed tomography [24]. Recent studies report many effective therapeutic options to aid in the treatment of infection caused by the coronavirus. There may be mentioned measures such as favipiravir, brincidofovir, monoclonal antibodies, hydroxychloroquine and oseltamivir. There are concerns that developing COVID-19 increases the risk of a flare-up of the skin lesions both before symptoms appear and after starting treatment. So far, it has been documented that infectious viruses (e.g. zika and dengue) can significantly intensify the course of psoriatic lesions [25]. The case report of a 71-year-old patient with psoriasis indicates a rela-

tionship between the incidence of COVID-19 and exacerbation of skin lesions. The patient was administered orally oseltamivir and additionally hydroxychloroquine. On the fourth day, there was an exacerbation of symptoms: psoriatic patches covered the entire body, sharply demarcated from the healthy surrounding tissue. This is the first case in which psoriatic lesions have flared up during COVID-19 infection in a patient receiving oseltamivir in combination with hydroxychloroquine (while there is no previous scientific report on the effects of oseltamivir on exacerbation of psoriasis). Presumably the main exacerbating factor was high dosage from the first day of treatment. This may be due to the fact that hydroxychloroquine is an inhibitor of transglutaminase, causing the accumulation of epidermal cells, and also promotes the production of IL-17 by releasing IL-23, causing the growth of keratinocytes and their differentiation (which is the essence of the exacerbation of

psoriatic lesions) [26]. The etiopathogenesis of psoriasis may suggest that COVID-19 infection may be another factor that increases the risk of an increase in psoriasis (which currently has an incidence of between 1% and 3%) due to increased concentration of cytokines in plasma related to the inflammation (including interleukins responsible for psoriatic lesions), as well as exacerbation of existing lesions during COVID-19 treatment with hydroxychloroquine [27].

CONCLUSIONS

As the cutaneous manifestations of COVID-19 are atypical and mostly non-specific, data should be collected and analyzed. Apart from dermatoses and other skin reactions accompanying the course of COVID-19 infection, oncological surgeons and dermatologists notice a problem in delayed diagnosis of patients with melanoma and other skin cancers.

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RECURRENT SYNCOPES AS A SYMPTOM OF ELECTRICAL STORM – CASE PRESENTATION

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Abstract

Dangerous ventricular arrhythmias leading to sudden cardiac death (SCD) are some of the most difficult diagnostic challenges. They are often mildly symptomatic. Their often self-limiting nature means that they are difficult to capture on ECG. A 75-year old woman with chronic heart failure due to non-ischemic cardiomyopathy reported to the cardiology clinic for a scheduled routine follow-up of the ICD, implanted three years prior as primary prevention of SCD. The patient reported recent episodes of sudden weakness and described the episodes as hypotension. The patient associated it with too aggressive treatment of arterial hypertension. During the visit the patient experienced one of these episodes that she had previously described. The monitoring equipment in the clinic revealed ventricular tachycardia (VT). The history of the implanted ICD revealed many similar previous episodes including 5 episodes in the last 24 hours which led to a diagnosis of electrical storm. Dangerous ventricular arrhythmias may be mildly symptomatic and they are often underestimated by the patient. Fainting, especially in situations unusual for the vasovagal reflex or orthostatic hypotension, should always arouse vigilance towards life-threatening ventricular arrhythmia.

Key words

ventricular tachycardia,
electrical storm,
syncope

INTRODUCTION

Dangerous ventricular arrhythmias leading to sudden cardiac death (SCD) are some of the most difficult diagnostic challenges. Their often self-limiting nature means that they are difficult to capture on ECG during scheduled visits either in primary care or during specialist consultations. Symptoms such as palpitations and syncope should cause to search for dangerous arrhythmias, however patients often report non-characteristic symptoms which do not raise the suspicion of ventricular arrhythmias, especially when the patient is not assigned to an SCD risk group, such as patients with ischemic heart disease (IHD) and with chronic heart failure or patients with family history of SCD.

THE AIM

In the presented case well documented patient's medical history and access to registered episodes of arrhythmia were found in the memory of the implantable cardioverter-defibrillator (ICD) and were of a significant help.

CASE PRESENTATION

A 75-year-old woman with hypertension, paroxysmal atrial fibrillation and chronic heart failure due to nonischemic cardiomyopathy reported to the cardiology clinic for a scheduled routine follow-up

of the ICD, implanted three years prior as primary prevention of SCD. The patient reported recent episodes of sudden weakness forcing her to sit or lay down which eventually resolved spontaneously. The patient described the episodes as hypotension, especially the diastolic component measured during these incidents. The patient denied angina pain and dyspnea, nor did she feel palpitations. The family history was negative for SCD and cardiovascular disease.

During the visit the patient experienced one of these episodes that she had previously described. The monitoring equipment in the clinic revealed ventricular tachycardia (VT) 180/min which was successfully interrupted with antitachycardia pacing (ATP) therapy. The history of the implanted ICD revealed many similar previous episodes including 5 episodes in the last 24 hours which led to a diagnosis of electrical storm (Fig. 1, 2).

The ECG recording only showed a few Premature Ventricular Contractions (PVCs) without traits of cardiac ischemia whereas on the monitor and in Holter ECG many episodes of self-termination VT as well as VT interrupted by ATP were revealed (Fig. 3).

DISCUSSION

Typical symptoms reported by patients with VTs are palpitations, dyspnea, sudden weakness or syncope. In patients with ischemic heart disease these may



Fig 1. Recording of ICD intracardiac electrocardiogram.

VS – sensed QRS complex

TS – sensed ventricular tachycardia

FS – sensed ventricular fibrillation or ventricular tachycardia with rapid ventricular activity classified as ventricular fibrillation by ICD

The device successfully revealed ventricular tachycardia.



Fig. 2. Recording of ICD intracardiac electrocardiogram.

TP – antitachycardia pacing (ATP)

Effective ATP – stimulation with cycle shorter than tachycardia (overdrive)

be accompanied by angina pain [1]. The described patient reported only episodes of sudden weakness which she correlated with too-intensive treatment of hypertension. Many cardiology clinic's patients present similar symptoms during control visits but only a small percentage have implanted devices that register episodes of cardiac arrhythmias. The medical history is often not as suggestive as in the presented example. A positive family history of SCD, being an important risk factor of dangerous arrhythmias, is often difficult to assess [2, 3]. In this particular case the patient was known to be in a high risk group for SCD which made

the diagnosis easier. It should be highlighted once again that the incident was captured during a scheduled visit. The non-urgent reason for her visit indicates that the symptoms of VT experienced by the patient were not disturbing enough for her to seek emergency care and could have led to a significantly delayed diagnosis of VT and electrical storm, a life threatening condition. Atypical symptoms such as sudden weakness, especially correlated with physical exertion or occurring with the patient in a sitting or supine position should raise attention and stimulate a search for potentially life threatening cardiac arrhythmias.

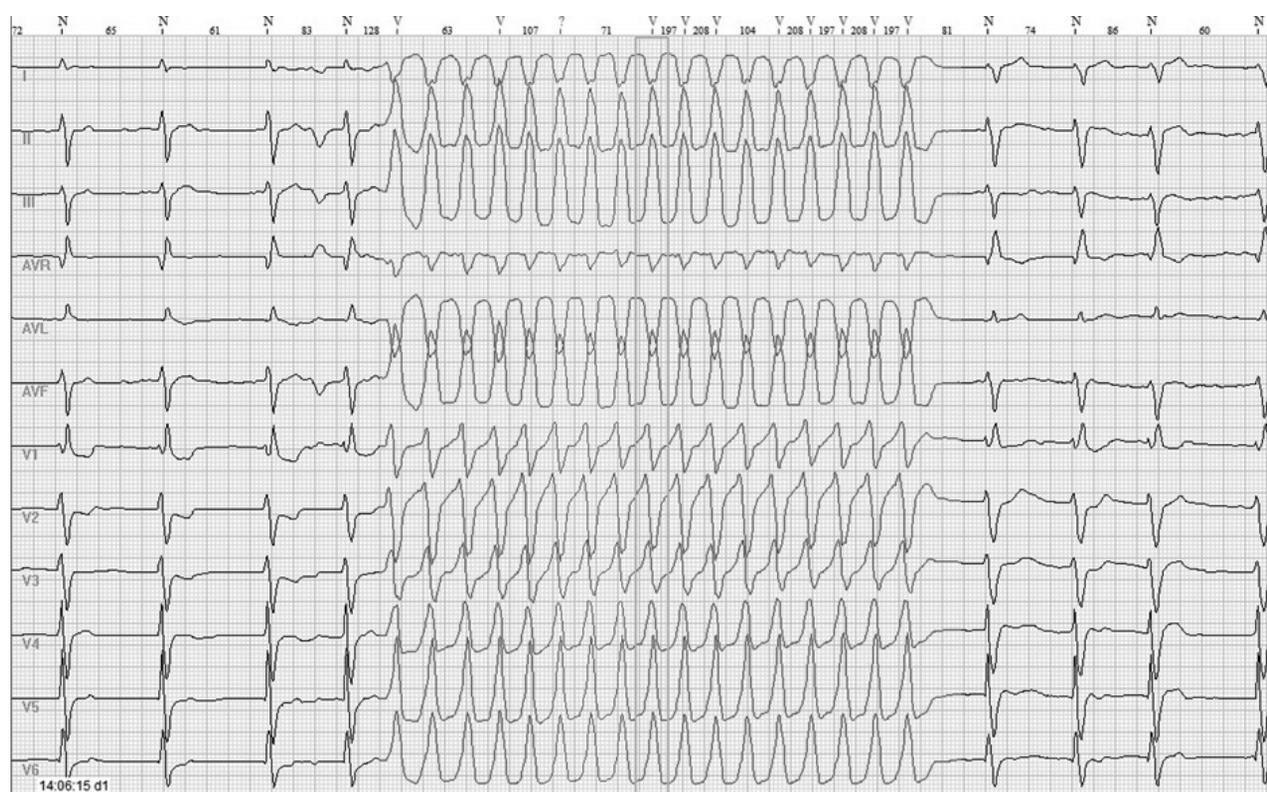


Fig 3. Self-terminating VT. Holter EKG recording.

CONCLUSIONS

Dangerous ventricular arrhythmias may be mildly symptomatic, which is why they are often underestimated by the patient.

Fainting, especially in situations unusual for the vasovagal reflex or orthostatic hypotension, should always arouse vigilance towards life-threatening ventricular arrhythmia. Especially in patients at high risk of SCD.

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LIFE-SAVING PROCEDURES AND CARDIOPULMONARY RESUSCITATION FROM THE ANCIENT HISTORY TO THE PRESENT DAY

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HISTORICAL VIEW

Undoubtedly the primitive man was exposed to the dangers of everyday life. The threats could be found in the surrounding nature, while hunting wild animals or fighting with the enemies. One of such unfortunate events is pictured in a late Palaeolithic rock painting from the Lascaux Cave in France [1].

The first ways of helping in diseases and injuries resulted from the observation of the surrounding nature, animal behaviour, experience passed down from generation to generation and trial and error method. All of this factors were very important to develop successful methods of aid. At the next stage of development the incomprehensible phenomena of the surrounding world was explained by the magic and sorcery. The amulets, spells and the mediators between man and supernatural powers like shamans or sorcerers began to appear. Along with the religion growth man has addicted himself from the magic. Whereas due to the experience gaining and preserving it in the written form by the priests it was around the temples where the healing and providing help to those in need took place [2].

The first tangible evidence for first-aid in health or life threatening situations was found thanks to archaeological studies. Already in the Mesolithic times, 10-12 thousand years ago, the skull trepanations have been performed, often with positive results [3]. Based on the discovered and examined skulls, it was calculated that the death rate of people undergoing such surgery in the Neolithic period was about 10%, while in the Bronze Age it increased to 30% [4]. Skulls with drilled trepanation holes have also been found in Poland, the oldest of which date

back to the Mesolithic period [5]. The first description of a successful skull trepanation performed in Poland comes from the Polish Chronicle of Gallus Anonymous. It concerns the effective skull trepanation on a badly injured king's butler Wojśław. This procedure was performed by the medic of King Bolesław Krzywousty: *...the king's butler Wojśław a man of great courage was so heavily wounded in his head that he was only saved by a medical procedure performed with a great skill involving a removal of the bone [6].*

Probably the first and the oldest life-saving record can be found in the Egyptian mythology, where, due to his wife, the goddess Isis, life is partially brought back to the Osiris (Fig. 1). During this act Horus opened the eyes and mouth of the deceased and the life-giving breath was brought back thanks to the mother of the goddess Nut [7-8].

Another records about revivals can be found in the First Book of Kings of the Old Testament where the prophet Elijah rescued the son of the widow in Zarephath in the region of Sidon. *He grew worse and worse, and finally stopped breathing... Elijah ... stretched himself upon the child three times... the life of the child came into him again, and he revived. [9].*

In a similar way Elijah again rescued a child of Sunemit, which complained on headaches and after that it seemingly died. The Prophet lay upon the child, putting his mouth upon his mouth, his eyes upon his eyes, and his hands upon his hands; and while he lay bent over him, the flesh of the child became warm... the child sneezed seven times, and the child opened his eyes. Over the centuries the artificial respiration method was called the Elijah's method [10].

Most of the ancient records about life-saving refer to drowning persons. Basic treatments in such cases was centred around attempts to remove water from the respiratory tract. In Egypt the drown man was hang by his heels and his chest was compressed and stretched in a repetitive manner, while in Japan, as well as China, the casualty was hung over the back of an ox, the movement of which supposed to remove water from the respiratory tract. Another mention about method to restore breathing in a cold exposed, pulled out from under the ice or drowned man, is laying hot charcoal on his stomach [11].

In the texts of ancient Greece, we find information on the provision of medical aid very early. In the Iliad of Homer, dating from the 8th-7th century BC, the method of removing the arrow from the body, dressing the wound and relieving pain is described several times. It was to be done, for example, by Patroclus, who was not a physician, in the absence of the physician Asclepius and his sons, Machaon and Podaleirios [12]. Similar scenes can be found on vase painting, with the most famous painted by Sosias from around 500 BC depicting Achilles tending the wounded Patroklos (Fig. 2) [13] Asclepius himself, in Greek mythology, was considered the god of medical art, and his counterpart in ancient Rome was Aesculapius [2, 14].

Similar mentions in which the medical assistance is described in emergency situations, are found in the writings of prominent ancient medics, among others Hippocrates and Pliny [11].

The aforementioned Hippocrates of Kos, who lived at the turn of the 5th and 4th centuries BCE. he was a doctor and at the same time the founder of the medical school, and is also considered the “father of medicine”.

Around 440 BC – 350 BC he written Corpus Hippocraticum, a collection of medical texts. He is also the author of the guiding principle in health care to this day “*primum non nocere*” – first, do not harm [2, 14].

Hippocrates is also credited with performing the first tracheotomy, an opening in the trachea which task is to save life by allowing to breathe [15]. However, a bas-relief from ancient Egypt dating back to 3100 BC. shows the performance of such an operation [16]. On the other hand, the first reported incision of the trachea by Asclepiades of Bithynia dates from the 1st century BCE, which recommended that it be performed especially in children suffering from diphtheria, as a rescue from suffocation [14]. The tracheotomy procedure was later described many times, among others, by Galen of Pergamum, who lived in the years 129 – 199 AD, the most outstanding physician of antiquity after Hippocrates, and by Avicenna (980-1037), the most widely read doctor of Arab and European countries, called the prince of doctors [14].

Middle Age European medicine was strongly influenced by the teachings of the Church. Belief in the existence of diseases caused by Satan was intertwined with theological and medical disputes about the role of God’s will in the disease process. The medieval period is also the era of plague, cholera and leprosy epidemics. It is during this period that we can find the beginning of prophylaxis, isolation and quarantine orders. Byzantine medicine, which remained continuous from antiquity, through the Middle Ages to the Renaissance, went in a different direction. At that time, the development of medicine was experienced by Arab and Jewish doctors, who often offered their services at European courts [2, 14].

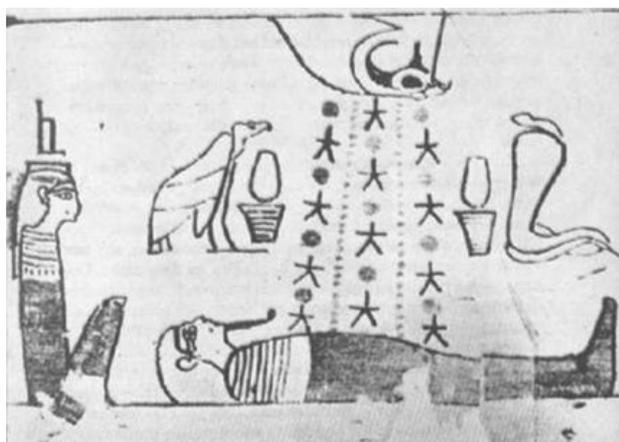


Fig. 1. The revival of Osiris. The Pa-di-Amun mythological papyrus. XXI Dynasty. Cairo, Egyptian Museum [7].



Fig. 2. Achilles bandages the arm of Patroclus. Scene from the goblet by Sosias, c. 500 B.C. [13].



Silvester's method. Inspiratory phase.



Silvester's method. Expiratory phase.

Fig. 3. Henry Silvester Method [24].



Fig. 4. James Otis Elam [26].



Fig. 5. Peter Safar [33].

In the Renaissance era, there was a significant development of anatomical research, which led to many important discoveries about the structure and functioning of the human body. The most significant was the 16th century, led by the outstanding anatomist Andreas Vesalius (1514-1564). The rise of anatomy during the Renaissance transferred to the development of medicine and lifesaving methods [2, 14].

Throughout the centuries, efforts to save lives have focused on breathing and on how to sustain it. Recognizing that it is breathing that is responsible for all human life processes. Over the centuries, methods of artificial respiration have been invented and perfected, so that it finally takes the form currently used.

From the beginning of the 16th century, for almost three centuries, the methods of blowing warm air and smoke into the mouths of victims were widely used [15]. Until 1812, the British Royal Fleet used a revival method adopted from the North American Indians, involving blowing in tobacco smoke [17]. In 1555, the aforementioned Vesalius used a reed placed in the dog's trachea to keep it alive while examining its anatomy [18]. In 1732, surgeon William Tossach

rescued a miner by conducting the first documented mouth-to-mouth respiration [19].

Even before 1774, the doctor Alexander Monro Secundus recommended that for blowing air into the lungs, a bellows connected with a special tube inserted blindly into one of the nostrils should be used. If ventilation was insufficient, a curved tube should be used, also blindly inserted into the trachea or glottis. In 1776, William Cullen was the first to describe endotracheal intubation as a method of lung ventilation [20].

Thanks to Tossach, the mouth-to-mouth method initially gained a number of followers, but as early as 1782, the British organization helping drowned people of the Royal Humane Society in London significantly changed its preferences and recommended ventilation using special pumping bellows [20].

The common interest in the knowledge of effective first aid has reached the Polish territory. In 1775, by the order of Prince Adam Czartoryski, a textbook was published, used for example in the Knight's School, titled *On saving drowning people* [10]. In 1782, the court physician of King Stanisław August, Franciszek Kurcysz, published a book *Description*

of Diseases of Rapid Rescue in those in need, which stated that after a quarter of an hour of being under water there was virtually no chance of saving the injured, and recommended that drowned people should have air breathed into their respiratory tract [21].

The exhaled air of the rescuer was often perceived as devitalized as it had already passed through another person's lungs. Additionally, there were reports of lung injuries in rescued people. For these reasons, other methods of artificial respiration have been explored and tested. Thus, in 1857, Marshall Hall published a method that was supposed to ventilate the casualties. The following year, Henry Robert Silvester developed a method (Fig. 3) of alternately lifting the arms and pressing the chest with the patient's arms folded on it [22-24].

In addition the following methods were developed: Schafer (from 1903), Holger Nielson (from 1932). The Holger Nielson method was practiced until the 1960s. However, as early as 1972, the Australian First Aid textbook recommended artificial respiration using the Silvester's method [25].

It was only in 1954 that James Elam (Fig. 4) was the first to prove that the air exhaled by the rescuer is sufficiently oxygenated to ensure an adequate level of ventilation for the victim [27]. Then Peter Safar (Fig. 5) in the years 1956-1957, based on experiments with volunteers in which Elam also participated, undermined the effectiveness of artificial respiration by means of compressing the chest and lifting the arms, [27-28] additionally demonstrated the effectiveness of ventilation with exhaled air [29-30] and how to prevent airway obstruction by tilting the head back [30-31]. As early as 1960, the methods of resuscitation developed by Safar and Elam were adopted and recommended by the National Academy of Science, the American Society of Anesthesiologists, the Medical Society of the New York, and the American Red Cross [32]. Thus, emergency medicine has gained a new, modern dimension, and Safar and Elam have become the "founding fathers" of modern emergency medicine.

Although the heartbeat and the pulse rate have been described and related to each other around 3,000 BC [34], the first fundamental observations on the cardiovascular system come from the Renaissance era.

In 1542, French physician, astronomer and mathematician Jean Fernel observed contraction of the heart chambers and subsequent expansion of the arteries. In turn, the London physician William Harvey (1578-1657) formulated and described in 1628 the theory of blood circulation [35].

Moritz Schiff in 1874 gave birth to the term "heart massage" by the observation that when a dog's heart

was squeezed manually, there was a pulsation in the carotid arteries. Thus, Schiff became a pioneer in direct cardiac massage, using which he tried to treat cardiac arrest due to the use of chloroform from at least 1874 [36].

Then, in 1898, Theodore Tuffier and Louis Hallion were the first to successfully perform CPR by direct cardiac massage [37]. On January 19, 1900, in the Polish territories, in Lviv, Jan Prus restored regular contraction of the atria of the heart by means of a 15-minute direct heart massage and ventilation through a tracheotomy tube in a man who had committed suicide by hanging 2 hours earlier [38-39]. His method was based on the assumptions that:

...one may be tempted to raise the deceased by means of artificial restoration of those conditions from which the life of higher-organized systems was primarily imposed, i.e. with the help of stimulating: 1) artificial respiration and 2) artificial blood circulation, of course, if we start the activity of resurrection in this period of death, in which the tissues have not yet completely lost their excitability.

...To fulfill the first condition, it is not enough, in my opinion, to use the Silvester method, ... to do a tracheotomy and connect the inside of the trachea with a suitable bellows through a table-shaped tube, through which a sufficient amount of air can be blown into the lungs steadily.

As for the second condition, ... this goal can most probably be achieved by regular (rhythmic) pressure on the exposed heart with fingers – this way we can effectively imitate the contraction and relaxation of the heart...[40].

Jan Prus and his achievements are widely known all over the world, but in Poland as a pioneer of resuscitation he remains underestimated and forgotten.

Rudolf Boehm, who already in 1976 carried out and documented attempts to restore circulation using this method, is considered to be the discoverer of external heart massage. In 1892, Friedrich Maass performed the first successful external massage of the chest, which actually did not arouse much interest in the medical community of that time [41-42].

It was not until 60 years later that Guy Knickerbocker, studying the effects of defibrillation in dogs, noticed that when he pressed the electrodes firmly to the chest, he caused a simultaneous increase in blood pressure. Then, by experimenting with the force of pressure, the location and the speed of compression in 1958, William Kouwenhoven, James Jude and Guy Knickerbocker (Fig. 6) in a way rediscovered external heart massage [41, 43-44].

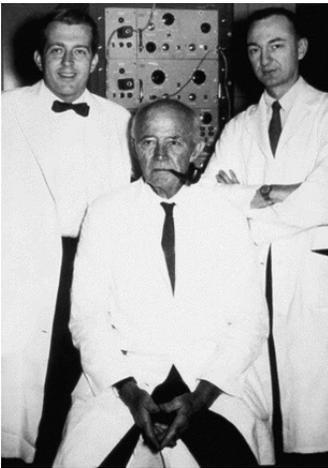


Fig. 6. William Kouwenhoven, Guy Knickerbocker and James Jude [44].



Fig. 7. The face of „Resusci Anne” [54].

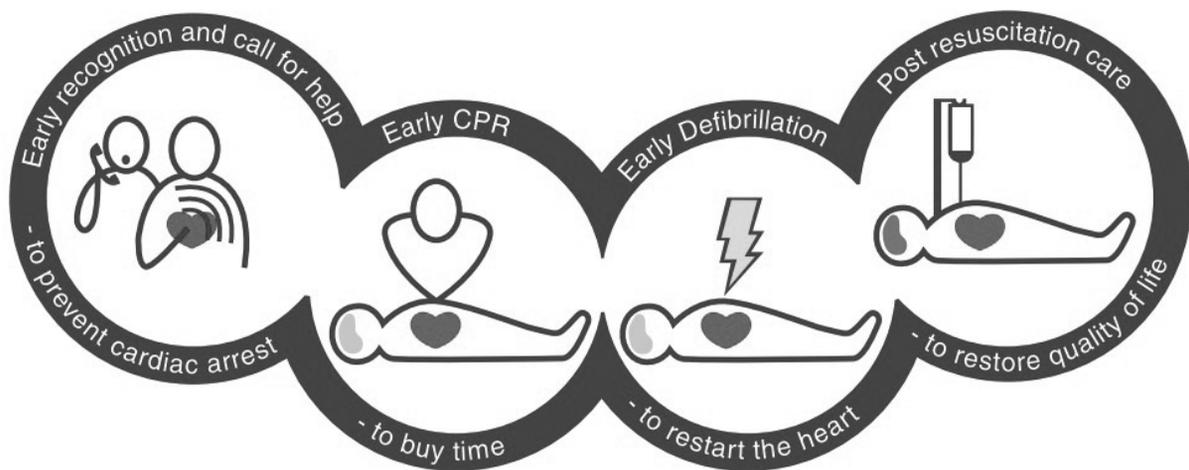


Fig. 8. The Chain of survival [59].

In 1887, the Englishman August Waller was the first to record the electrical activity of the heart [45-46]. However, it is the Dutch physician Willem Einthoven who is considered to be the discoverer of electrocardiography. It was he who developed the limb lead system, the so-called Einthoven's triangle, and its theoretical assumptions are the basis for the use of the electrocardiogram until today [46-47]. In 1924, Willem Einthoven was awarded the Nobel Prize for his discovery.

As soon as the electricity was discovered, there were ideas how to use this phenomenon in medicine. As early as 1792, British scientist James Curry recommended the use of electricity to stimulate the heart to return to its regular functioning. In 1802 the Royal Humane Society in England suggested in its report the use of electricity to distinguish real from apparent death [48]. Then, in 1849, Carl Ludwig and his student Moritz Hoffa observed and documented ventricular fibrillation, initiated by an electric current [49]. And John McWilliam was the first

to conclude in 1889 that ventricular fibrillation is a mechanism responsible for sudden human death. In 1899, two doctors, Jean-Louis Prevost and Frederic Battelli, showed that even a small amount of electricity supplied through the chest can cause ventricular fibrillation, and in a footnote they included the key information that higher electrical energy could successfully restore sinus rhythm. This information, however, didn't attract too much attention [48].

In the Polish lands, in 1805, Jerzy Śniadecki published a work in Vilnius entitled *On the cases of apparent death and ways of bringing back such dead people to life*. He presented a compendium of knowledge on how to deal with sudden life-threatening conditions, describing how to perform mouth-to-mouth ventilation, when and how to perform a tracheotomy, and recommended ... *to pass an electric spark through the chest, so that a strike through the lungs and heart itself would hit and thus stimulate them to the contraction...* [50].

The following years provided a lot of new information thanks to experiments using electricity test-

ed on animals. In 1947 all these experiments were completed with the first successful external defibrillation performed by cardiac surgeon Claude Beck. A 14-year-old patient during a surgery of sternal deformation suffered cardiac arrest in the ventricular fibrillation mechanism. After dozens minutes of direct resuscitation without effect the surgeon used a defibrillator built in collaboration with James Rand, which used AC directly from the socket. Just after the second shock the sinus rhythm returned, and the boy eventually survived without any deficits. This incident led to the immediate worldwide acceptance of defibrillation as an effective treatment method. In 1956, Paul Zoll performed a successful external direct current defibrillation. Soon after, in 1960, in Paris, Fred Zacouto used an external automatic defibrillator for the first time. The device was able to detect ventricular fibrillation on the basis of ECG and provide transdermal stimulation until the spontaneous recovery of cardiac activity [41, 48].

In 1959, Bernard Lown combined defibrillation with cardioversion on a patient with recurrent ventricular tachycardia. Lown was the first to use transthoracic electrical discharge using a defibrillator. This fact is considered the beginning of the functioning of cardioversion. Lown is also credited with formulating the concept of cardioversion as a synchronized discharge during arrhythmia other than ventricular fibrillation [48].

The first defibrillation devices weighed several dozen kilograms and, due to their size and weight, were reserved for hospital rooms. It was not until Frank Pantridge, along with John Anderson, a biomedical engineer, developed a portable 3.2 kg defibrillator, which became generally available in 1971. Then Anderson and Jennifer Adgey at the turn of the 70s and 80s constructed a semi-automatic and automatic portable external defibrillator [48].

Due to the further development of common knowledge and skills to provide assistance in a life-threatening situation, the portable defibrillator gradually moved from the exclusive use of doctors, then paramedics, to firefighters, and finally into the hands of the public as a program of public access to defibrillation. The benefits of such a solution are obvious and undeniable [48].

James Elam, Peter Safar and William Kouwenhoven are undoubtedly the fathers of modern resuscitation. The first two are credited for artificial respiration, the last one for chest compressions, and if we add defibrillation to it, we have a full picture of modern resuscitation. Their joint research results were first presented at the Maryland Medical Society

meeting on September 16, 1960 in Ocean City, and over the course of a decade they have gained widespread acceptance by the medical community [51].

Peter Safar was also involved in the public education on first aid, developing standards, textbooks and courses teaching first aid and cardiopulmonary resuscitation [52-53].

In order to facilitate the education and popularization of knowledge as well as skills in the field of resuscitation, the Norwegian toy manufacturer Åsmund Laerdal in collaboration with Bjørnen Lind in 1960 created the manikin “Resusci Anne”. The prototype for the mannequin’s face was the posthumous mask of a young woman who drowned in the Seine (Fig. 7). Thus, learning and providing correct and effective CPR in the event of sudden cardiac arrest entered the stage of providing help by witnesses of the incident who did not have professional medical training [54].

The American Heart Association became the first organization to widely and publicly promote the emerging methods of resuscitation. Simple rules based on the acronym ABC, where A – airway, is the opening of the upper respiratory tract, B – breathing, and C is circulation, covered the whole world [51].

In 1966, the American National Academy of Science organized the first conference on cardiopulmonary resuscitation, the main goal of which was to create standards for resuscitation procedures and training principles. However, since 2000, the International Liaison Committee on Resuscitation (ILCOR) has been updating the guidelines, principles and methods of resuscitation, which publishes updates of resuscitation guidelines based on the latest research and scientific reports every 5 years. In Poland, a similar purpose has been served by the Polish Resuscitation Council since its inception in 2001 [15].

The concepts concerning the principles of effective medical assistance have also become irreplaceable and widely known today. In 1961, Adams Cowley, a military surgeon and pioneer in trauma treatment, introduced the term “golden hour” [55]. He showed that the best chances for effective treatment of people in a life-threatening condition exist only when the patient receives specialist medical assistance within an hour from the moment the emergency occurs. The theory of the “golden hour” is valid to this day, and at the same time it is an indicator of the effectiveness of providing medical aid and the performance of emergency medical systems.

The development of the concept of the “emergency chain” by the professor of anaesthesiology Friedrich Wilhelm Ahnefeld in 1970 was another mile-

Table 1. Milestones. Emergency lifesaving procedures and cardiopulmonary resuscitation.

Date	Milestones
8000-10000 BC	The first cases of trepanations
3100 BC	The first tracheostomy attempted on the basis of depiction on tablets from ancient Egypt
3000 BC	Linking heartbeat and pulse based on description in the Smith Papyrus
9th century BC	The time of the prophet Elijah (Elijah from Tishbe), who according to The Old Testament, resurrected a child of the widow in Zarephath as well as a son of the woman from Shunem by performing artificial respiration
The turn of the 5 th and 4 th century BC	The time of the Hippocrates of Cos, to whom is credited the first tracheotomy procedure
1113–1116	Gallus Anonymus puts in the Polish Chronicle the first description of a successful trepanation performed on the Polish lands
1628	William Harvey publishes his explanation of the circulatory system
1732	William Tossach resuscitates a coal miner by mouth-to-mouth method which becomes the first clinical description of the procedure in the medical literature
before 1774	Alexander Monro Secundus recommends using bellows connected to a tube that is inserted into one of the nostrils for mechanical ventilation of the lungs
1776	William Cullen is first to describe the instructions for tracheal intubation
1782	Royal Humane Society in London endorses artificial ventilation using inflating bellows for drowning victims
1792	James Curry recommends using electrical energy in order to stimulate the heart to beat
1849	Carl Ludwig and Moritz Hoffa observe and document ventricle fibrillation
1857	Marshall Hall publishes the artificial breathing method
1858	Henry Robert Silvester elaborates his own method of the artificial breathing
1874	Moritz Schiff notes the presence of the carotid arteries pulsations after manually compressing a heart of a dog. This led to the term „cardiac massage“.
1887	August Waller records the first electrocardiogram
1895	Willem Einthoven labels various deflections of the electrocardiogram with the letters P, Q, R, S and T
1898	Theodore Tuffer and Louis Hallion for the first time successfully resuscitate a patient using open chest cardiac massage
1900	Jan Prus restores a regular atrial contractions using the open heart massage method combined with a ventilation through a tracheostomy tube
1932	Holger Nielsen develops a set of rules for cardiopulmonary resuscitation
1947	Claude Beck performs the first successful external defibrillation
1954	James Elam is the first to prove that expired by a rescuer air is sufficiently oxygenated for the ventilation of a rescuee
1956	Paul Zoll performs the first successful external defibrillation using direct current
1956-1957	Peter Safar proves the effectiveness of the mouth-to-mouth ventilation with the head tilt to prevent the airways obstruction
1958	William Kouwenhoven, James Jude and Guy Knickerbocker proves effectiveness of the external heart massage
1959	Bernard Lown performs cardioversion on a patient with recurrent ventricular tachycardia
1960	Åsmund Laerdal and Bjørn Lindem develop a training manikin „Resusci Anne“ for CPR teaching
1960	Resuscitation methods elaborated by Safar and Elam are recommended by National Academy of Science, American Society of Anesthesiologists, Medical Society of the New York and American Red Cross
1960	Fred Zacouto uses the first external automatic defibrillator
1961	Adams Cowley introduces the term „golden hour“
1966	American National Academy of Science arranges the first conference in order to establish the guidelines on how to perform and teach the CPR methods
1970	Friedrich Wilhelm Ahnefeld develops the concept of the „rescue chain“
The turn of the 1970s and 1980s	John Anderson and Jennifer Adgey construct a portable, external, semi-automatic and automatic defibrillator
1971	The defibrillator weighed 3,2 kg, invented by Frank Pantridge and John Anderson, is brought into common use
from 2000	International Liaison Committee on Resuscitation (ILCOR) starts to handle updating the guidelines, rules and methods of the CPR
from 2001	Polish Resuscitation Council (Polska Rada Resuscytacji) starts to handle updating guidelines, rules and methods of the CPR in Poland

stone. Its assumptions based on hard scientific data describe the key elements, or chain links, in effective assistance to the injured, from early diagnosis and notification of emergency services, through first aid, to hospital treatment [56-57]. Currently, the most effective medical rescue systems in the world are based on the concept of the “rescue chain” (Fig. 8) [58].

SUMMARY

Life and health are the most precious values that each of us can have. It is not surprising then that since the dawn of time people have cared for them and tried to develop effective techniques of life-saving procedures (Table 1). Initially, basing them on magic, beliefs and science adequate to the times, level of social and cultural development, they developed methods of providing medical assistance. From today’s perspective, often those assumptions of saving life and

health may seem at least irrational, but we must remember that without this knowledge, we would not be where we are today.

It was not until the Renaissance that there was a major turning point. The study of the human body and many experiments conducted have shifted medicine onto a new course. However, the discoveries of the 20th century allowed to form the modern life-saving procedures. James Elam, Peter Safar and William Kouwenhoven defined the assumptions of modern cardiopulmonary resuscitation, and in addition, the concepts of the “golden hour” and “chain of survival” have determined the effectiveness of providing medical assistance and the operation of emergency medical systems.

*My son, seek knowledge
from past generations, inquire about it! [60]*

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CONFLICT OF INTEREST

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